Textbook of
THERAPEUTIC EXERCISES

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JAYPEE BROTHERS
MEDICAL PUBLISHERS (P) LTD
New Delhi

Published by

Jitendar P Vij
Jaypee Brothers Medical Publishers (P) Ltd
EMCA House, 23/23B Ansari Road, Daryaganj
New Delhi 110 002, India
Phones: +91-11-23272143, +91-11-23272703, +91-11-23282021, +91-11-23245672
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Textbook of Therapeutic Exercises

First Edition : **2005**

ISBN 81-8061-469-7

Typeset at JPBMP typesetting unit
Printed at Gopsons Papers Ltd. A-14 Sector 60, Noida

All to
Lord Krishna

Acknowledgements

I, first of all, express my gratitude and thank the people those worked hard with me to complete this project successfully in time. I don't have the words to express my thanks to Dr KP Neeraja, Principal, Navodaya College of Nursing, Raichur who initiated and motivated me to start this project and encouraged to complete this project in time successfully.

And I express my special thanks to my friends who spent their lots of time and guided me while editing this book. Dr Radhakrishnan MPT student, Navodaya College of Physiotherapy, Raichur with whom I spent 10 years of lifespan from my college days, guided and helped me a lot to the completion of the project. And I also extend my thanks to management, colleague, students and well-wishers of Navodaya College of Physiotherapy, Mahaboobnagar, Andhra Pradesh who encouraged, helped and guided to create one venture in my life. And also I thank the Publisher, Jaypee Brothers Medical Publishers (P) Ltd. and staff of Bangalore branch.

Thanks one and all, I need your help too to continue my achievement.

Preface

Many of them told me that writing a book is not an easy thing, at last I came to know it is true. This project I bring to you is purely helpful for the beginners of exercise therapy. The books available on therapeutic exercises are above the level of the undergraduates and highly advanced one. This made me to select my project of exercise therapy. I believe that this book gives the basic knowledge in the field of exercise therapy. This book is the first venture and the future editions will be updated to the need and demand of the profession. I request the readers to comment, guide and express opinions on this book, which will be helpful for me to make perfect and qualitative in the next edition. Kindly send your comments to sailakiyan@yahoo.com.

S Lakshmi Narayanan

Contents

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CHAPTER

Mechanics

FORCE

Force is that which produces the motion or modifies the motion of an object and moves it for a particular distance it is the alteration in the state of resting object or the motion created in the object to create the force one object has to act on another, it may be pull or push. Force has the vector quantity, i.e. magnitude and direction.

The force may act on two varieties of objects:

1. Static
2. Dynamic.

The force acts on the stable or the body, which is in equilibrium, the body may be in rest or in contact motion. The force may be acting on the object, which in motion and it may be changing the state of motion.

Force = Mass × Acceleration,

where, force is measured in newton, mass in kilogram, acceleration in meter (m/s^2).

Force is applied on the object particular weight to move it for particular distance. One newton is defined as the force applied on the 1 kg weight object and moves it for 1 meter distance.

1. The magnitude is represented by the length of the arrow.
2. The distance is represented by the direction of the arrow.

The force can be defined by the effect what it produces.

Linear Force

If the two forces are acting along the same line and produces the straight-line motion is referred on the linear force.

Example:

a. When two forces are acting on an object in same direction produces the linear motion, the forces are said to be the pushing linear force (Fig. 1.1A).
b. When the two forces pull an object in same direction it produces the linear motion, the force is said to be the pulling linear force (Fig. 1.1B).
c. When the two forces are acting opposite to each other with the equal magnitude it results in equilibrium (Fig. 1.1C).
d. When the two forces are acting opposite to each other with unequal magnitude the movement occurs towards the greater magnitude side.

Parallel Force

The two equal magnitudes are acting in the

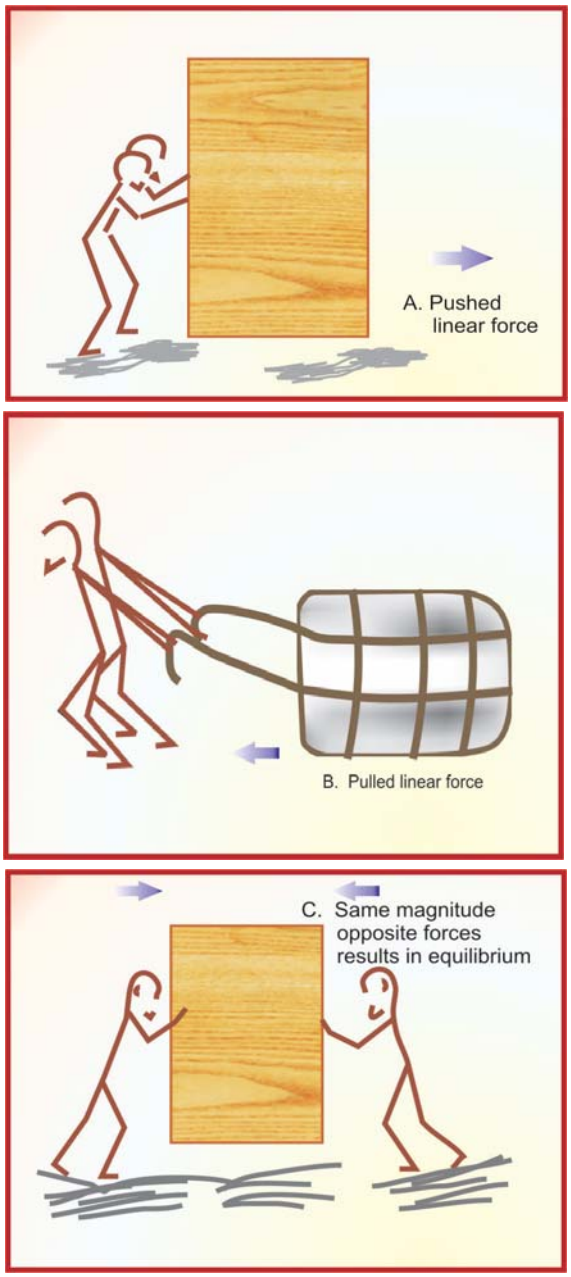


Fig. 1.1: Linear force

same direction and same plane with the counter force in the middle (Fig 1.2).

Example: See-saw

The children are applying the two forces in the end and the fulcrum gives the counter force to maintain the see-saw in neutral position.

Rotational Force

In the parallel forces any one of the forces is greater than other results the rotation that force is said to be the rotational force.

or

If the two different magnitude forces act on the different points of an object result in the rotation movement, i.e. twisting effect; the forces are said to be force couple (Fig. 1.3).

Concurrent Force

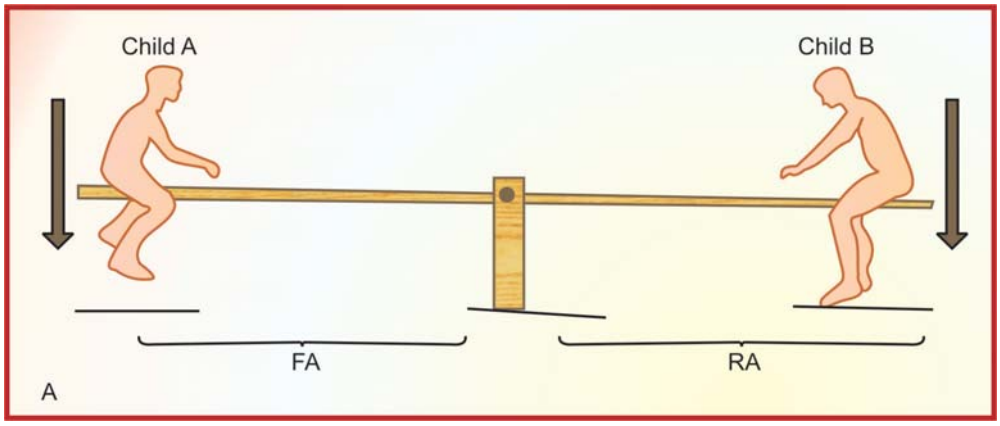
If the two forces are acting on the object in different directions is perpendicular to each other. The resultant force will be in between the two forces. It can be diagrammatically represented by the parallelogram method (Fig. 1.4).

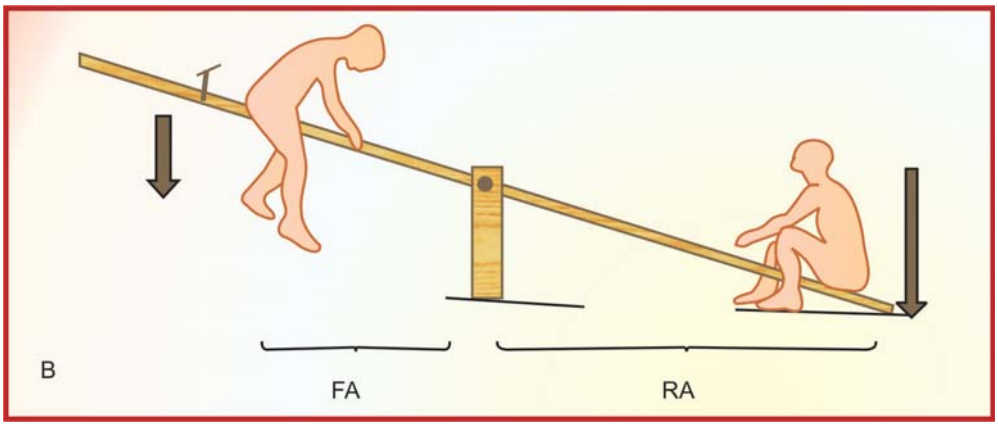
CENTER OF GRAVITY (COG)

The center of gravity is a imaginary point at which the mass of the object is concentrated. The symmetrical objects will have the COG at the center of the object. It may depend on the size, shape, structure, weight, and portion of the particular object. In asymmetric object the COG is located in the heavier end where the mass is concentrated. In a rod the COG is located near to the upper end, if it is vertically placed and the same will be near to the ground if it is horizontally placed due to its height, weight difference, and the weight transmitted area (Fig. 1.5).

LINE OF GRAVITY (LOG)

The imaginary vertical line passes through the center of gravity is called as line of gravity. Normally, the center of gravity (COG) lies in the second sacral vertebra in the human body





Figs 1.2A and B: A. Parallel forces with same magnitude, B. Parallel forces with different magnitude

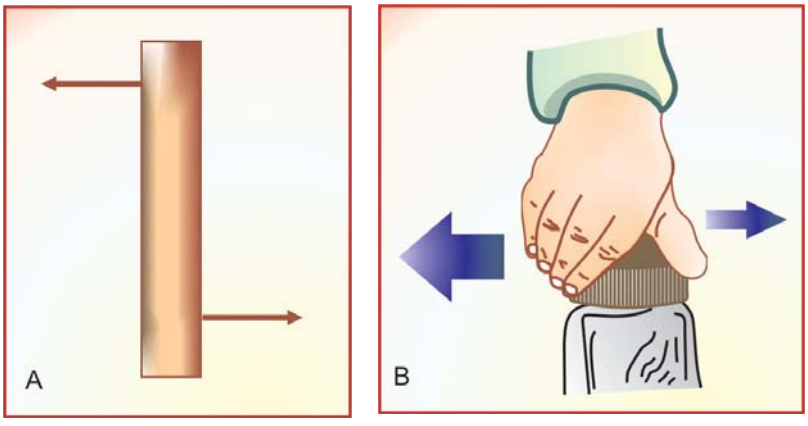


Fig. 1.3: Rotational forces (Force couple)

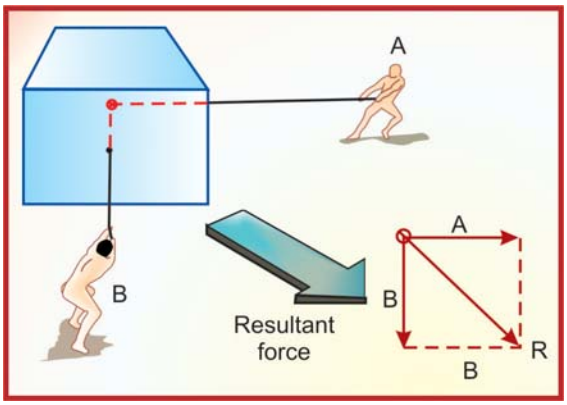


Fig. 1.4: Concurrent force system

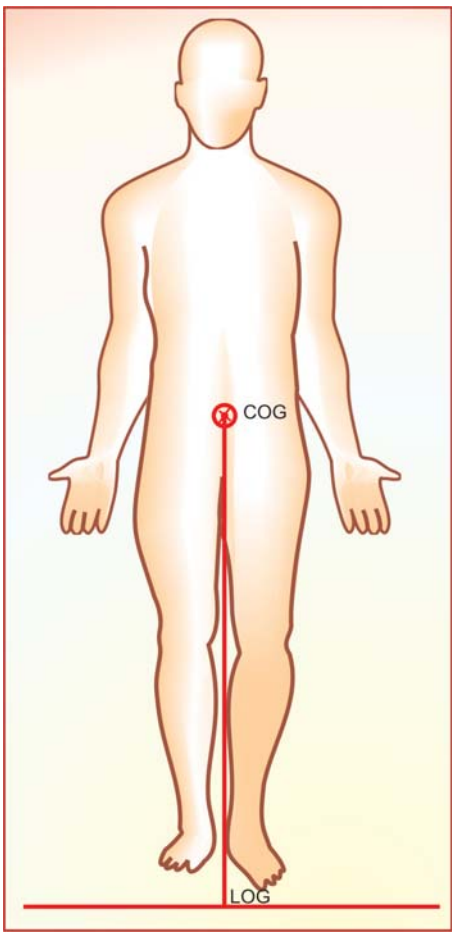


Fig. 1.5: COG and LOG

while erect bilateral standing posture. It will change with the positional changes. In the human body each and every segment of the body has its separate COG and the two or three segments together gives the different COG. For example, the arm, forearm and hand will be having its own separate COG but the upper limb as a whole gives some other different COG.

BASE OF SUPPORT (BOS)

The base of support means the area supported beneath the object. Whenever the base of support is more the stability will be more. Greater the BOS lower the COG of any object.

$$BOS \alpha \frac{1}{COG}$$

For example, the fundamental position of standing the BOS is lesser than the lying, so COG in the standing position it is in the higher level whereas in the lying posture it will be just near to the ground as a result lying posture is more stable than the any other fundamental position and also it can be maintained for the longer period. The stability is directly proportional to BOS and inversely proportional to COG (Fig. 1.6).

$$\text{Stability} \alpha BOS$$

$$\text{Stability} \alpha \frac{1}{COG}$$

EQUILIBRIUM

Equilibrium is balancing or keeping in remain rest of the body even though the force is exerted on it (or) it is the state of an object where all the forces acting on it are equal in magnitude and opposite in direction.

Types of Equilibrium

It is classified into the following three types:

1. Stable equilibrium
2. Unstable equilibrium
3. Neutral equilibrium.

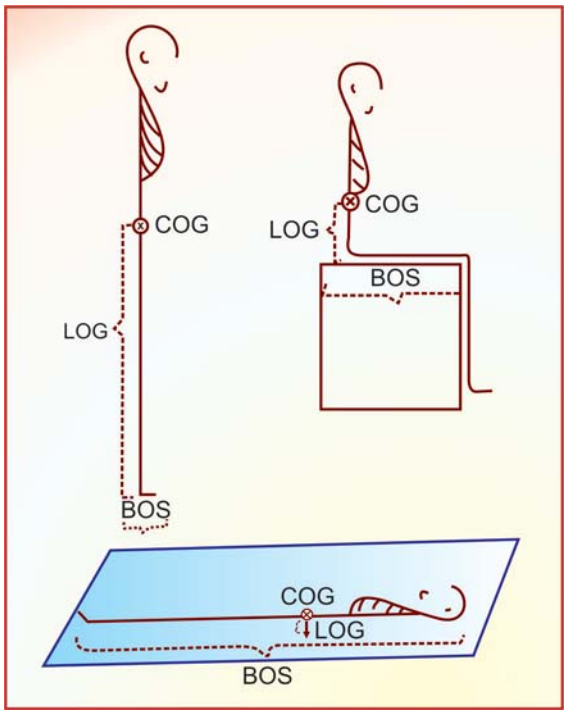


Fig. 1.6: A. Standing—COG in higher level, LOG is in highiest height, less BOS, B. Sitting—COG in lower level, LOG is in lesser height, BOS is more, C. Lying—COG near to floor, LOG is in very much lesser height, BOS is huge

Whenever the object is in resting position, it may not be having the tendency of moving or rotating so the resultant force and movement is equal to 0.

Stable Equilibrium

The object will restore in resting position even though the force alters its equilibrium. This is called as the stable equilibrium. Generally, the equilibrium will be more when the BOS is more and COG lies in the lower part of an object (Fig. 1.7).

Example: Book placed on the table. When the force is applied on the book, the book regains its original state after the removal of the force.

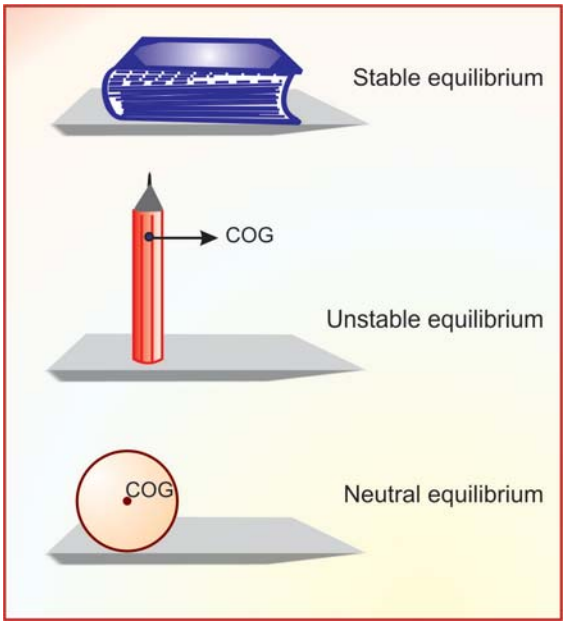


Fig. 1.7: Different types of equilibrium

Unstable Equilibrium

The minimum force is enough to alter the equilibrium of an object is called as the unstable equilibrium. The BOS is less and the COG is in higher position. The object will be having the lesser equilibrium.

Example: Pen is balanced to stand on the floor. When the force is applied to the pen, it alters its original state.

Neutral Equilibrium

Even though the movement or position changes in the object by the force exerted on it, there will not be any change in the COG of the object.

Example: Ball is rolling on the floor.

LEVER

A lever is defined as the rigid bar, which moves about on some fixed point called fulcrum (F). To perform an activity or a movement, the bone acts as the lever and the joints acts as the

fulcrum (F). The movement will be created by two types of forces, i.e. resistance (R), and effort (E), in which the resistance (R) is the opposing force and the effort (E) is action achieving force. The resistance may be the weight of the body parts and the effort may be the pull of the muscle. The perpendicular distance between the effort to the fulcrum is called as effort arm (EA) and the perpendicular distance between the resistance to the fulcrum is called as resistance arm (RA).

Achieving the ROM of the joints may sometime depend on the strength of the muscles or the place of the insertion of the particular muscles. For example, if the two muscles are acting on the same joint for a same movement; the effort (E) will be added more, as a result the ROM will be so easier and also more faster the movement. Consider the equal powered two muscles are acting on the same joint for same action but their insertions are: (a) one is farther to the joint (fulcrum), (b) another is closer to the joint (fulcrum). The muscle, which inserted closer to the joint produce stronger movement than the farther inserted muscles

Types of Levers

These are of three types. They are as under:

1. First order lever (1°)
2. Second order lever (2°)
3. Third order lever (3°).

First Order Lever

The fulcrum (F) is between the effort (E) and the resistance (R). Sometimes the fulcrum is situated closer to the resistance or effort.

Example: See-saw, scissors, nail-cutter, etc.

If the fulcrum is closer to the resistance (R) it produces more speed or ROM but with less strength. If the fulcrum is close to the effort (E) it produces the less speed or ROM but with more strength. There are less number of first order levers are seen in the human body and also the lesser mechanical advantage.

Example in human body—Atlanto-occipital joint.

During the nodding movement of the head, the neck extensors act as the effort (E) Atlanto-occipital joint as fulcrum and the facial part is the resistance (R).

Second Order Lever

The resistance (R) lies between the fulcrum (F) and the effort (E), these levers are the lever of the strength but not the speed and ROM. These types of levers are less seen in the human body.

Example: Wheelbarrow.

Example in human body—raising the body on the toes. In which the ball of the toes are the fulcrum (F) the tendo-Achilles tendon is the effort (E) and the body weight is passing through the middle part of the foot is the resistance (R). This variety always having the mechanical advantage. So that varieties of levers or called are the levers of the strength.

Third Order Lever

The effort lies in between the fulcrum (F) and the resistance (R). These levers having mostly mechanical disadvantage. But the third order levers are seen plenty in the human body.

Example: Bettle nut cutter, *Chapatti* press.

Example in human body—flexing the elbow

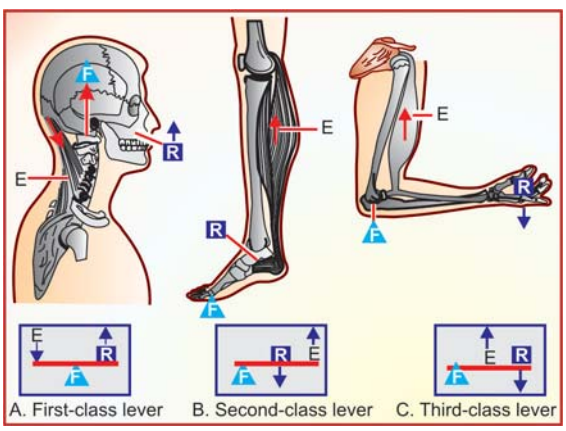


Fig. 1.8: Levers of various classes

in which the elbow is the fulcrum (F) biceps insertion is the effort (E) and the forearm and hand is the resistance (R) (Fig. 1.8).

Mechanical Advantage

The mechanical advantage of the lever depends on the few factors: force (F), resistance (R) and its perpendicular distance, i.e. resisted arm (RA) and effort arm (EA). If the RA and EA are in same length, there may not be any mechanical advantage. The same effort force is necessary to oppose the resistance. Then the mechanical advantage (MA) = 1.

If the RA greater than the EA, then the effort force should be more to oppose the resistance, so it is difficult to perform the movement. Above said two varieties are not having the mechanical advantage.

$$MA < 1$$

If the EA exceeds the RA, less effort is required to oppose the force. This is called as the mechanical advantage. It can be achieved in all the second order levers and the 1st order levers where the fulcrum is closer to the resistance (R).

Mechanical Advantage—EA/RA

When the effort arm (EA) is more than the resistance arm (RA) then the mechanical advantage will be more than 1. When the mechanical advantage is more than 1, less effort is required to perform the movement.

$$EA > RA$$

a. In first order levers there is no rule of mechanical advantage. EA may be greater, lesser or equal to RA. Among these, if the EA is greater than RA, it gives more mechanical advantage.
b. In all second order levers the mechanical advantage is greater than one.
c. In all third order levers the mechanical advantage is normally less than one. So, the effort should be more to produce the movement.

NEWTON'S LAWS OF FORCE

There are three laws of motion given by Newton.

1. Law of inertia
2. Law of acceleration
3. Law of action-reaction.

Law of Inertia

The object remains at rest or of uniform motion unless and until it is disturbed by an external force.

For example, while traveling in the car the body is in motion suddenly if the break applies the body will be moved forward, because the body tends to be in motion.

Law of Acceleration

The rate of changing of velocity is called as acceleration. The velocity is directly proportional to the acceleration and inversely proportional to the mass of an object.

$$a = F / m$$

where, a is acceleration, f is force, and m is mass of the body.

It can also be written as

$$F = ma$$

which is the Newton's second law of motion.

Law of Action-Reaction

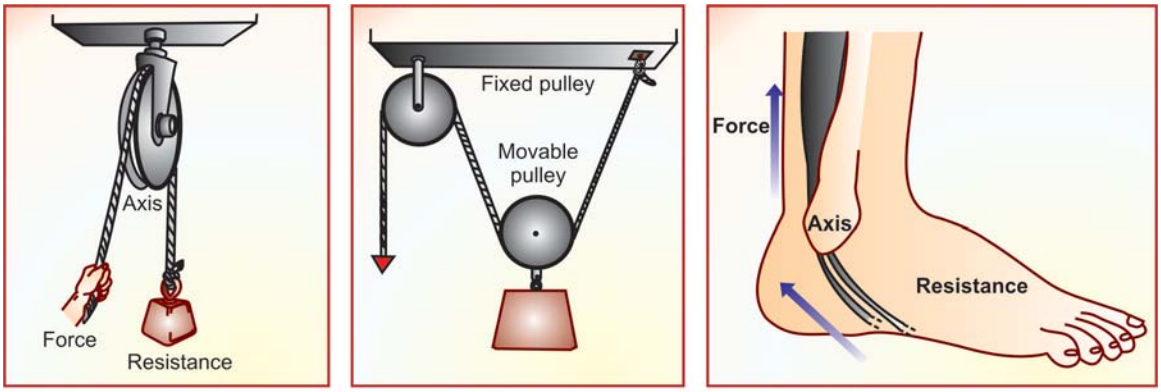
For every action there is an opposite and equal reaction.

The heavier the mass, lesser the movement and the lesser the mass greater the movement. The strength of the action is equal to strength of reaction.

Example: Recoil of the gun.

PULLEY

Pulley is the grooved wheel, which moves around an axis and the rope or the iron cable



A. Fixed pulley B. Movable pulley C. Lateral malleolus acting as the pulley for the peroneus longus muscles

Fig. 1.9: Pullies

passing through the groove. Two categories of pulley are seen as under:

1. Fixed.
2. Movable.

Fixed Pulley

The pulley is attached to the fixed point, the fixed pulley is acting as the first-order lever. The weight (R) on one side and the effort (E) on another side with the fixed axis is fulcrum (F) in middle. This type of pulley is used to alter the direction of the force by which the resistance or the traction can be applied to the body parts.

Example: Lateral malleolus acts as the pulley for the peroneus longer tendon to reduce the resistance force of that muscle (Fig. 1.9).

Movable Pulley

One end of the rope is attached to the fixed point and another end is passed through the fixed pulley. The movable pulley is attached in between the fixed point and the fixed pulley, the movable pulley acts like the second order lever. Generally, second order lever will have the mechanical advantage. This movable pulley reduces the restricted force into half.

There is no second order lever seen in the human body.

This type of pulley is used in the suspension therapy units which makes easy to lift the body parts. This reduces the restricted force to half and easy lifting the body parts.

SPEED

Speed is the rate at which the object moves. It does not take in account of the direction. The normal speed of an object may vary depends on the hurdles it passes. The speed of an object moving in one plane may vary between in each and every particular distance; even though we can calculate the average speed of that particular object.

WORK

Work is defined as the force moves an object for a particular distance. It is measured in joules or ergs.

Work = Force × Distance

where, work measured in joules, force in newtons, and distance in meters

POWER

Power is the rate at which the work is done or rate of energy expenditure.

Power = Work × Direction.
Where, Work in joules.
Duration in seconds.

ELASTICITY

Elasticity is the capacity of regaining its original form after releasing the force exerted on it.

Example: Springs, elastic rubber, sorbo rubber.

Hook's Law

The stress and strain are directly proportional to each other.

Stress α Strain

SPRINGS

Springs are used to assist or resist the movement in exercise therapy. Sometimes it is used for the passive mechanical stretching of the soft tissues. One end of the spring is attached in the beam another end is elongated by the force.

Weight of the Spring

Sometimes the springs are graded in the weights.

Example: 20 lbs, 40 lbs, 50 lbs, 75 lbs. The 20 lbs springs needs the 20 lbs of force to elongate it. According to the pounds of the springs it requires the force to elongate it.

Springs in Parallel

If the two springs are used in parallel manner the weight of the springs are added and it requires the sum of the springs force to produce the maximum of elongation (Fig. 1.10).

Springs in Series

If the two springs are added in the series manner that is equal to the single spring and the effort to elongate them is the sum of the two springs divided by two.

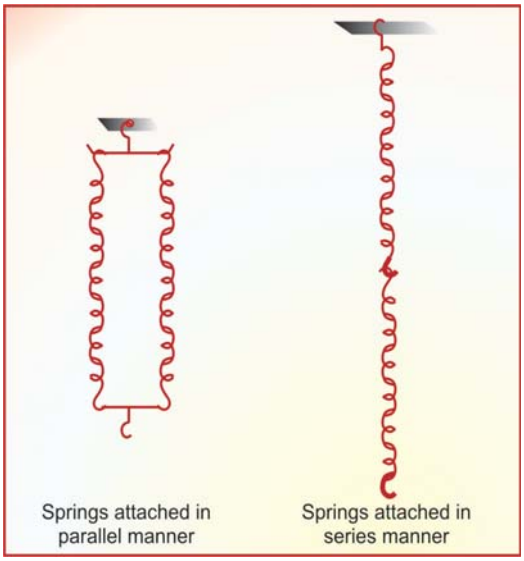


Fig. 1.10: Springs

ENERGY

Energy is the capacity to perform the work. It is mainly of two types namely:

- Potential energy
- Kinetic energy

Potential Energy

It is the capacity of doing the work with the help of the stored energy. For example, the maximum flexion of the knee in the standing position has the potential to fall down with the help of the gravity due to the position (Fig. 1.11).

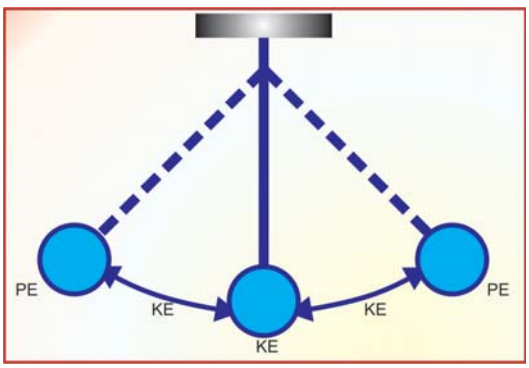


Fig. 1.11: Kinetic and potential energy

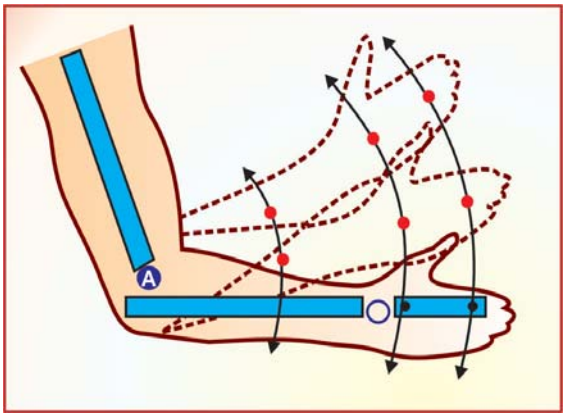


Fig. 1.12: Rotational motion

Kinetic Energy

This is the work done by an object as a result of motion.

The potential and kinetic energy can be explained with the pendulum. The potential energy is stored in either side of the pendulum while moving. The potential energy is changed into kinetic energy while falls with help of the gravitational force.

TYPES OF MOTION

Rotatory Motion (Fig. 1.12)

- Otherwise called as angular motion.
- Movement of an object around a fixed axis known as rotatory motion.
- Each segment moves through the same angle, same time at a constant distance.

Translatory Motion (Fig. 1.13)

- Each segment or object moves in straight line.
- Each segment moves through same distance at the same time in parallel path.
- If the movement occurs in straight line is called as "linear motion".
- If it occur in curved pathway is called "curvilinear motion".

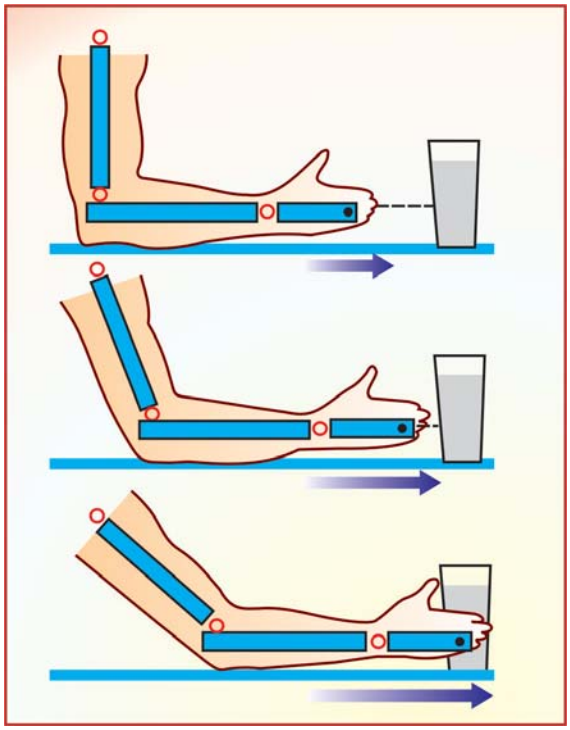


Fig. 1.13: Linear motion

To perform osteokinematic movement there should be an axis and a plane.

PLANES AND AXES

Planes

Planes are the space or surface where the movements take place.

Axes

Axes are the points by which the movements take place. The anatomical position (standing erect with the head, toes and the palm of the hand facing forwards and the finger extended.) is the correct position to discuss about the planes and axes. The imaginary planes are made to each other perpendicular in the human body. These are called as "Cardinal planes".

Fig. 1.14: Curvilinear motion

Types

1. Frontal plane (Coronal plane)
2. Sagittal plane (A-P plane)
3. Transverse plane (Horizontal plane) (Fig. 1.15)

Frontal Plane

- The plane, which divides the body into equal front and back parts.
- This plane passes through the coronal suture of the skull.
- Movement occurs in X-Y plane.
- Movement occurs in **sagittal axis** or **A-P axis**.
- Movements possible are abduction and adduction.

Sagittal Plane

- The plane, which divides the body into equal right and left parts.
- Movement occurs in Y-Z plane.
- This plane passes through the sagittal suture of the skull.
- Movements possible are flexion and extension.
- Movement occurs in **frontal axis** or **coronal axis**.

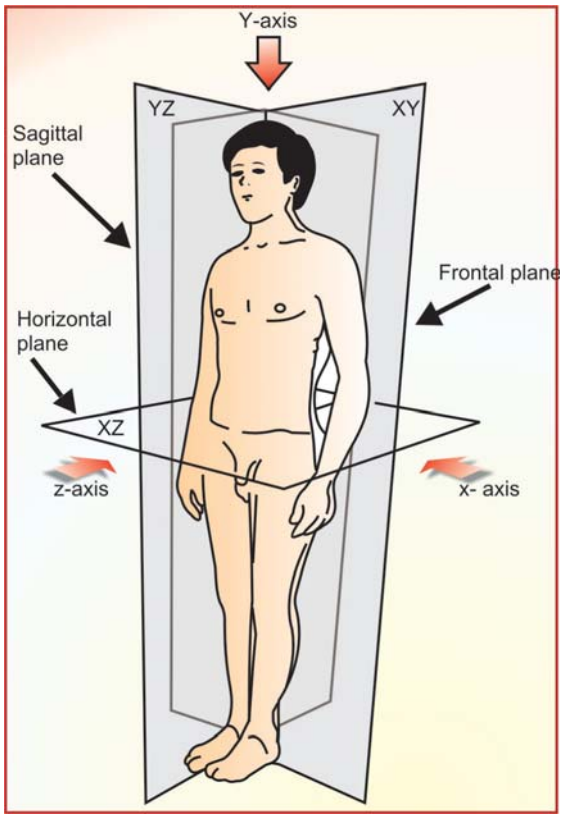


Fig. 1.15: Axes and planes

Transverse Plane

- The plane, which divides the body into equal upper and lower parts.
- Movement occurs in X-Z plane.
- Movements possible are medial and lateral rotation.
- Movement occurs in **vertical axis**.

MOVEMENT ARM

Definition: This is the distance between the axis of the joint to the action line.

Rarely the movement arm comes in the line of the lever arm. Whenever the force is applied 90° to the lever arm, the perpendicular distance will fall on the lever arm and coincides. In human joint most of the line of forces parallel

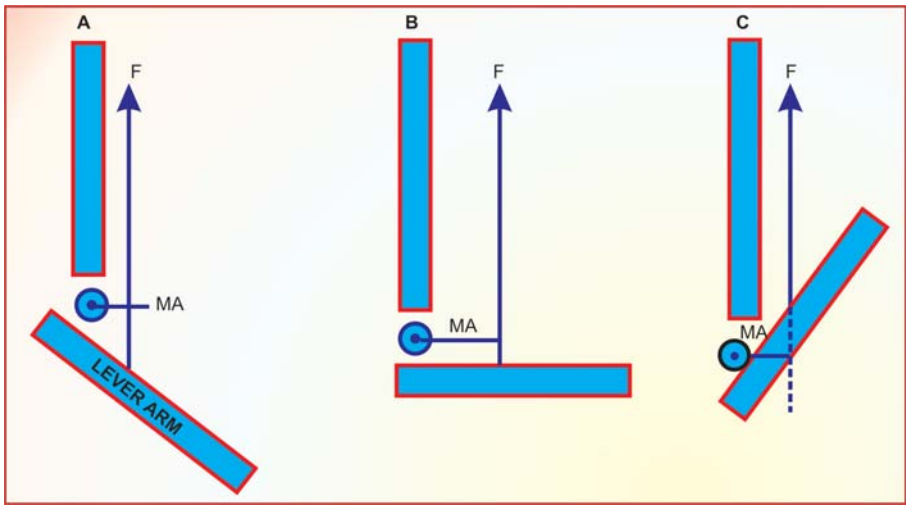


Fig. 1.16: Hamstring exerting the force on the leg. A. 45°, B. 90°, C. 125° flexion of knee

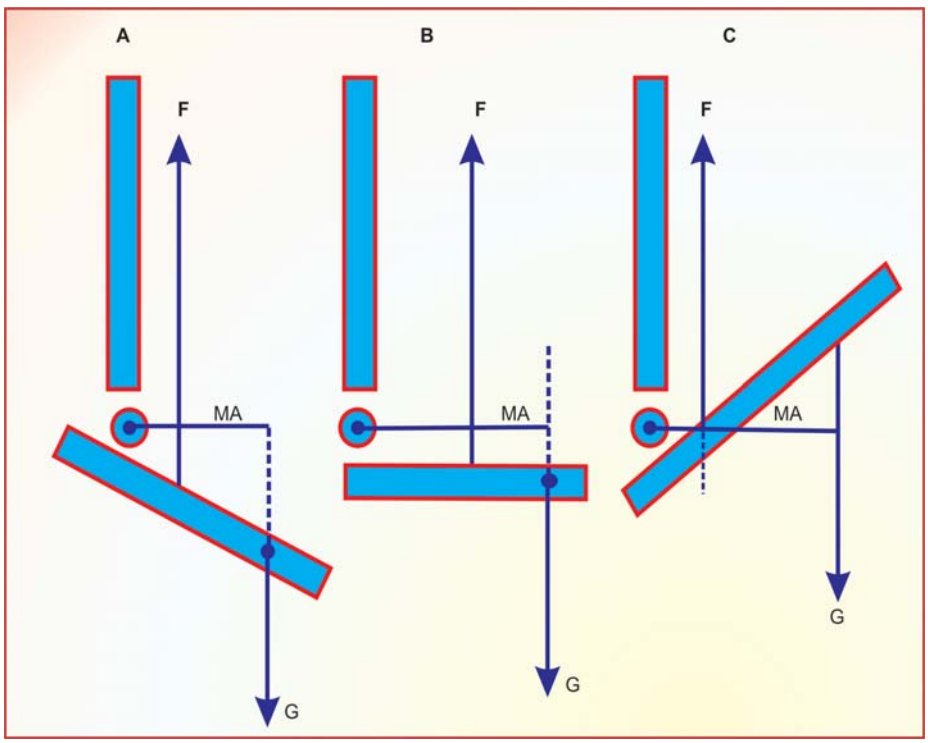


Fig. 1.17: Movement arm in relation with gravitational force. A. 45°, B. 90°, C. 125° flexion of knee

to the lever arm due to the muscular arrangement, so the movement arm will have the more short distance and also rarely some joint line of force comes perpendicular to the lever arm (lever arm is the movable segment of the joint). So, whenever the force is applied 90° to the lever arm, the movement arm coincides with the lever arm. If the line of force is applied 90° to the lever arm, the torque created in the muscle will be maximum.

$T = f \times \perp d$

$\perp d = ma$

$T = f \times ma$

For example: Hamstring muscle action (Figs 1.16 and 1.17)

Generally, the lever arm will be constant and the line of force and the movement arm changes depend on the arrangement of the movement. In 45º, 90º, 125º of flexion of knee the torque created by the muscle will be more during 90º. Because whenever the line of force comes perpendicular to the lever arm and the movement arm distance will be more and also the movement arm coincides with the lever arm.

During 45º and 125º, i.e. below and above 90º of movement, the movement arm distance reduces and comes closer. So, the torque created in the muscle will be very less. Variation in the angulations of the lever results in increasing or decreasing of the movement arm. The application of the LOG also decides the *ma* of the lever. Generally, gravity acts vertically, so the LOG will be perpendicular to the lever arm. Whenever the lever is in 90º position the gravity exerts more torque on the lever. The muscular torque has to counteract the gravitational torque to generate the movement over the lever. Whenever the gravitational torque is less, i.e. during below or above 90º angulations, there will be less muscular torque needed to generate the movement on the lever.

2

CHAPTER

Introduction to Exercise Therapy

TYPES OF SKELETAL MUSCLE FIBERS

Skeletal muscles are the voluntary and striated muscles. These skeletal muscles are responsible for the activities or movements around a particular joint. These skeletal muscles are not having the same structure and function. There are three types of skeletal muscles (Table 2.1).

a. Type I fibers
b. Type IIa fibers
c. Type IIb fibers.

Type I Fibers

These fibers contain more number of the mitochondria, myoglobin and the blood capillaries. Because of the more number of myoglobin and blood vessels, the muscle fibers are red in color. It is having the capacity to generate the ATP from the aerobic system, so that it is called as oxidative fibers. It is innervated by the less number of nerve fibers. These muscle fibers are in small diameter and fatigue-resisted fibers.

Slow Twitch—Fatigue-resisted—Red Colored—Oxidative Muscle Fibers

Example: Postural muscles like neck and trunk muscles.

Type IIa Fibers

They contain more amounts of myoglobin, mitochondria and blood capillaries. But comparative with type I, these are less pink in color. These are fatigue-resisted fibers but not like Type I. They split the ATP much faster, as the result contraction velocity is also fast. These fibers also generate the ATP from aerobic system.

Oxidative—Fast Twitch—Pink Colored—Fatigue-resisted Muscle Fibers

Example: Leg muscles, which is responsible for walking and running.

Type IIb Fibers

They contain less numbers of mitochondria, myoglobin and blood capillaries. They generate the ATP from the anaerobic system, i.e. by the processes of glycolysis. They are large in diameter fibers and are fatigue earlier. The contraction of these muscle fibers will be more rapid and strong. These muscle fibers also contain the glycogen, they are in white color.

Glycolytic—Fast Twitch—Early Fatiguable—White Muscle Fiber

Example: The muscle responsible for rapid movement are—Shoulder flexors and abductors.

Table 2.1: Types of muscle fibers

Characters	*Type I*	*Type IIa*	*Type IIb*
Color	Red	Pink	White
Fatiguability	Very less	Slow	Fast
Myoglobin	More	More	Less
Capillaries	More	More	Less
ATP Production	Aerobic system	Aerobic system	Anaerobic system
Velocity of conduction	Slow	Medium	Fast
Mitochondria	More	More	Less
Example	Postural muscles like neck muscles	Leg muscles	Rapid contracting muscles
Activity	Maintaining posture	Walking, running, jogging	Weight lifting, gymnastic activities

Normally, each and every muscle contains the mixture of all the muscle fibers. Depending on the activity the muscle fibers are working and also depends on the proportionate of muscle fibers in the muscle spindle determines the contraction of muscles. In postural muscles the proportion of the type I fibers are more and in rapid contraction muscles the type II b proportion is more. During the minimal contraction of the muscle, the Type I muscle fiber motor fibers are stimulated as a result type I muscle fiber goes for contraction. If the more amount of contraction is needed, the Type II motor units will be stimulated.

Sometimes depend on the exercise the type of the muscle fibers also changing. If the strenuous activity is less, the type IIb fibers may be converted as type II a or type I. If the strenuous activity is more the type I fibers may become type IIa or type IIb.

For example, the gymnastic people, who are performing the rapid movements and exercise will be having the more proportionate of the white fibers (type IIb). The runners will be having more proportionate of the pink fibers (type IIa). The normal people like housewife, clerks, company MDs will be having the more of red fibers (Type I).

- Type I—Housewife, those who are performing the normal day-to-day activities.
- Type IIa—Runner, athletes.
- Type IIb—Gymnastic people, body-builders.

ARRANGEMENT OF THE FASCICULI OF THE MUSCLES

The muscular fasciculi are arranged in three directions.

1. Parallel
2. Oblique
3. Circular.

Parallel

The fasciculi muscles having the strong action and also higher ROM capacity. These muscles are again divided into four varieties. They are:

i. Strap
ii. Fusiform
iii. Rhomboidal
iv. Triangular.

Strap

In this muscle, fasciculi are parallel with each other and run total length of the muscles and ends in flat tendon.

Example: Sternomastoid, stylohyoid.

Fusiform

The fasciculi are parallel to each other and runs full length of the muscles and terminate in the

flat tendon. But the muscular part is more bulky in middle than the tendon.

Example: Biceps, brachioradialis.

Rhomboidal

These muscles are rhomboid shape or quadrangular in shape, the muscles having the broad attachment with the broad flat tendon.

Example: Rhomboidus major, pronator quadratus.

Triangular

The muscles having the spreaded fasciculi, which ends with the flat and small tendon, these are triangular or fan-shaped.

Example: Pectoralis major, temporalis (Fig. 2.1).

Oblique Muscle Fibers

The muscles are having the strong fibers but less ROM capacity muscles. There are three varieties.

1. Unipinnate
2. Bipinnate
3. Multipinnate

In this variety the fasciculi are short and the tendon runs maximum length of the muscle.

Unipinnate

The muscular fasciculi are arranged in the one side of the tendon.

Example: Tibialis anterior, EDL, and semimembranosus.

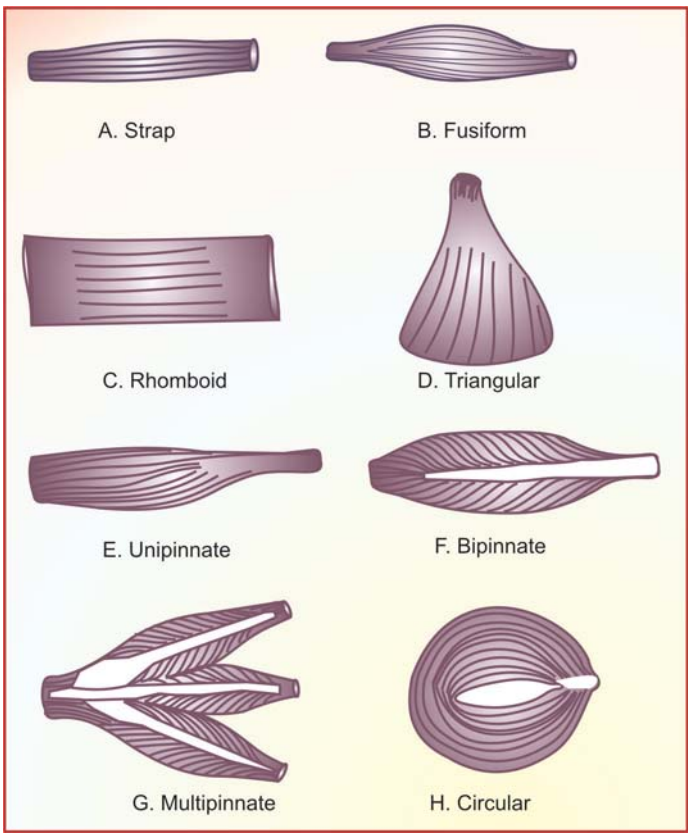


Fig. 2.1: Arrangement of fasciculi of muscles

Bipinnate

Fasciculi are arranged in both sides of the tendon.

Example: Intraosseous muscles of the hand.

Multipinnate

Many tendons are having both the side fasciculi arrangement.

Example: Deltoid.

Circular Muscle Fibers

Fasciculi are arranged in the circular manner and help to close an orifice.

Example: Orbicularis oris, external anal sphincter.

ANATOMICAL MOVEMENT

- *Flexion:* Bending movement reduces the angle between the articular surfaces.
- *Extension:* Stretching movement, which increases the angle between articular surfaces.
- *Abduction:* Bony segments move away from the midline.
- *Adduction:* Bony segment moves towards the midline.
- *Medial rotation:* Rotational movement occurs in the articular surface towards the midline (Internal rotation).
- *Lateral rotation:* Rotational movements occur in the articular surface away from the midline (External rotation).
- *Circumduction:* Combination of flexion, extension and abduction, adduction and medial rotation, lateral rotation.
- *Inversion:* Moving the sole of the foot inwards so that each sole of the foot faces each other.
- *Eversion:* Moving the sole of the foot outwards.
- *Dorsiflexion:* Bending the ankle in upward direction.
- *Plantar flexion:* Bending the ankle in downward direction.
- *Protraction:* Forward movement of the mandible or shoulder girdle.
- *Retraction:* Backward movement of the mandible or shoulder girdle.
- *Supination:* Movement in which the palm facing upwards.
- *Pronation:* Movement in which the palm facing downwards.
- *Elevation:* Upward movement of the body part.
- *Depression:* Downward movement of the body part.

RANGE OF MOTION (ROM)

Movement of the joint can be performed by the internal or external force. The internal force can be produced by the muscles and the external force may be produced by manually or mechanically. The movement of a joint results in angulations of that particular joint. The angulation of the movements are referred as the range of motion. The ROM will be perfect in one joint if the soft tissues are intact. If any change occurs in any soft tissues results in disturbance or alteration of the range of motion. Generally, in the hypomobile joint the ROM will be less than the normal prescribed ROM of that particular joint. In hypermobile joint it is *vise versa*. This ROM can be measured with the help of goniometer.

There are two types of ROM (i) Active, and (ii) Passive

1. *Active ROM:* The ROM, which is achieved without any external force, i.e. by the effort of his own called as active ROM. Generally, the Active ROM, will be less in the hypomobile joint.
2. *Passive ROM:* The ROM which is achieved with the help of the external force is called as Passive ROM. Normally, by the Passive ROM we can achieve greater ROM than Active ROM. In hypomobile joint, the Passive ROM will be more than the Active

ROM because the tightened structures will be stretched by the passive force but it cannot achieve actively. The ROM may be different from each and every joint.

The ROM may be varying from each and every joint and each and every individual depends on the variety, size, and bony prominence. The same joint ROM may be differing from an individual to individual due to variation in muscle bulk and the bony prominence.

The prescribed ROM for each and every joint in normal individual is given below:

- Shoulder
  - Flexion 0°-180° (150°-180°)
  - Extension 0°-45° (40°-60°)
  - Abduction 0°-180° (150°-180°)
  - Adduction 0°
  - Internal rotation 0°-90° (70°-90°)
  - External rotation 0°-90° (70°-90°)
- Elbow
  - Flexion 0°-135° (120°-150°)
  - Extension 0°
- Forearm
  - Supination 0°-90°
  - Pronation 0°-90°
- Wrist
  - Flexion 0°-90° (70°-90°)
  - Extension 0°-70° (50°-70°)
  - Ulnar deviation 0°-40° (25°-40°)
  - Radial deviation 0°-20° (15°-25°)
- MCP
  - Flexion 0°-90°
  - Extension 0°-20° (15°-30°)
  - Abduction 0°-20°
  - Adduction 0°
- PIP
  - Flexion 0°-110° (90°-120°)
  - Extension 0°
- DIP
  - Flexion 0°-90°
  - Extension 0°
- Thumb
  - MCP flexion 0°-45°
- HIP
  - Flexion 0°-120° (110°-130°)
  - Extension 0°-35° (25°-40°)
  - Abduction 0°-55°
  - Adduction 0°
  - External rotation 0°-45° (35°-50°)
  - Internal rotation 0°-35° (30°-45°)
- Knee
  - Flexion 0°-120°
  - Extension 0°
- Ankle
  - Plantar flexion 0°-45°
  - Dorsi flexion 0°-20°
  - Inversion 0°-45°
  - Eversion 0°-15°
- MTP
  - Flexion 0°-40°
  - Extension 0° 80° (10°-90°)
  - Abduction 0°-15°
- Interphalangeal
  - Flexion 0°-60° (50°-70°)
  - Extension 0°

RANGE OF MUSCLE WORK

Range of muscle work means the degree of the movement done by the muscle contraction. The range of the movement can be measured by the goniometer. To produce a movement, the group of muscles has to contract or stretch. There are 4 types of ranges.

1. *Full range:* The muscle is moving the joint from the full stretched position to full contracted position (Concentrically) or from full contracted position to full stretched position (Eccentrically). The full range of movement rarely required in normal day-to-day activity. Full range exercises are required to perform by the patients to maintain the full ROM of the joints.
2. *Inner range:* The muscles move the joint from the medium contracted position to the full contracted position (Concentrically) or from minimum contracted position to the full stretched position (Eccentrically). Extreme inner range movements are difficult to perform and it requires the more numbers of motor unit contractions.

3. *Middle range:* Muscle moves the joints between the minimal range to the medium range. There is no fully stretched or fully contracted muscles seen. This is the range which we use more in our day-to-day life. In this range the muscle has the maximum strength. Exercise in this range increases the muscle power, strength and tone.
4. *Outer range:* The muscles move the joint from the stretched position to the minimal contracted position (Concentrically) or from full contracted to the medium contracted position. Outer range movements also are very much difficult to perform. While performing the outer range movement, the angle of pull will be adverse and some of the energy is used for the compression of the articular surface. The gravity also resists the movement, so that out range movement will be difficult to perform (Fig. 2.2).

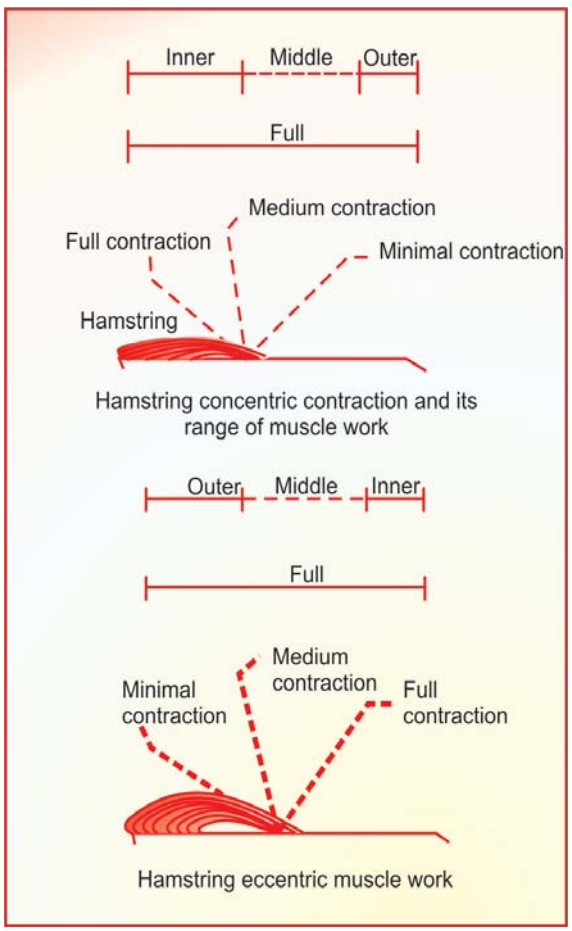


Fig. 2.2: Hamstring eccentric and concentric muscle work

Muscle Action

In normal action a single muscle cannot produce the effective movement. Depends on the function of the muscles they are named as: (i) agonists, (ii) antagonists, (iii) synergists, and (iv) fixators.

Agonists

These are chief muscles, which produce the effective movement. These groups of muscles are called as prime movers.

Example: For elbow flexion biceps and brachialis are helpful, but the brachialis has its major part in the contraction or movement. So, brachialis is called as the prime mover or agonists.

Antagonists

These are the muscles, which is acting against the agonists.

Example: Triceps act as the antagonists to the brachialis while flexing the elbow. If the agonists contracts, the antagonist goes for relaxation by the neurological reflex. Same mechanism is used in the PNF techniques to reduce the spasm or the spasticity of the muscle group.

Synergists (Syn-with)

The name itself explains us the muscle acting with the other muscle. The synergists are acting with the agonists and making stronger the action of agonists.

Example: Biceps acts as synergists to brachialis for the elbow flexion.

Fixators

Fixators are the muscle, which fixes the attachments of the agonists, antagonists and synergists.

Example: The muscles attached with the shoulder girdle to the trunk acts as the fixator for the deltoid action. Fixators are not only fixing the bony component while movement of agonists, antagonists or synergists and also have the dynamic properties. It is not only having the isometric contraction but also has isotonic in altering the pattern of movement.

Fixator work is very much (nearly 75%) needed in normal day-to-day activities.

Example: Threading in the needle, throwing the ball.

KINEMATIC CHAIN

The movement of one joint may require the motion over the proximal and distal joints, and sometimes it may not be required.

Two types of kinematic chains are present.

1. Closed kinematic chains
2. Open kinematic chains.

Closed Kinematic Chain

In human body the joints are having interlink with each other, so the motion occurs in one particular joint causes motion over the other joints in predictable manner. In the closed kinematic chain the proximal and distal joint will be moving to produce the movement over one particular joint.

Example: (1) Performing the sit-ups and (2) performing the push-ups.

In the first example the hip joint flexion and the ankle joint dorsiflexion occurs to produce the flexion over the knee to go for the sitting posture. The proximal joint (hip) is moving towards the distal (ankle) joint but the distal joint is fixed without any movement.

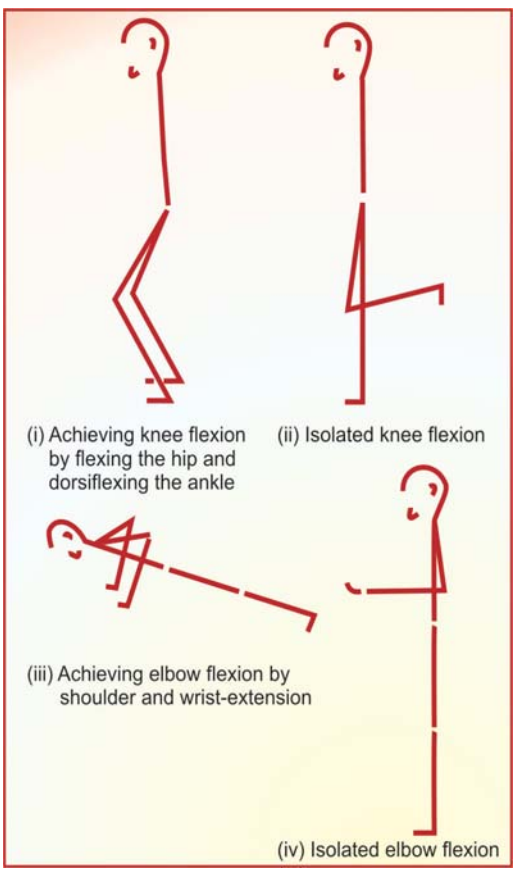
In the second example the shoulder extension and wrist extension produce the elbow flexion to perform the push-ups. The shoulder joint moves towards the fixed wrist.

Open Kinematic Chain

The movement occurring independently and not in predictable manner. The distal joint moving and the proximal joint will be fixed without any motion.

Example:

a. In shoulder 90° flexion, performing the elbow flexion and extension movement.
b. In standing posture, the leg is lifted from the ground and performing the knee flexion and extension movement (Fig. 2.3).



Figs 2.3i to iv: (i), (iii)—Closed kinematic chain, and (ii), (iv)—Open kinematic chain

In the figure example elbow flexes without the motion of the shoulder and the distal joint (wrist) is free to do any motion. In the second example the knee is flexed without the movement of the hip and the ankle is free to do any movement.

ACTIVE AND PASSIVE INSUFFICIENCY

In one joint muscle the movement may not be restricted by the proximal or distal joint motion. But it is not possible in the two or multi-joint muscles, the ROM may be changing depends on the proximal and distal joint movement. If the muscles are crossing more than one joint, there is possibility for active and passive insufficient said by *Brunnstrom*.

Active Insufficiency

The muscle cannot go for further shortening while performing the activity around the joints, which the muscle crosses. It occurs to the agonists.

Example: Flexor compartment muscles of the forearm. These muscles responsible for elbow flexion, MCP flexion PIP and DIP flexion. If the above said movements are done in the same sequence, the person feels difficult in flexing the MCP and finger after flexing the elbow and wrist, because the muscles are already shortened by the elbow and wrist flexion. So, further shortening is difficult, this is called as active insufficiency (Tenodesis).

Passive Insufficiency

The muscle cannot lengthen further while performing movement around more than two joints, which it crosses. It occurs in the antagonists (Fig. 2.4).

Example: Extensor compartment muscles of the forearm. These muscles are responsible for elbow, wrist, MCP, PIP and DIP extension. While performing the opposite movement

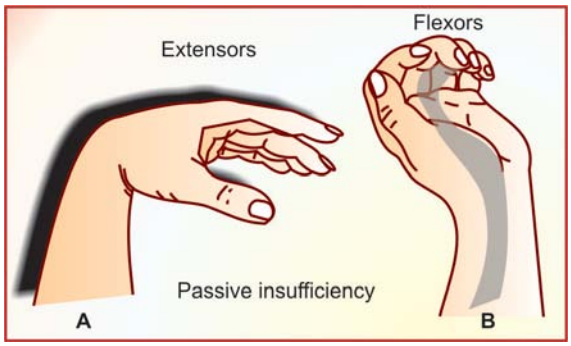


Fig. 2.4: Passive insufficiency

around these joints in the given sequence, the muscle cannot go for further more lengthening in the MCP, PIP and DIP. This phenomenon is called as passive insufficiency. If the agonist muscle goes active insufficiency, the antagonist goes for the passive insufficiency.

TYPES OF MUSCLE WORK

Muscle activity increases the intramuscular tension and changes in the muscle length. The muscle fibers are contracted and relaxed during the muscle work. We can categorize these muscle works by the change in the length and tone of the muscles into three varieties.

1 Isotonic contraction
2 Isometric contraction
3 Isokinetic contraction.

Isotonic Contraction

Iso—equal, *Tonic*—tone. By changing the length of the muscle, the same amount of tension is created throughout the contraction is said to be isotonic contraction. There are two types of isotonic contractions.

- Concentric contraction
- Eccentric contraction.

Concentric Contraction

Concentric—towards the center. This type of contraction is otherwise called as shortening contraction. The muscle is isotonically shortens

to produce the movement. The proximal and distal bones are drawn towards the center. Normally, one bony component is fixed and another will be moving to perform the movement. If the proximal bony component is fixed the distal bony component will be pulled towards the center.

Example: Lifting the dumb-bells.

If the distal component is fixed the proximal bony component moves towards the center.

Example: Push-ups.

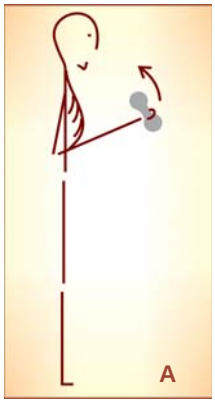
Insertion of the muscle moves towards the origin or origin the muscle moves towards the insertion of the muscles during the concentric contraction. The concentric contraction moves the bony lever through some distance in the direction of the muscle pull. So that it results in an action or muscle work (Figs 2.5 and 2.6).

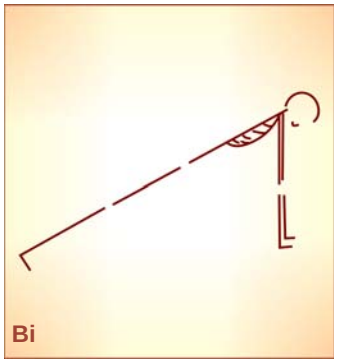
$$W = F \times D$$

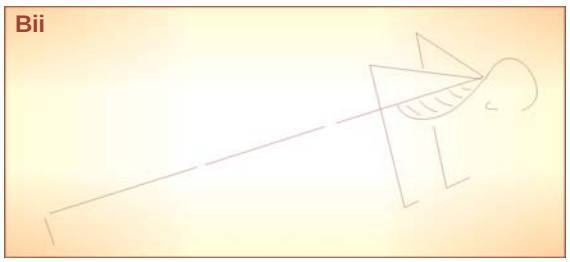
where W = Work,
F = Force, and
D = Distance

Force, i.e. tension is created inside the muscle that the tension pulls the bony component to some distance, so that it results in movement. Isotonic contractions are used to build up the muscle power and the muscle bulk and it requires more energy to perform. Normally, in the body-building exercise, the concentric contraction exercises are playing major role than the other varieties of contractions. Resisted concentric contractions are mostly useful to increase the muscle power and bulk.

Fig. 2.5: Concentric contraction







Figs 2.6A to Bii: A. Proximal component is fixed and the distal component is moving, Bi,ii. Distal component is fixed and the proximal component is moving

Eccentric Contraction

Eccentric—from the center (Fig. 2.7). This is otherwise called as lengthening contraction. Here the proximal and distal bony components are pulled apart from the center. Eccentric contraction lengthens the muscle and the insertion of the muscle is pulled distally. The energy expenditure in this contraction is very less than the concentric contraction. The muscular tension moves the bony lever through a distance in the direction of the muscle pull. But the muscle work is said to be negative muscle work. Normally, these eccentric

Fig. 2.7: Eccentric contraction

contractions are assisted by the gravitational force. The contraction occurs inside the muscle even though it lengthens. For example, carrying a bucket by the hand and filling water from the tap. In this example the length of the muscle is increased and the bony components are drawn apart in the direction of the muscle pull and the tension will be generated inside the muscle and slowly increases with the filling of the water in the bucket.

Isometric Contraction

Iso—equal, *Metric*—measurement. In isometric contraction there is no changes in the length of the muscle but the tension. Intramuscular tension is created without changing the length of the muscle. There is no mechanical muscle work occurs in isometric contraction because the force (F) is generated, i.e. tension is created but is not moving the bony lever because both the proximal and distal bones are fixed here. These types of contractions are otherwise called as static or holding contraction. Isometric contractions are more easy and less energy expensive contraction. Isometric contraction against resistance also can build up the muscle bulk and the power. This type of isometric exercise can help to improve the muscle strength. Less fatiguability is also seen in this type of contraction.

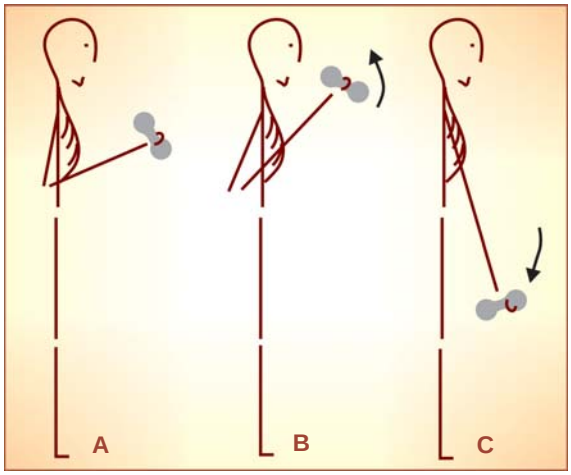
Isokinetic Contraction

Iso—equal, *Kinetic*—Force. In isokinetic contractions the velocity, speed is same and the resistance is variable. This type of contraction and the exercise can be done with the help of the special equipment such as Biodex, Cybex, Orthron, Kincom. The speed and velocity is preset and the resistance is directly proportional to the torque produced by the muscle. The speed is constant; if the patient wants to increase the speed also it is not possible. If the patient offers more force, the resistance exerted by the instrument will be more. If the patient pushes less force there will be less resistance by the instrument. *For example,* in concentric contraction.

While lifting the dumb-bells (e.g. 6 kg) with the hand, the resistance exerted by the dumb-bells will be same throughout the movement. Normally in the middle range, muscle has more strength than in the beginning and in the end range. If the resistance stays same throughout the ROM, the muscle has to work harder in beginning and in the end range, so that the speed also varies throughout the ROM. But in isokinetic exercise whatever the torque produced in the muscle same amount of resistance produced by the instrument. In the middle range the strength of the torque is more, so that the resistance given by the equipment also more. Sometime in the beginning and in end range is less. So, this advantage is not seen in the isotonic or isometric contraction and exercise. If the person feels pain he cannot stop the movement all of a sudden safely in the isotonic contraction or exercise. But it is possible in isokinetic contraction.

The tension created inside the muscle changes depend on the type of muscle contraction; the tension generated in the eccentric contraction is more than the other contraction (Fig. 2.8).

Eccentric contraction > Isometric contraction > Concentric contraction.



Figs 2.8A to C: A. Isometric, B. Concentric, C. Eccentric contraction

ENDURANCE

Endurance means performing an activity for a prolonged period of time without any fatigue, this is the fatiguability resistance exercises and aerobic type of exercises. The O_2 is used as a fuel for the energy in endurance exercises. It is of two types namely,

1. Muscular endurance, and
2. General body endurance.

Muscular Endurance

A group of muscles contracts for a prolonged period of time without fatigue.

General Body Endurance

This is otherwise called as cardiopulmonary endurance. Many groups of muscles of the body performing an activity for a prolonged period of time without fatigue.

Example: Walking, jogging, running.

PHYSIOLOGICAL CHANGES DURING EXERCISES (EXERCISE PHYSIOLOGY)

Increasing muscular activity needs the more O_2 and RBC supply to the acting muscles. This can be done by:

- By increasing HR
- By increasing BP
- By increasing cardiac output
- By increasing venous return
- By reducing blood flow to the inactive muscles and non-vital organs
- By redistributing the blood from the non-vital organ to vital organ.

Changes in Cardiovascular System

Effect on Heart

A prolonged exercise causes the enlargement of heart. Generally, hypertrophy of the heart in athletes caused by the strenuous exercises. This type of hypertrophic and enlarged heart is totally different from the diseased enlarged heart, i.e. cardiomegaly. What the athletes are having is the physiological change but the diseased enlargement due to the diseased pathology. The athletes of hypertrophic heart having the increased stroke volume but the dilated diseased heart will not be having the strength to work harder.

Effect on Heart Rate

The enormous increasing of the heart rate observed at the beginning stage of the exercise and after some time the raising ratio of heart rate comes down. During the early stage of the exercise the raising of the heart rate due to the cerebral activation on the medullary cardiac center. This heart rate raising differs from an individual to individual. The athletes having the reduced heart rate than the normal man while performing exercise, if the stamina increases the heart rate decreases with the exercises.

Effect on Cardiac Output

The cardiac output tremendously increases with the strenuous exercise. In athletes the cardiac

output may be 30 liters per minute but the same is 22 liters per minute for the normal man. Cardiac output increases with the increased stroke volume mostly observed in the athletes as said above (see effect on heart).

Effect on Venous Return

During the muscular exercise the venous return increase. It may be due to (1) continuous muscular contraction which squeezes and pumps blood towards the heart, (2) reflex venous constriction increases the venous return, and (3) respiratory movement increases the sucking effect on the right heart, during the inspiration the intrathoracic pressure decreases and the abdominal pressure increases which causes the rapid return of the blood to the heart.

Effect on BP

The muscular exercise increases the systemic BP. The raising of the BP due to the (1) Increased HR (2) Increased COP (3) Increased vasoconstriction in the non-vital organ. The increasing of the HR and the cardiac and vasoconstrictor centers of the medulla stimulate the cerebral cortex to increasing BP.

Effect on Circulation

During exercise blood supply to the active muscles and vital organ increases, it is found that the blood supply increases 30 times during exercise than the normal state. While performing exercise, the workload of the heart increases with the need. In moderate exercise coronary flow increased depends on the O_2 requirement of the cardiac muscles. Sometimes due to strenuous exercise the cardiac muscle may not be getting the sufficient amount of O_2, in that situation the person may feel the angina pain. The muscular exercise increases the pulmonary circulation but the blood supply to the brain remain normal. While performing exercise the blood flow to the active muscle, heart, and lung are increased but the same is decreased in the abdominal organs, kidney and other non-vital organ.

Changes in Respiration

Pulmonary Ventilation

Pulmonary ventilation is so stable up to the severe exercise is done. The pulmonary ventilation is not increasing with the increasing of consumption of the O_2 by the muscle tissue or the O_2 lack. This pulmonary ventilation increases with the severe increasing of the workload.

Respiratory Rate

The O_2 demand during the strenuous exercise increases the respiratory rate of an individual, it may be due to:

1. Increased production of the CO_2 by the working muscles.
2. Proprioceptive activation of the joint.
3. Reflex effect by the respiratory centers.
4. Increases temperature.
5. Adrenaline hypersecretion.

Effect on Second Wind

In early stage of the strenuous exercise the person feels the distress, headache, throbbing pain, breathlessness and irregular pulse, but if the exercise continued, the distress comes down. This sense of relief is called as second wind. During the second wind distress disappears and the discomfort disappears. But the physiology of the second wind is not so clear.

Effect on O_2 Exchange

During the normal or moderate exercise the O_2 flow to the muscles, lung and the heart is increased. The O_2 tension raises in the alveoli and the arteries. Generally, the O_2 saturation goes up to 4 lt/min. In the severe exercise the O_2 will be lacking due to production of lactic acid by the active muscles. So, the lactic acid

quantity increases in the blood plasma and active muscles. To reduce the lactic acid metabolism, excess amount of O_2 is needed; this lack is called O_2 debt.

Changes in Blood Cell

During the strenuous exercise the fluid enters into the tissue from the blood. So, the hemoconcentration occurs but the prolonged exercise may reduce the hemoconcentration by sending back the fluid into the blood. Sometimes during the strenuous exercise the hemolysis may also occur. The WBC count increases in any sort of exercise. But the raising of the WBC may vary between the normal people to the athletes; it may be less for athletes while comparative with the common man.

Changes in Blood Temperature

Muscular activity produces the heat, if the heat loss is less the body temperature goes up. Normally, during exercise the body temperature goes up due to the temporary failure of the temperature regulation center activation.

Changes in Blood Fluid

During the muscular exercise, there will be the rapid loss of the water through sweating and expired air. In early stage of exercise the fluid enters into the tissue from the blood results in hemoconcentration and comes down by the fluid back to the blood. So, the sweating observed during the early stage of exercises, if exercise prolonged the excessive sweating comes down.

Effect on Kidney Functions

During the exercise the blood flow to the non-vital and the inactive muscles decreases. Due to the decreased blood flow to the kidney, there will be lacking of the urine formation and the increased secretion of the ADH, this ADH increases the fluid reabsorption up to 1 or 2 hours from cessation of the exercise there will be reduced urine flow. Normally, the exercises cause the increased amount of albumin in the urine. Sometimes physical exercise causes the red urine, which contain hemoglobin, it is due to the breakdown of the RBC during the strenuous exercises. It also breaks the myoglobin, which results in the black urine formation 24 to 48 hours after exercise.

Digestive System

The mild exercise, like walking, increases the gastric juice secretion and the motility of stomach. But the strenuous exercise decreases the gastric juice secretion and the stomach motility, but increasing after cessation of the exercise will compensate the same.

Endocrine Function

The endocrine function during the exercise has not been fully studied. The growth hormone secretion increases with the strenuous exercise. ADH also increases more as discussed earlier but there is no change in the thyroid hormone. The utilization of cortical hormone is increased during the exercise.

3

CHAPTER

Examinations

CINICAL EXAMINATION OF MOTOR NERVOUS SYSTEM

The clinical examination of the motor nervous system consists of the following identities. It is as follows.

Bulk of Muscles

The state of nutrition is examined by inspection and palpation of various muscles, and comparing these on the two sides. In muscular atrophy, the muscle mass decreases and the muscle gives a soft and flabby feeling. Atrophy may be general, following a prolonged illness. Physical exercise increases the bulk (hypertrophy) of the muscles. In some diseases of the muscles (dystrophies), the muscle mass increases (pseudohypertrophy), but these bulky muscles are weak despite their size. Calf and buttock muscles are especially involved.

Measurement of Muscle Bulk

The muscular weakness or the atrophy leads to the reduction of the muscle bulk. To measure the muscle bulk, the bulky area is selected. In general, muscle bulk measurements are done for the quadriceps and calf muscles.

Quadriceps Muscle Bulk

From the base of the patella three points are marked in the bulky area with a difference of

Figs 3.1 and 3.2: Measurements of quadriceps muscle bulk with inch tape

2 or 3 inches. The circumference is measured from all the three marked areas by the inch tape. The difference is compared with the normal side limb (Figs 3.1 and 3.2).

Calf Muscle Bulk

From the apex of the patella three points are marked in the bulky area with a difference of 1 or 2 inches. The circumference is measured from all the three points, the difference is compared with the normal side.

Sometimes circumference measurement is taken for the biceps and the brachioradialis muscles also.

Muscle Tone

It is a state of sustained partial contraction of the muscle, where it may be increased or decreased during pathological condition. Tests for increased tone (hypertonia), or decreased muscle tone (hypotonia), for checking the tones are by passively moving the parts of the limb and assessing the resistance offered by the muscles.

Strength of Muscles

It is the assessment for weakened or paralyzed muscles. It enables to find out the strength of the muscle and its capacity of performing an activity. The strength of the muscles are assessed manually and are graded into five stages according to the medical research council. The manual muscle testing has developed by **Wright** and **Lovett** in 1912. But the **Daniels** and **Worthingham, Kendall** and **Kendall** methods are most commonly used. Before entering into strengthening program one should have the thorough knowledge about the manual muscle testing.

There are two methods of muscle grading.

First Method

0 — No contraction
1 — Flicker of contraction
2 — Full range of movement in elimination of gravity position
3 — Full range of movement in against gravity position
4 — Full range of movement in against gravity position with minimal resistance
5 — Normal.

Second Method

0 — No contraction
1 — Flicker of contraction
1^+ — One-third of movement in eliminating gravity position.
2^- — Two-thirds of movement in eliminating gravity
2 — Full range of movement in eliminating gravity
2^+ — One-third of movement in against gravity position
3^- — Two-thirds of movement in against gravity position
3 — Full range movement in against gravity
3^+ — One-third of movement in against gravity position with minimal resistance
4^- — Two-thirds of movement in against gravity position with minimal resistance
4 — Full range of movement in against gravity position with minimal resistance
4^+ — One-third of movement in against gravity position with maximal resistance.
5^- — Two-thirds of movement in against gravity position with maximal resistance
5 — Full range of movement in against gravity position with maximal resistance or normal.

CLINICAL EXAMINATION OF THE SENSORY NERVOUS SYSTEM

Kinds of Sensations

The sensory nervous system comprises different kinds of sensations, which can be examined in different ways. There are different kinds of sensations, which are as follows:

Epicretic Sensation

These are the mild or light sensations, which are perceived accurately. These are of different types as follows:

a. Fine touch or tactile sensation
b. Tactile localization
c. Tactile discrimination.

Protopathic Sensations

These are the crude and primitive types of sensations.

a. Pressure sensation
b. Pain sensation
c. Temperature sensation.

Deep Sensations

These are the sensations, which are arising from the deep structures.

a. Pallesthetic sensation
b. Kinesthetic sensation (Conscious and subconscious)
c. Visceral pain sensation.

Special Sensations

These are the special and complex sensations like taste, vision, hearing, smell, etc.

The nervous pathways of the sensations are called the sensory pathways and carry the impulses from the receptors to the centers in brain, which are of two types like somatosensory system and viscerosensory system.

Methods of Testing of Different Sensations

Fine Touch

Test with a wisp of cotton, on identical points of the two sides of the body. Test for two points discrimination in addition to touch appreciation and localization. These have been perceived by **Meissner's** corpuscles and **Merkel's disc**, and its center located in sensory cortex. Loss of all sensations and abnormal sensations results in *anesthesia* and *paresthesia* respectively.

Crude Touch

These are still heavier form of touch like a pressure type. Subject may be pressed by a heavy pressure of the examiner's thumb, tested for both sides. Sensations were perceived by *pacinian corpuscles* and its center is located in sensory cortex. Abnormality causes *anesthesia, paresthesia, and hyperesthesia* and *hypoesthesia,* which is the increased and decreased sensitivity of sensory stimuli.

Pain

This sensation is tested by a pin or needle prick of the skin, on identical marks of both sides. This sensation is perceived by *free nerve endings* and its center is located in sensory cortex. Loss of this sensation leads analgesia and other abnormality of *hyperalgesia* or *paralgesia.*

Temperature

This sensation is tested by having the identical parts of both sides to be tested by hot water test tube and cold-water test tube alternatively. The subject is asked to say about the temperature felt. This is perceived by **Raffinis end bulb** for warmth sensation and **Krause's end bulb** for cold sensation. The center is located in sensory cortex. Loss of this sensation leads to *thermic anesthesia.*

Kinesthetic Sensations

These are the sensations by which a person becomes aware of the position and movements of different joints of the body. The impulses arise from muscles, tendons, joints, and ligaments. This is perceived by *proprioceptors, muscles spindles and Golgi bodies.* The center located in cerebellum. Loss of this kinesthetic sensation leads to *akinesia* and loss of vibratory sense leads to *pallenesthesia.* Loss of ability to recognize any known object with closed eyes due to loss of cutaneous sensations called as *astereognosis.*

EXAMINATION OF REFLEXES

The reflexes which are of importance in clinical neurology can be divided mainly into the following groups:

1. Superficial reflexes
2. Deep or tendon reflexes
3. Visceral reflexes of organic reflexes
4. Pathologic reflexes.

The following points must be remembered in all reflexes:

1. Method of eliciting the reflexes
2. Response or the result produced
3. Afferent and efferent pathway
4. Centers for the reflexes
5. Clinical significance of each reflex.

Superficial Reflexes

The stimulation of a particular part of skin or mucous membrane results in the contraction of certain muscles. The reflex arc for skin reflexes seem to be complex and long, and include a number of internuncial neurons. The afferent impulses appear to be carried up through the posterior white columns and spinothalamic tracts and end in midbrain, thalamus or even the forebrain. From here, the impulses are carried down by pyramidal and extrapyramidal tracts to the anterior gray column cells. The neural paths for deep reflexes, on the other hand, are simple and short, ending in the spinal cord itself.

Skin Reflexes

Plantar Reflex (Plantar Flexor Reflex)

A scratch is given along the outer edge of the sole of the foot with a pencil or the blunt point of a needle, starting from the heel towards the little toe, and then, along the bases of the toes, medially. In healthy adults, there is a plantar flexion of the toes, especially the big toe, and the ankle is dorsiflexed and inverted. Stronger stimuli may produce withdrawal of the limb. This reflex is mediated by the first sacral segment of the spinal cord. The extensor plantar response or the Babinski's sign is a pathology occurring in UMN lesions. There occurs a dorsiflexion of the big toe followed by extension and fanning of the other toes. Babinski sign is a part of the mass flexor withdrawal reflex, which is seen in the cases of spinal cord transection.

The pathway for this reflex is afferent by tibial nerve (L_5, S_1), efferent by L_4, L_5, center is S_1, S_2.

Epigastric Reflex

Stroking the chest with a blunt point of the needle, downwards from the nipple results in drawing in of the epigastrium on the same side. Center is T_7,T_8.

Superficial Abdominal Reflex

A light stroking of the skin, preferably directed towards the umbilicus, results in brisk contraction of anterior abdominal muscles lying directly under the stimulus. Centers are T_8, T_9, T_{10}, T_{11}, T_{12}.

Cremastric Reflex

Stroking the inner side of upper thigh results in drawing up of the testicle due to contraction of cremastric muscle. Center is L_1, L_2.

Mucous Membrane Reflex

Corneal or Conjunctival Reflex

Touching the cornea or conjunctiva with a wisp of cotton results in bilateral blinking. Afferent pathway is by ophthalmic division of 5th cranial nerve, efferent pathway is by 7th nerve and center is in pons.

Pharyngeal Reflex

A touch upon the posterior pharyngeal wall with a tongue depressor results in constriction of pharynx. Afferent pathway is by 9th nerve, efferent by 10th nerve, center is in medulla.

Palate Reflex

Touching the mucous membrane covering the soft palate results in elevation of the palate. Afferent by 9th nerve, efferent by 10th nerve, center is in medulla.

Deep Tendon Reflexes

If the tendon of a slightly stretched muscle is sharply tapped with percussion hammer, the muscle contracts immediately. Deep reflexes are 'fractionated' stretch reflexes. The stimulus that initiates the reflex is the stretch of the muscle spindles and not the tendon receptors. Impulses originating in the muscle spindles are conducted to the CNS, and pass directly to the motor neurons, which supply the same muscle. Elicit the deep reflexes on both sides, and compare their speed, amplitude, and the duration of contraction and relaxation of the muscle in each case.

Maxillary Reflex

Strike the middle of the chin with the tip of middle finger when the mouth is slightly opened. The response is a sudden closure of the jaw. Afferent and efferent pathway is by 5th nerve, and center is in pons.

Biceps Reflex

Tap the tendon of the biceps, the response is flexion of the elbow. Afferent and efferent pathway is by musculocutaneous nerve, center is C_5,C_6.

Triceps Reflex

Tap the tendon of the triceps, with the elbow slightly flexed, the response is extension at the elbow. Afferent and efferent pathway is by Radial nerve, and center is C_6, C_7.

Radial Supinator Reflex (Brachioradialis)

Flexion and supination of the forearm upon striking the styloid process of the radius in mid-prone position of the forearm. Afferent and efferent pathway is radial nerve, center is C_6,C_7,C_8.

Patellar Reflex or Knee Jerk

In the high sitting position or when the leg is in the relaxed position tap the patellar tendon. The response is extension at the knee joint. Afferent and efferent pathway is by femoral nerve, center is L_3,L_4.

Ankle Jerk

Dorsiflex the foot slightly with one hand and strike the Achilles tendon with the percussion hammer, the response is plantar flexion of the foot, afferent and efferent pathway is by tibial nerve, and center is in S_1, S_2.

Visceral Reflexes

These are the papillary reflexes, which are grouped into direct and indirect light reflexes.

Light Reflex (Direct Light Reflex)

Examine each eye separately with the subject in a shady, indirectly illuminated place. Shine a bright light into the eye being tested (bring the torch from the side of the eye and never from directly in front of the eye as the subject will reflexly close his eyes). There is constriction of pupil almost immediately; then it dilates a little, and assumes a smaller size after undergoing a few oscillations. Switch off the light; the pupil quickly dilates to its previous size. The optic nerve is the afferent pathway; the center is in the midbrain (the concerned fibers leave the optic tract before the lateral geniculate body and end in the pretectal region of the midbrain on the Edinger-Westphal nuclei of both sides). The efferent pathway is the oculomotor nerve.

Consensual Light Reflex (Indirect Light Reflex)

Place a hand between the two eyes and focus light into one eye, observing the effect on the

pupil of the unstimulated side. There is constriction of the pupil in the other eye (i.e., both pupils constrict). The constriction of the pupil on the unstimulated side is called the consensual or indirect light reflex. This response is due to crossing of some of the fibers in the optic chiasma and their termination on the oculomotor nuclei of both sides. Switch off the light and note that both pupils dilate. The consensually mediated reaction is more active than the direct reaction of a pupil in some lesions of the optic nerve. Afferent pathway is by 2nd nerve, efferent pathway is by oculomotor nerve, and center is in midbrain.

Accommodation Reflex

When one looks at a near object the pupils constrict, the eyes converge, and the lenses become more convex. These three responses constitute accommodation reaction. Hold up your index finger close to the subject's nose and ask him to look at a distant object (or the far side of the room). Then ask him to quickly focus his eyes at your finger. As the eyes converge the pupils constrict, if the patient is unable to see ask him to look at his finger held in front of his eye. Afferent pathway is by 2nd nerve, efferent pathway is by oculomotor nerve, and center is in visual cortex.

Pathological Reflexes

This group includes some primitive responses, which occur only with lesions of UMN. Normally, they are suppressed by cerebral inhibition. The reflexogenic area is widened in upper motor neuron lesions, and the Babinski-like response is obtained from widespread areas.

Babinski's Sign

It is otherwise called extensor plantar response; it was named extensor because the movement of the toe is in extension according to anatomical terminology. This occurs in UMN lesions where, there will be a dorsiflexion of the big toe followed by extension and fanning of the other toes along with dorsiflexion of the ankle and flexion of the knee and hip joint may also occur. This response has also been called 'Babinski toe sign', 'up going toe', and 'positive Babinski reflex'. With slight lesions, this response may be obtained only from the lateral region while a normal response is obtained from the medial region of the sole of the foot. Babinski sign is a part of the mass flexor reflex (withdrawal reflex) seen in cases of spinal cord transection.

The other pathological signs are Gordon's leg sign, Oppenheim's sign, Chaddok's sign, Hoffmann's sign.

CLINICAL EXAMINATION OF CRANIAL NERVES

First or Olfactory Nerve

Take small amount of oil of peppermint and oil of cloves in two small test tubes. Bring these near each nostril separately, one after the other, and ask the patient if he can identify the smell. Irritants such as ammonia and acetic acid should not be used as they also act through the trigeminal nerve. It should be confirmed before the test that the patient is not suffering from common cold. Loss of sense of smell is called *anosmia*. Ask the patient if he has any hallucinations of smell. The olfactory area of the cerebral cortex lies in the uncus of the parahippocampal gyrus.

Second or Optic Nerve

To test the optic nerve first ask the patient if his vision is normal. Acuity (sharpness) of vision can be tested by making the patient read letters of various sizes printed on a ischiaras chart from a fixed distance. It must, of course, be remembered that loss of acuity of vision can be caused by errors of refraction, or by the presence of opacities in the cornea or the lens

(cataract). As part of a normal clinical examination the field of vision can be tested by confronation test as follows. Ask the patient to sit opposite you (about half a meter away) and look straight forwards at you. As one eye to be tested at a time ask the patient to place a hand on one eye so that he can see only with the other eye. Stretch out one of your arms laterally so that your hand is about equal distance from your face and that of the patient. In this position you will probably not be able to see your hand. However, you may notice it if you move a finger. Keep moving your index finger and gradually bring the hand towards yourself until you can just see the movements of the finger. This gives you an idea of the extent of your own visual field in that direction. By asking the patient to tell you as soon as he can see the moving finger you can get an idea of the patients field of vision in the direction of your hand. By repeating the test placing your hand in different directions a good idea of the field of vision of the patient can be obtained. If an abnormality is suspected detailed testing can be done using a procedure called *perimetry*.

If there is any doubt about the integrity of optic nerve the retina is examined using an *ophthalmoscope*. With this instrument we can see the interior of the eye through the pupil of the eye. The optic disc and blood vessels radiating from it can be see.

Injuries to different parts of the visual pathway can produce various kinds of defects. Loss of vision in one-half (right or left) of the visual field is called *hemianopia*. If the same half of the visual field is lost in both eyes the defect is said to be *homonymous* and if different halves are lost the defect is said to be *heteronymous*.

Third, Fourth and Sixth Nerve (Oculomotor, Trochlear and Abducent Nerve)

The oculomotor (3rd nerve), trochlear (4th nerve), and the abducent (6th nerve) are tested together as they innervate the external ocular muscles, which move the eyes. The 6th nerve supplies the lateral rectus, the 4th nerve innervates the superior oblique, and the 3rd nerve supplies all the other extraocular muscles, along with the sphincter pupilae, ciliary muscle (the muscle of accommodation) and the levator superiors.

i. Ask the patient to look at your finger held at a distance of about 2 feet from his eyes. Notice if there is any squint *(strabismus*). Ask the patient if he has double vision (*diplopia)* or gets attacks of vertigo.
ii. Test for pupillary light reflexes and the convergence accommodation reflex. Notice the size, shape, and mobility of the pupil.
iii. Fix the chin of the patient with left hand and ask him to follow the movements of your right index finger with his eyes. Move your finger in the cardinal directions. The eyes move normally 50° outwards, 50° inwards, 33° upwards, and 50° downwards. Test the rotatory movements of the eyes also. Observe if there is any limitation of movement in any direction.

Injury to these nerves leads to pathology of *diplopia* which means the double vision, *squint (strabismus)* where two eyes are deviated from the normal angle which are of two types—paralytic squint and concomitant squint, and *skew deviation* where one eye is directed upwards and the other downwards.

Fifth or Trigeminal Nerve

Both the motor and the sensory functions are tested.

Motor Functions

Ask the patient to clench his teeth—the masseter and temporal muscles contract, and should become equally prominent on either side. Confirm by placing your hands on the muscles. The muscles will fail to become prominent if there is paralysis on that side. Ask him to open his mouth—the jaw will deviate to

the side of paralysis, the healthy lateral pterygoid muscles pushing it to that side.

Sensory Functions

Test the sensations of touch, pain and temperature over the entire face and over posterior one-third of the tongue. Test the corneal reflex on both sides because the trigeminal nerve forms the afferent path of this reflex. As already mentioned, loss of corneal reflex is one of the early signs of 5th nerve lesion.

Injury to this nerve causes paralysis of the muscles supplied by this nerve and *referred pain, trigeminal neuralgia, mandibular nerve block*.

Seventh or Facial Nerve

The facial nerve supplies the muscles of the face including the muscles that close the eyelids, and the mouth. The nerve is tested as follows:

i. Ask the patient to close his eyes firmly. In complete paralysis of the facial nerve, the patient will not be able to close the eye on the affected side. In partial paralysis the closure is weak and the examiner can easily open the closed eye with his fingers.
ii. Ask the person to smile. In smiling the normal mouth is more or less symmetrical, the two angles moving upwards and outwards. In facial paralysis the angle fails to move on the paralyzed side.
iii. Ask the patient to fill his mouth with air. Press the cheek with your finger and compare the resistance (by the buccinator muscle) on the two sides. The resistance is less on the paralyzed side. On pressing the cheek air may leak out of the mouth because the muscles closing the mouth are weak.
iv. The sensation of taste should be tested on the anterior two-thirds of the tongue.

Injury to this nerve leads to *facial palsy* and *Bell's palsy*, where supranuclear lesions occur in the former and infranuclear lesions occur in the later in which both upper and lower parts of the face are equally affected. Loss of taste sensation over the anterior two-thirds of the tongue can be found.

Eighth or Vestibulocochlear Nerve

This nerve is responsible for hearing (cochlear part) and for equilibrium (vestibular part). Normally, we test only the cochlear part. The hearing of the patient can be tested by using a watch. First, place the watch near one ear so that the patient knows what he is expected to hear. Next, ask him to close his eyes and say, when he hears the ticking of the watch. The watch should be held away from the ear and then gradually brought towards it. The distance at which the sounds are first heard should be compared with the other ear.

In doing this test it must be remembered that loss of hearing can occur from various causes such as the presence of wax in the ear, or middle ear disease. Nerve deafness can be distinguished from deafness due to a conduction defect by noting the following:

i. Sounds can be transmitted to the internal ear through air, and can also be transmitted through bone. Normally, conduction through air is better than through bone, but in defects of conduction the sound is better heard through bone.
ii. Air conduction and bone conduction can be compared by using a tuning fork against an object so that it begins to vibrate producing sound. Place the tuning fork near the patients ear and then immediately put the base of the tuning fork on the mastoid process. Ask the patient where he hears the sound better (*Rhinne's test*). In another test the base of a vibrating tuning fork is placed on the forehead. The sound is heard in both ears but is clearer in the ear with a conduction defect (*Weber's test*).

Defects in the vestibular apparatus or in the vestibular nerve are difficult to test and such cases need to be examined by a specialist.

Ninth or Glossopharyngeal Nerve

Testing of this nerve is based on the fact that (a) the nerve carries fibers of taste from the posterior one-third of the tongue; and (b) that it provides sensory innervation to the pharynx.

i. Sensations of taste can be tested by applying substances that are salty (salt), sweet (sugar), sour (lemon), or bitter (quinine) to the posterior one-third of the tongue. The mouth should be rinsed and the tongue dried before the substance is applied.
ii. Touching the pharyngeal mucosa causes reflex constriction of pharyngeal muscles. The glossopharyngeal nerve provides the afferent part of the pathway for this reflex.

Tenth or Vagus Nerve

This nerve has an extensive distribution but testing is based on its motor supply to the soft palate and to the larynx.

i. Ask the patient to open the mouth wide and say 'aah'. Observe the movement of the soft palate. In a normal person the soft palate is elevated. When one vagus nerve paralysed the palate is pulled towards the normal side. When the nerve is paralysed on both sides the soft palate does not move at all.
ii. In injury to the superior laryngeal nerve the voice is weak due to paralysis of the cricothyroid muscle. At first there is hoarseness but after some time the opposite cricothyroid compensates for the deficit and hoarseness disappears.
iii. Injury to the recurrent laryngeal nerve also leads to hoarseness, but this hoarseness is permanent. On examining the larynx through a laryngoscope it is seen that on the affected side the vocal fold does not move. It is fixed in a position midway between adduction and abduction. In cases where the recurrent laryngeal nerve is pressed upon by a tumor it is observed that nerve fibers that supply abductors are lost first.

Eleventh or Accessory Nerve

Put your hands on the right and left shoulders of the patient and ask him to elevate (shrug) his shoulders. In paralysis the movement will be weak on one side due to paralysis of the trapezius.

Ask the patient to turn his face to the opposite side against resistance offered by your hand. In paralysis the movement is weak on the affected side due to paralysis of the sternoclidomastoid muscle.

Twelfth or Hypoglossal Nerve

This nerve supplies muscles of the tongue. To test the nerve ask the patient to protrude the tongue. In a normal person the protruded tongue lies in the midline. If the nerve is paralyzed the tongue deviates to the paralyzed side.

Protrusion of the tongue is produced by the pull of the right and left genioglossus muscles. The origin of the right and left genioglossus muscles lies anteriorly and the insertion lies posteriorly. Each muscle draws the posterior part of the tongue forwards and medially. Normally, the medial pull of the two muscles cancels out, but when one muscle is paralyzed, it is this medial pull of the intact muscle that causes the tongue to deviate to the opposite side.

Deviation of the tongue should be assessed with reference to the incisor teeth, and not to the lips. Remember that in facial paralysis the tongue may protrude normally, but may appear to deviate to one side because of asymmetry of the mouth.

CLINICAL EXAMINATION OF THE CARDIOVASCULAR SYSTEM

A person suffering from heart disease may present with many symptoms, some of which may not appear to be apparently connected with cardiovascular system. Heart disease may be detected during a routine clinical examination, though the patient may not complain of any symptoms. Some symptoms are constantly encountered in heart diseases, which are dyspnea, palpitation, cardiac pain, GI symptoms, respiratory symptoms, and urinary symptoms. Clinical examination of the cardiovascular system undergoes through different processes and it consists the following examinations:

1. Examination of the arterial pulses
2. Recording of the blood pressure
3. Inspection and palpation of the system
4. Percussion
5. Auscultation.

Examination of Arterial Pulses

The pulse is the lateral pressure exerted by the walls of the blood vessels. It forms an elastic coiling and recoiling type. The pulse has been felt by the tip of the three fingers ((index, middle, and ring finger). Middle finger feels the pulse, index finger varies the pressure on the artery whereas ring finger is used to prevent the retrograde pulsation from the palmar arch. The examiner should notice for the rate, rhythm, volume, tension, and character of the pulse to find out the abnormal changes or may be of any pathology.

The normal pulse rate is 70-80 beats/minute.

The pulses were felt all over the body, which are of, carotid artery pulse, superficial temporary artery pulse, brachial artery pulse, radial artery pulse, femoral artery pulse, posterior tibial artery pulse, popliteal artery pulse, dorsalis pedis, etc. Increase in pulse more than 100/min represents tachycardia and decrease in the rate less than 60/min represents bradycardia.

Recording of the Blood Pressure

This is done by auscultatory method, in which subject's blood pressure is measured by an apparatus called sphygmomanometer. Here subject's hand is tied by the cuff present in the apparatus around the elbow and pressure is raised by the hand pump. Then as the pressure is being released the pulse beats have been auscultated with a stethoscope, noting down the appearance and disappearance of the sound. This has been noted as the systolic and diastolic pressure. Normal blood pressure is 120/80 mm of Hg. Increase in this pressure leads to hypertension and decrease in this pressure leads to hypotension.

Inspection and Palpation

The subject should be examined in good light, with chest bared, but without unnecessary exposure to chill, both in sitting and supine positions. Notice the shape of the chest and precardium and observe if there is any dyspnea and cyanosis. Subject should be examined for the pulsations of the veins, pulsations in the thoracic region, pulsations in the epigastrium, apex beat and the thrills and murmurs. Thrill is the palpable murmur.

Percussion

Place your left middle finger firmly in contact with the skin. Strike its middle phalanx with the tip of the right middle finger 2-3 times. The percussing finger should be relaxed and should not be lifted up more than 3 inches or so and the movement of the hand should be loose and at the wrist and the finger joints and not at the elbow. Notice two things while percussing (a) the feeling imparted to the percussed finger and (b) the sound produced, which differs both quantitatively and qualitatively.

Auscultation

The auscultation takes a major role in the examination of the cardiovascular system. Here the heart sounds were being auscultated with the help of stethoscope. These sounds were heard due to the closure and opening of the valves present in the heart.

There are four heart sounds to be heard and these sounds can be heard in four places around the heart.

- Aortic area—2nd right intercostal space close to sternum
- Pulmonary area—2nd left intercostal space close to sternum
- Tricuspid area—Apex or xiphoid process of sternum
- Mitral area—5th right intercostal space in midclavicular line.

The sounds are rhythmic in nature and, first and second sounds were heard close in a short interval whereas, interval is long between the second and the first sounds. Third sound is heard immediately after the second sound, which is not audible usually, and the fourth sound hears just before starting of the first sound. The sounds which are heard is given below as follows:

- First sound (S1)—Louder and resembles LUBB sound heard during the closure of AV valves in ventricular systole.
- Second sound (S2)—Not louder resembles DUBB sound heard during the closure of semilunar valves in ventricular diastole.
- Third sound (S3)—Not heard loud, occurs in rapid ventricular filling.
- Fourth sound (S4)—Not heard loud, occurs in atrial contraction.

Heart murmur is an abnormal sound that consists of a flow noise that is heard before, between, or after the normal heart sounds or that may mask the normal heart sounds.

LEG LENGTH DISCREPANCY

In normal individual itself we can observe the mild difference in the leg length. If the leg length difference is less than one inch. It is considered as normal but the difference goes more than one and half inches is considered as abnormal. It needs the proper corrective treatment. First, the reason for the leg length discrepancy is analyzed before the treatment is carried out.

Causes

1. Congenital deficiency of limb, e.g. congenital shortening of femur, phocomelia congenital shortening of tibia.
2. Trauma, e.g. malunited fracture, premature epiphyseal closure in fracture, loss of bony fragment after open fracture
3. Poliomyelitis
4. Pelvic tilt or drop
5. Scoliosis
6. Gout disease like osteomyelitis
7. Soft tissue shortening or contracture
8. Bony abnormalities, e.g. coxa vara, coxa valga, genu varum and genu valgum.

Leg Length Measurement

There are two types of leg length measurements:

1. True shortening measurement
2. Apparent shortening measurement

True Shortening Measurement

To measure the true shortening of the limb, the patient is positioned in supine lying. The legs are kept parallel to each other 15 to 20 cm apart. The measurement is taken from ASIS to the medial or lateral malleolus of the patient with the inch tape.

To know the correct area of the leg discrepancy the examiner has to measure.

- From ASIS to greater trochanter (for coxa-vara)
- From greater trochanter to lateral knee joint line (for femoral shortening)
- From medial joint line of the knee to the medial malleolus (for tibial shortening)

Apparent Shortening of the Leg

Even though the true shortening measurement shows nil difference in the leg length but the examiner may feel the height difference by observation. That time the apparent shortening has to be performed; by this method we can know the leg length difference due to spinal or pelvic problem. If any difference in the spinal level or in the pelvic level, it cannot be measured by the true length measurement. Apparent length measurement has to be made by positioning the patient in supine lying. The measurement is taken from umbilicus or the xiphoid sternum to the medial malleolus.

Spasticity Grading

0 — Normal muscle tone
1 — Slight increasing in muscle tone catch when limb is moved
2 — More marked increased in muscle tone but limb easily flexed
3 — Considerable increase in muscle tone
4 — Limb rigid in flexion or extension.

MEASUREMENT OF THE PELVIC ANGLE OF INCLINATION

See in the Chapter Pelvic Tilt (Chapter 7).

TESTS FOR INCOORDINATION

Upper Limb

Finger Nose Test

Patient is asked to touch the tip of the index finger of the one hand and the nose alternatively with the index finger of another hand. In cerebellar disease, the patient touches the nose with the wavy and oscillatory motion (here and there) and finally touches the nose. In posterior column disease, the patient can touch the nose accurately with eye-opening but he cannot touch with closed eyes.

Finger-to-Finger Test

Patient is asked to abduct both the shoulders 90° with elbow in extension and ask the patient to bring both the index fingers towards midline and touch each other. Cerebellar diseased patient may touch each other by the wavering and oscillating fashion. But the posterior column diseased person can touch accurately with opened eyes, but not with closed eyes.

Rapid Alternating Movement

The patient is asked to do the pronation and supination movement alternatively. In cerebellar lesion the patient feels difficulty in performing this movement, this phenomena is called as dysdiadochokinesia.

Lower Limb

Finger Toe Test

The therapist's finger is pointed two feet above the patient's great toe and instructs him to touch with the great toe. The cerebellar disease patient can touch the finger with the oscillatory or light bouncing movements. But it can be done accurately with the opened eyes but not while closed, by the posterior column diseased patient.

Heel-Shin Test

Patient is asked to touch the knee with the opposite side heel and is sliding on the shin towards the great toe. Same test is asked to the patient to perform without rubbing on the shin. In cerebellar disease, the heel is carried up to overshoot the knee. If the heel is carried down, it begins to execute an action tremor. In posterior column disease the patient cannot perform it due to the inability to recognize the position of the joint.

Romberg's Test

Patient is made to stand straight with the eyes opened. Then the patient is instructed to shut the eyes. Patient may begin to sway and may even fall if he is not supported, it occurs the patient with posterior column disease. But cerebellar diseased patient can stand even the eyes are closed also.

TEST FOR JOINT RANGE OF MOTION

The fourth chapter (Goniometry) explains in detail about the techniques of measuring the joint passive and active range of motion measurement.

4

CHAPTER

Goniometry

DEFINITION

The instrument, which is used for measuring the range of motion of the joint, is called as goniometer. The term goniometry is derived from the Greek words *Gonio*—Angle and *Metron*—Measurement.

To measure a range of motion of a particular joint the therapist should have the thorough knowledge on the range of motion of an individual joint, types of range of motion, osteo and arthrokinematic of the joint and axis and plane of the joint. Above said portions are mentioned in the Chapters 2 and 10.

TYPES OF GONIOMETER

1. Universal goniometer
2. Gravity dependent goniometer or fluid goniometer
3. Pendulum goniometer
4. Electrogoniometer

Universal Goniometer

It is designed by *Mr. Moore*. This is very commonest variety. It is having stationary arm, movable arm, and body.

Body

Body of the goniometer resembles like half or full circle protractor. Normally, the half circle protractor contains 0º to 180º or 180º to 0º of readings and the full circle protractor body consists of 0º to 360º and 360º to 0º readings. In the middle of the body axis and fulcrum screw is present, it connects the stationary and movable arm. This axis of the goniometer placed over the axis of the joint, which has to be measured.

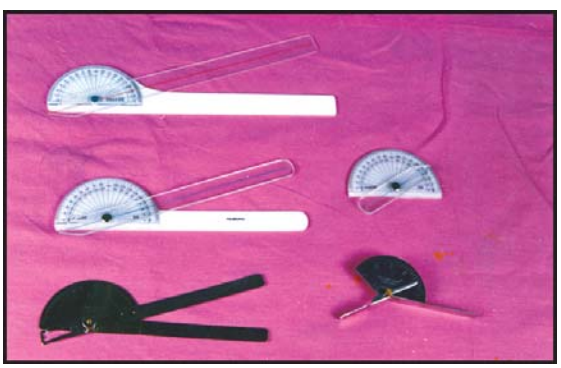


Fig. 4.1: Types of goniometer

Stable Arm

This is the extension from the body of the goniometer. The stable arm does not have any

motion. This will be aligned with the proximal segment of the measuring joint.

Movable Arm

This is the additional attachment with the body of the goniometer in the axis. Movable arm is aligned with the distal segment of the measuring joint.

Gravity Dependent Goniometer or Fluid Goniometer

It is otherwise called as pelvic inclinometer, it is designed by ***Schenkar*** in 1956. It is having gravity effecting pointer and the fluid filled chamber with the air bubbles. It resembles like the carpenter's level meter. It is mostly used for measuring the pelvic tilt or drop.

Pendular Goniometer

It is designed by ***Fox*** and ***Van breemen*** in 1934. It consists of 360º protractor with the weighed pointer.

Electrogoniometer

It is designed by ***Karpovich*** and ***Karpovich*** in 1959, it has two arms. One is attached with the proximal segment and another is attached with the distal segment of the measuring joint. The potentiometer is connected with these two arms. Changes in the joint position show the angulations in the potentiometer. It is mostly used for the research purposes.

PROCEDURE

- Patient's clothes are removed where the joint measurement to be taken.
- Position the patient in the relaxed manner and the joint to be measured should be free from any obstructions like pillow, couch, etc.
- Measuring joint has to be in 0º position.
- Total procedure should be explained to the patient.
- Therapist has to stand near to the patient and facing the joint, which has to be measured.
- Axis or the fulcrum of the goniometer is placed over the axis of the joint to be measured.
- Stable arm is fixed with the proximal segment of the joint.
- Movable arm is fixed with the distal segment of the joint.
- Therapist has to move the distal segment of the joint with the movable arm of the goniometer to measure the joint range.

SELECTION OF THE GONIOMETER

Selection of the goniometer is much more important factor while measuring the range of motion of the joint. If the bony segments of the joints are big, the bigger size, i.e. bigger length movable and stable armed goniometer has to be used and for the smaller segment *vise versa*. Normally, the inclinometer is mostly used to measure the pelvic motion.

POSITION OF THE PATIENT

Position of the patient is another factor has to be noticed carefully while measuring the joint range with the goniometer. Proper positioning of the patient itself is the competition of half of the procedure of measuring the joint range. To measure the range of motion of one particular joint, the below mentioned factors has to be followed.

- The joint structures have to be in relaxed manner.
- Joint should be in zero or starting position.
- The complete range of motion of the joint has to be permitted.
- Proximal joint has to be fixed or stabilized

There is no proper recommended position to measure the range of motion with the goniometer. It may vary depends on the creativity of an examiner. Only thing is, it should fulfill

the above said condition with the convenient position for the patient as well the therapist.

FACTORS AFFECTING THE JOINT RANGE OF MOTION

Soft Tissue Tightness

Joint soft tissues like muscle, ligament, capsule, cartilage, synovial membrane spasm or tightness causes the reduction of range of motion of the joint. The soft tissue tightness may be due to the prolonged immobilization of the joint, injury around the joint or any joint diseases like osteoarthritis, rheumatoid arthritis, ankylosing spondylitis and TB arthritis.

Adhesion Formation

Adhesion formation of the joint reduces the ROM of the joint. Lack of mobility of the joint leads to reduction in the flexibility and the nourishment circulation around the joint structures. If the joint structures are immobilized for prolonged period reduces the extensibility, formation of the adhesion and formation of the contraction of the soft tissue around the joint. There will be increasing of the collagen fibers and reduction of the elasticity property of the fibers of the connective and soft tissues of the joint.

Injuries or Inflammation around the Joint

Any recent injuries, inflammatory condition and the joint diseases like osteoarthritis, rheumatoid arthritis, ankylosing spondylitis and TB arthritis and psoriatic arthritis may cause severe pain around the joint. As the result of the pain patient may avoid performing the full range of movement. Sometimes due to fear of pain also patient may not perform any movement. So, as a result, there will be reduction in the active and passive range of movement.

Muscle Bulk

Increasing the muscle bulk may cause the reduction of the active and passive range of motion. For example, for a common man the elbow flexion range of motion will be 125° to 135° but it is very much lower for the body-builders due to their huge biceps muscle bulk.

Sex

The range of motion may vary with the sex. For example, females will be having less hip extension and hyper hip flexion after 25 years, but the same is reverse in male. Generally, female will be having the more flexible increased range of motion than the male.

Age

The range of motion of joint will be more in the infant and childhood due to nonfusion of the bones. Day by day the range of motion reduces with the age difference. While reaching the adulthood, the range of motion reduces while comparing with the childhood and late childhood. The range of motion again bit increases in the old age due to the hypotonicity of the muscles and the reduction of the muscle bulk.

Nervous System

Sometimes the range of motion may vary with the pathological changes, i.e disease process in the nervous system. Spasticity of the muscle, which is the result of the UMN lesion, will be reducing the range of motion and the joint said to be hypomobile. The LMN lesion, which causes the flaccidity, will result in hypermobile joint. If the musculoskeletal disorder arises due to the lesion of any parts of the nervous system like cerebellum, basal ganglion, cerebral cortex, thalamus, hypothalamus, internal capsule, midbrain and pons result in the decreasing or increasing the range of motion.

MEASURING PROCEDURES

Shoulder Joint

Flexion

Fig. 4.2: Measuring the shoulder flexion movement with the goniometer

- *Position of the patient:* Supine lying.
- *Axis:* Greater tuberosity of the humerus is taken as the axis.
- *Movable arm:* Movable arm is placed over the midline of the lateral aspect of arm and is holding by the therapist's right hand.
- *Stable arm:* It is placed straight line to the movable arm and is kept in the air without the patient's body contact and is holding by the therapist's left hand.
- *Procedure:* Therapist's right hand is performing the flexion movement of the shoulder joint with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Extension

- *Position of the patient:* Prone lying.
- *Axis:* Greater tuberosity of the humerus is taken as the axis.
- *Movable arm:* Movable arm is placed over the midline of the lateral aspect of arm and is holding by the therapist's left hand.
- *Stable arm:* It is placed straight line to the movable arm and is kept in the air without the patient's body contact and is holding by the therapist's right hand.

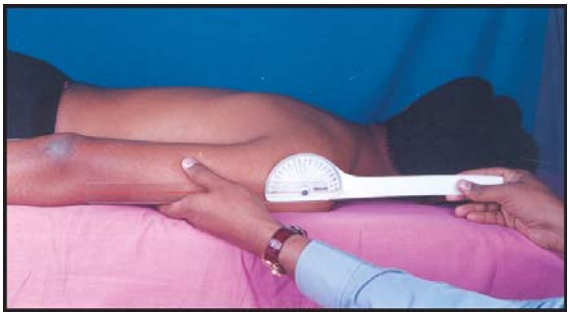


Fig. 4.3: Measuring the shoulder extension movement with the goniometer

- *Procedure:* Therapist's left hand is performing the extension movement of the shoulder joint with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Abduction

- *Position of the patient:* Supine lying.
- *Axis:* One inch below the acromion process of the scapula is taken as the axis.

Fig. 4.4 Measuring the shoulder abduction movement with the goniometer

- *Movable arm:* Movable arm is placed over the midline of the anterior aspect of arm and is holding by the therapist's right hand.

- *Stable arm:* It is placed horizontally on the clavicle and is holding by the therapist's left hand.
- *Procedure:* Therapist's right hand is performing the abduction movement of the shoulder joint with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Medial and Lateral Rotation

- *Position of the patient:* Supine lying with shoulder and elbow 90° position.
- *Axis:* Olecranon process of the ulna is taken as the axis.
- *Movable arm:* Movable arm is placed over the midline of the posterior aspect of forearm and is holding by the therapist's left hand.
- *Stable arm:* It is placed straight line to the movable arm, kept in the air without the patient's body contact and is holding by the therapist's right hand.

Fig. 4.5: Measuring the shoulder medial and lateral rotation movement with the goniometer

- *Procedure:* Therapist's left hand is performing the medial and lateral rotation movement of the shoulder joint with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Elbow Joint

Flexion

- *Position of the patient:* Supine lying.
- *Axis:* Lateral epicondyle of the humerus.
- *Stable arm:* Stable arm is placed over the lateral midline of the humerus.
- *Movable arm:* It is placed over the lateral midline of the forearm.

Fig. 4.6: Measuring the elbow flexion movement with the goniometer

Procedure

- Therapist's left hand is holding the stable arm with the arm of the patient.
- Therapist's right hand is holding the movable arm with the forearm of the patient.
- *Procedure:* Therapist's right hand is performing the flexion movement of the elbow with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Radioulnar Joint

Pronation

- *Position of the patient:* Long sitting and the forearm in midprone position.
- *Axis:* Ulnar styloid process is taken as the axis and the movable arm and the stable arm is kept 90°.
- *Stable arm:* Stable arm is placed perpendicular to the movable arm without any body contact.
- *Movable arm:* It is placed over the anterior aspect of the wrist.

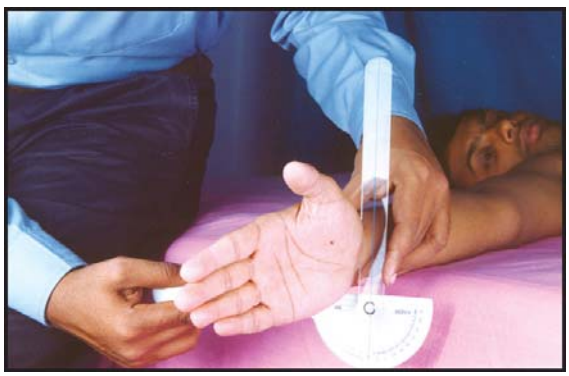


Fig. 4.7: Measuring the radioulnar joint pronation movement with the goniometer

Procedure

- Therapist's right hand is holding the stable arm without the patient's body contact.
- Therapist's left hand is holding the movable arm in anterior aspect of wrist of the patient.
- *Procedure:* Therapist's left hand is performing the pronation movement of the forearm with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Supination

- *Position of the patient:* Long sitting and the forearm is midprone position.

Fig. 4.8: Measuring the radioulnar joint supination movement with the goniometer

- *Axis:* Ulnar styloid process is taken as the axis and the movable arm and stable arm is kept at 90°.
- *Stable arm:* Stable arm is placed perpendicular to the movable arm without any body contact.
- *Movable arm:* It is placed over the posterior aspect of the wrist.

Procedure

- Therapist's left hand is holding the stable arm without the patient's body contact.
- Therapist's right hand is holding the movable arm posterior aspect of wrist of the patient.
- *Procedure:* Therapist's right hand is performing the supination movement of the forearm with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Wrist Joint

Flexion

- *Position of the patient:* Long sitting. The shoulder is abducted 90°, forearm is supinated and resting on the table and the wrist is kept hanging in the couch end.

Fig. 4.9: Measuring the wrist joint flexion and extension movement with the goniometer

- *Axis:* Medial margin of the wrist is taken as the axis.
- *Stable arm:* Stable arm is placed over the lateral midline of the forearm and is holding by the therapist's left hand.
- *Movable arm:* It is placed over the lateral midline of the little finger and is holding by the therapist's right hand.
- *Procedure:* Therapist's right hand is performing the flexion movement of the wrist with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Extension

- *Position of the patient:* Long sitting. The shoulder is abducted 90°, forearm is pronated and resting on the table and the wrist is kept hanging in the couch end.
- *Axis:* Medial margin of the wrist is taken as the axis.
- *Stable arm:* Stable arm is placed over the lateral midline of the forearm and is holding by the therapist's left hand.
- *Movable arm:* It is placed over the lateral midline of the little finger and is holding by the therapist's right hand.
- *Procedure:* Therapist's right hand is performing the extension movement of the wrist with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Ulnar Deviation

- *Position of the patient:* Long sitting. The shoulder is abducted 90°, forearm is pronated and resting on the table and the wrist is kept hanging in the couch end.
- *Axis:* Middle of the posterior aspect of the wrist is taken as the axis.
- *Stable arm:* Stable arm is placed over the midline of the posterior aspect of forearm and is holding by the therapist's left hand.
- *Movable arm:* It is placed over the midline of the posterior aspect of the middle finger and is holding by the therapist's right hand.
- *Procedure:* Therapist's right hand is performing the ulnar deviation movement of the wrist with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

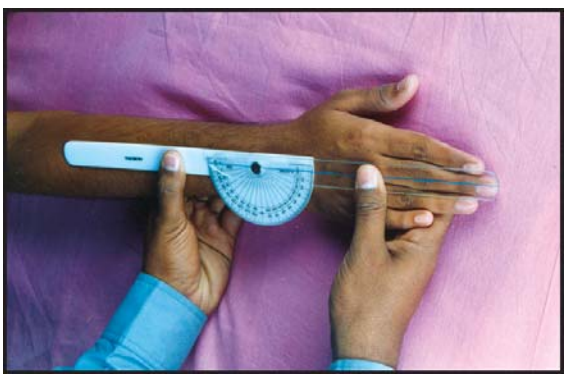


Fig. 4.10: Measuring the wrist joint ulnar and radial deviation movement with the goniometer

Radial Deviation

- *Position of the patient:* Long sitting. The shoulder is abducted 90°, forearm is pronated and resting on the table and the wrist is kept hanging in the couch end.

- *Axis:* Middle of the posterior aspect of the wrist is taken as the axis.
- *Stable arm:* Stable arm is placed over the midline of the posterior aspect of forearm and is holding by the therapist's left hand.
- *Movable arm:* It is placed over the midline of the posterior aspect of the middle finger and is holding by the therapist's right hand.
- *Procedure:* Therapist's right hand is performing the radial deviation movement of the wrist with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

MCP

Flexion

- *Position of the patient:* Long sitting. The shoulder is abducted 90°, forearm is pronated and resting on the table and the wrist is kept hanging in the couch end.
- *Axis:* Middle of the posterior aspect of the joint line of the MCP is taken as the axis and the goniometer is placed in standing manner.
- *Stable arm:* Stable arm is placed over the midline of the posterior aspect of wrist and forearm and is holding by the therapist's right hand.
- *Movable arm:* It is placed over the midline of the posterior aspect of the metacarpal and is holding by the therapist's left hand.

Fig. 4.11: Measuring the MCP joint flexion movement with the goniometer

- *Procedure:* Therapist's left hand is performing the flexion movement of the MCP with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Extension

- *Position of the patient:* Long sitting. The shoulder is abducted 90°, forearm is pronated and resting on the table and the wrist is kept hanging in the couch end.

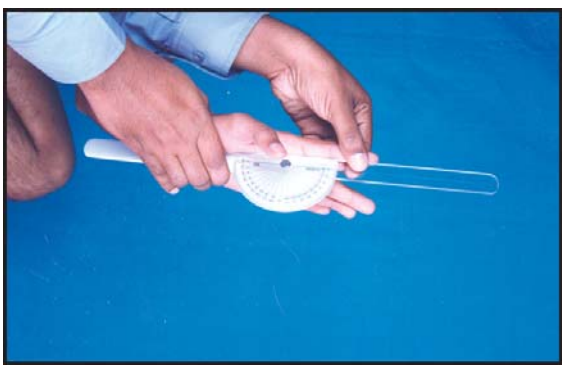


Fig. 4.12: Measuring the MCP joint extension movement with the goniometer

- *Axis:* Middle of the anterior aspect of the joint line of the MCP is taken as the axis and the goniometer is placed in standing manner.
- *Stable arm:* Stable arm is placed over the midline of the anterior aspect of wrist and forearm and is holding by the therapist's right hand.
- *Movable arm:* It is placed over the midline of the anterior aspect of the metacarpal and phalanx and is holding by the therapist's left hand.
- *Procedure:* Therapist's left hand is performing the extension movement of the MCP with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Abduction and Adduction

- *Position of the patient:* Long sitting. The shoulder is abducted 90°, forearm is pronated and resting on the table and the wrist is kept hanging in the couch end.
- *Axis:* Middle of the posterior aspect of the joint line of the MCP is taken as the axis and the goniometer is kept in lying position.
- *Stable arm:* Stable arm is placed over the midline of the posterior aspect of wrist and forearm and is holding by the therapist's left hand.
- *Movable arm:* It is placed over the midline of the posterior aspect of the metacarpal and is holding by the therapist's right hand.
- *Procedure:* Therapist's right hand is performing the abduction and adduction movement of the MCP with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Fig. 4.13: Measuring the MCP joint abduction and adduction movement with the goniometer

PIP

Flexion and Extension

- *Position of the patient:* Long sitting.
- *Axis:* Middle of the posterior aspect of the joint line of the PIP is taken as the axis and the goniometer is placed in standing position.
- *Stable arm:* Stable arm is placed over the midline of the posterior aspect of metacarpal, wrist and forearm and is holding by the therapist's right hand.
- *Movable arm:* It is placed over the midline of the posterior aspect of the phalanx and is holding by the therapist's left hand.
- *Procedure:* Therapist's left hand is performing the flexion and extension movement of the PIP with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Hip Joint

Flexion

- *Position of the patient:* Supine lying.
- *Axis:* Greater trochanter of the femur is taken as the axis.
- *Stable arm:* Stable arm is placed over the midline of the lateral aspect of lower trunk and is holding by the therapist's left hand.
- *Movable arm:* It is placed over the midline of the lateral aspect of the thigh and is holding by the therapist's right hand.

Fig. 4.14: Measuring the hip joint flexion movement with the goniometer

- *Procedure:* Therapist's right hand is performing the flexion movement of the hip with the goniometer and measuring the angle to see the passive range of motion and the

active ROM is measured by patient himself performing the movement.

Extension

- *Position of the patient:* Prone lying.
- *Axis:* Greater trochanter of the femur is taken as the axis.
- *Stable arm:* Stable arm is placed over the midline of the lateral aspect of lower trunk and is holding by the therapist's right hand.
- *Movable arm:* It is placed over the midline of the lateral aspect of the thigh and is holding by the therapist's left hand.
- *Procedure:* Therapist's left hand is performing the extension movement of the hip with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Fig. 4.15: Measuring the hip joint extension movement with the goniometer

Abduction

- *Position of the patient:* Supine lying.
- *Axis:* Two inches below the ASIS is taken as the axis.
- *Movable arm:* It is placed over the midline of the anterior aspect of the thigh and is holding by the therapist's right hand.
- *Stable arm:* Stable arm is placed 90° to the movable arm and is holding by the therapist's left hand.

Fig. 4.16: Measuring the hip joint abduction movement with the goniometer

- *Procedure:* Therapist's right hand is performing the abduction movement of the hip with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Medial and Lateral Rotation

- *Position of the patient:* Sitting in the end of the couch and the legs are kept hanging.
- *Axis:* Tip of the patella is taken as the axis.

Fig. 4.17: Measuring the hip joint medial and lateral rotation movement with the goniometer

- *Movable arm:* It is placed over the midline of the anterior aspect of the leg and is holding by the therapist's right hand.
- *Stable arm:* Stable arm is placed straight line to the movable arm and is holding by the therapist's left hand.
- *Procedure:* Therapist's right hand is performing the medial and lateral rotation movement of the hip with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Knee Joint

Flexion

- *Position of the patient:* Prone lying.
- *Axis:* Lateral joint line is taken as the axis.
- *Movable arm:* It is placed over the midline of the lateral aspect of the leg and is holding by the therapist's right hand.
- *Stable arm:* It is placed over the midline of the lateral aspect of the thigh and is holding by the therapist's left hand.
- *Procedure:* Therapist's left hand is performing the flexion movement of the knee with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Fig. 4.18: Measuring the knee joint flexion movement with the goniometer

Ankle Joint

Plantar and Dorsiflexion

- *Position of the patient:* Sitting in the end of the couch and the legs are kept hanging.
- *Axis:* Tip of the medial malleolus is taken as the axis.
- *Stable arm:* It is placed over the midline of the medial aspect of the leg and is holding by the therapist's left hand.
- *Movable arm:* Movable arm is placed 90° to the movable arm and is holding by the therapist's right hand.
- *Procedure:* Therapist's right hand is performing the plantar and dorsiflexion movement of the hip with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

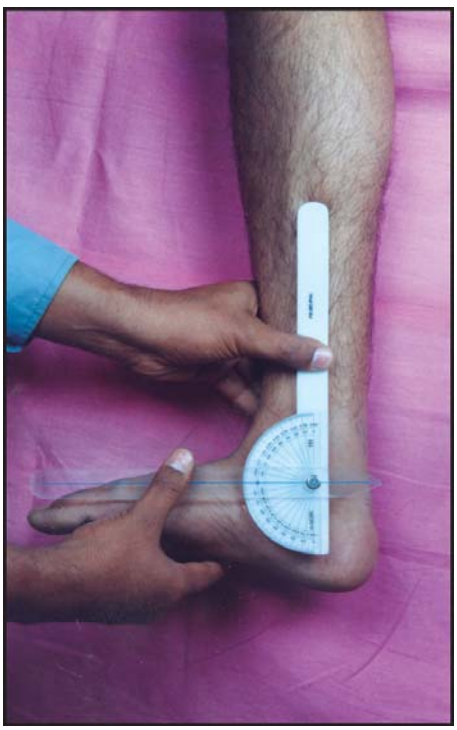


Fig. 4.19: Measuring ankle joint plantar and dorsiflexion movement with the goniometer

Subtalar Joint

Inversion

- *Position of the patient:* Long sitting and the legs are kept hanging.
- *Axis:* Medial joint line of the head of the 1st metatarsal taken as the axis and the movable arm and the stable arm is kept 90°.
- *Stable arm:* Stable arm is placed parallel to the medial aspect of the ankle and lower leg.
- *Movable arm:* It is placed over dorsal aspect of the foot, perpendicular to the stable arm.

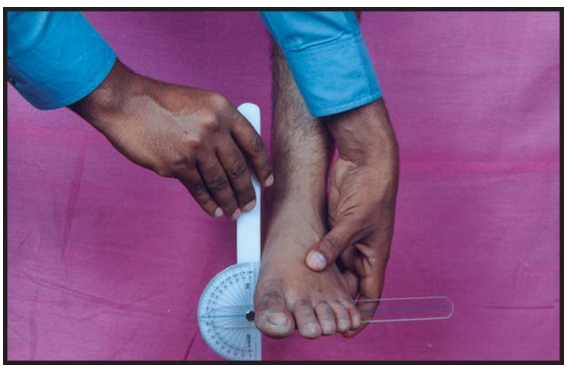


Fig. 4.20: Measuring the subtalar joint inversion movement with the goniometer

Holding

- Therapist's right hand is holding the stable arm.
- Therapist's left hand is holding the movable with the dorsal aspect of the foot.
- *Procedure:* Therapist's left hand is performing the inversion movement of the subtalar joint with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

Eversion

- *Position of the patient:* Long sitting and the legs are kept hanging.

Fig. 4.21: Measuring the subtalar joint eversion movement with the goniometer

- *Axis:* Lateral aspect of the head of the 5th metatarsal taken as the axis and the movable arm and the stable arm is kept 90°.
- *Stable arm:* Stable arm is placed parallel to the lateral aspect of the lower leg.
- *Movable arm:* It is placed over dorsal aspect of the foot perpendicular to the stable arm.

Holding

- Therapist's right hand is holding the stable arm.
- Therapist's left hand is holding the movable with the dorsal aspect of the foot.
- *Procedure:* Therapist's left hand is performing the inversion movement of the subtalar joint with the goniometer and measuring the angle to see the passive range of motion and the active ROM is measured by patient himself performing the movement.

5
CHAPTER

Starting and Derived Positions

STARTING POSITION

The position, which is adopted, by the patient or an individual to perform the exercise or the movement, to gain relaxation and stabilize the body is called as *starting position*. To perform a movement or exercise, the person should adopt one stable position. "Every movement begins in posture and ends in posture". It is applicable for the day-to-day activities too. For example, drinking bed coffee. In this example, the person has to come out of the lying posture and attain sitting posture to drink the coffee or tea. So, the every activity, which we do in our day-to-day life also starts in one posture and ends in some other or same posture. There are five fundamental positions are found by which all the positions are derived. Whatever position we adopt for exercise or movement, it is the position, which altered from the five fundamental positions.

1. Standing
2. Sitting
3. Lying
4. Kneeling
5. Hanging.

DERIVED POSITIONS

These are the positions, which are derived from the starting position. From the five fundamental positions, depend on the patient convenient as well as therapist's convenient, the positions are altered to perform an activity or movement.

Uses

1. To increase stability
2. For relaxation
3. To perform a particular exercise
4. For reducing the muscle work
5. For localizing the activity.

These derived positions may be useful for our daily activities or to perform an exercise. This chapter elaborately explains about the position, which is helpful for an exercise and for the day-to-day activities with the relevant examples. The muscle work for a particular derived position is not explained in this chapter instead of that the movements, which occur in that particular position, are mentioned.

STANDING (FIG. 5.1)

Starting Position—Standing

Introduction

The whole body is supported or aligned by the smaller base. So that this position is most difficult to adopt for longer period. There will

Fig. 5.1: Standing

be a lot of coordinated muscle activity to maintain this posture.

Position

- Foot is placed together and toes placed slightly apart.
- Knees are extended and aligned straight.
- Hip is in neutral position and slight lateral rotated.
- Spine is erect.
- Shoulder adducted and slightly retracted.
- Upper limb is hanging closely to the body.
- Neck is aligned straight.
- Eyes look forward.

Muscle Works

- Flexors and extensors of neck muscles counteract and align the neck in straight position.
- Evertor of the mandible closes the mouth.
- Retractors and adductors of the shoulder keep it in the adducted and slightly retracted position.
- Normally arms are relaxed or sometimes muscle work is minimal or nil.
- Spinal extensors work more to stabilize the spine in erect position.
- The spinal flexor counteracts and balances the spinal extensors.
- Hip extensors maintain the hip in neutral position and the flexors counteract on it for balancing the limb.
- Hip lateral rotator keeps the hip in slightly rotated position.
- Ankle plantar and dorsiflexors counteract and keeps in neutral position.
- Toe flexors work more and make the ball of the toe grip with the floor.
- Intrinsic muscles of the foot stabilize the foot.

Derived Positions—Standing

Many of the derived positions can be derived from the standing by altering the arm, trunk and the lower limb. These positions can be utilized for the different types of exercise regimen, relaxation and stability.

By Altering Lower Limb

a. High standing
b. Walk standing
c. Stride standing
d. Step standing
e. Half-standing
f. Toe standing
g. Close standing
h. Foot and onfoot standing
i. Cross standing.

High standing

- Standing on the stool or in any raised platform (Fig. 5.2).
- Movements as mentioned in the standing.

Uses in exercise therapy

- To perform upper and lower limb exercises.
- To perform hanging, swinging the arm and leg.

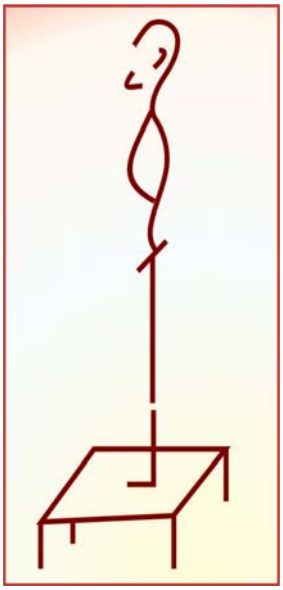


Fig. 5.2: High standing

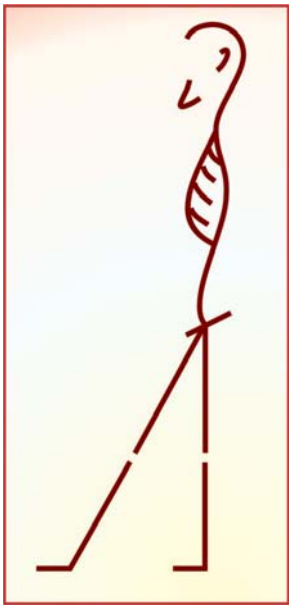


Fig. 5.3: Walk standing

Examples
- To take some object from the height.
- Example fitting the fan in the ceiling.

***Walk standing*:** One leg is placed forward and the base is increased. So, stability will be more in this position (Fig. 5.3).

Movements:
- Hip—Flexion
- Knee—Extension
- Ankle—Mild plantar flexion.

Uses in exercise therapy
- Starting position for jogging.
- To perform the hip, knee, ankle, and trunk muscles self-stretching.
- Relaxation from the prolonged standing.

Example
- Balancing on rope or rod.

***Stride standing**:* Both the foot kept apart in the side ways. It gives more lateral stability (Fig. 5.4).

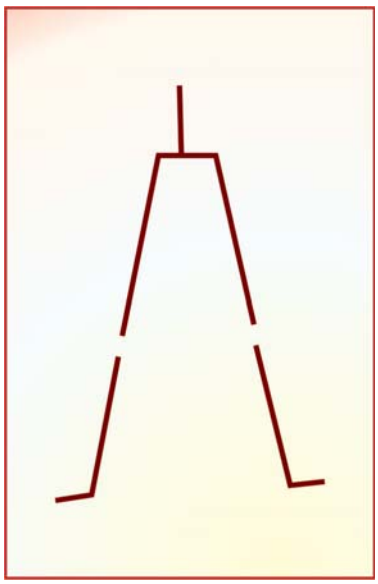


Fig. 5.4: Stride standing

Movements
- Hip abduction
- Knee extension.

Uses in exercise therapy
- To perform the trunk, hip, knee exercises.
- Used for stability.
- Helps to stretch the hip adductors.

Examples
- Sailors standing position.
- Standing posture while traveling in the bus.

Step standing: One foot is kept on the stool or on height. Hip and knee is flexed. This is also one of the stable postures (Fig. 5.5).

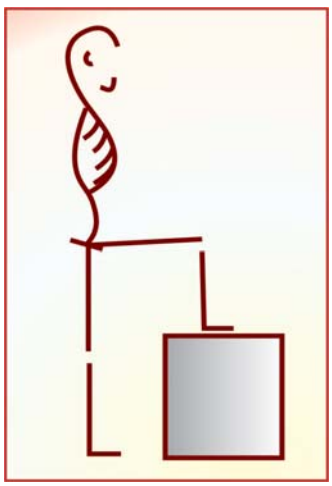


Fig. 5.5: Step standing

Movements
- Hip flexion
- Knee flexion.

Uses in exercise therapy
- For stretching the knee ankle, hip and trunk muscles.

Examples
- Position adopted to tie the shoelace.
- Position adopted to cutting the toenails.

***Half standing*:** Standing with the one leg. One leg is flexed totally. It is the very difficult position to maintain for long period (Fig. 5.6).

Muscle works
- Abductors of the opposite side, i.e. supporting leg prevent the tilting.

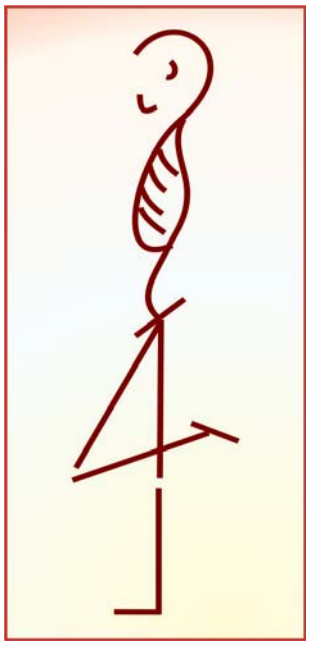


Fig. 5.6: Half-standing

- Spinal side flexors support the spine.
- Supporting leg muscles work strongly.

Uses in exercise therapy
- Leg swinging exercise.
- Stretching the knee, hip and muscles.

Examples
- Pick-up some objects from the floor with the toes.
- Position adopted to remove the thorn in the sole of the foot.

***Toe standing*:** Standing with the toes and toes raise the body. This is also one of the unstable position because the COG increases and the BOS decreases in this position (Fig. 5.7).

Uses in exercise therapy
- Strengthening the plantar flexors and toe extensors.
- Stretching the dorsiflexors.

Example
- Raising the body by the toes to see the invisible things in the crowd.

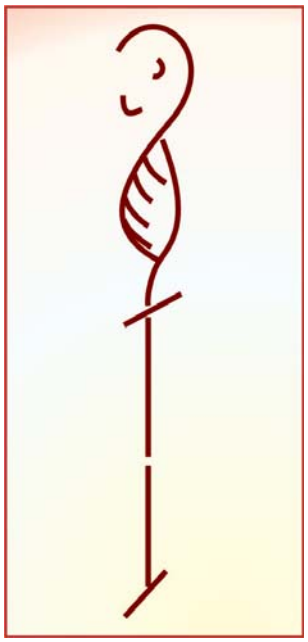


Fig. 5.7: Toe standing

Close standing: Both the foot is kept closer and parallel to each other. It is difficult to maintain this posture due to the tension created in the leg muscles (Fig. 5.8).

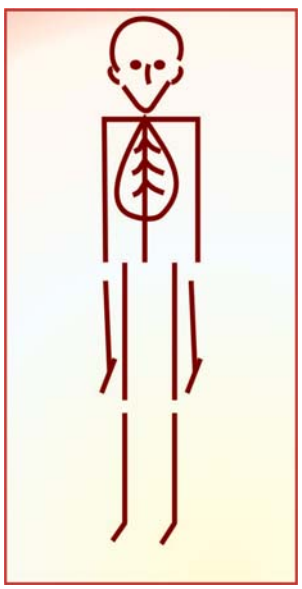


Fig. 5.8: Close standing

Movement

- Hip internally rotated.

Uses in exercise therapy

- To perform hip, trunk bending and rotational exercises.
- Arm swinging exercises.
- Starting position for sit-up exercises.
- To perform the upper and lower extremity exercises.

Examples

- Suriya namaskar position.
- Erect standing posture in military.
- Standing posture during national anthem.

Lunge standing: The feet are placed right angle to each other. If the forward leg bends, the weight transmitted to the same leg (Fig. 5.9).

Movements

- Hip abduction and lateral rotation.
- Knee flexion of the relaxing leg.

Uses in exercise therapy

- Weight transmitting exercises.
- To perform balancing and coordination exercises.
- Lower limb stretching exercises.

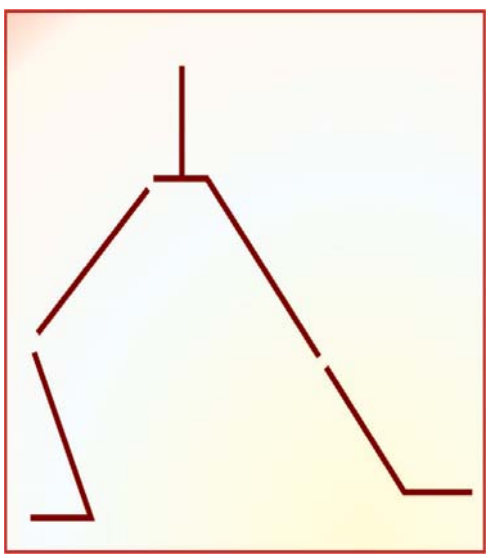


Fig. 5.9: Lunge standing

Example
- Relaxed standing positions after prolong standing.

Cross leg standing: Legs are kept crossed. This is the unstable position due to the improper weight transmission. One leg is kept straight and weight bears, another leg is rotated and kept cross to the supporting leg and the toes are placed on the floor (Fig. 5.10).

Movements (non-weight bearing leg)
- Hip laterally rotated and slightly abducted.
- Knee flexed and laterally rotated.
- Ankle lightly plantar flexed.

Uses in exercise therapy
- For relaxation.
- Weight transmission and balancing exercises.

Examples
- Stylish and casual relaxed standing position.
- Lord Krishna's standing position.

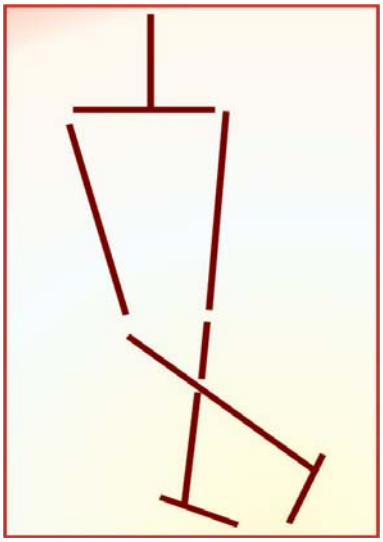


Fig. 5.10: Cross standing

Foot and onfoot standing: One foot is kept on the dorsal surface of the other foot (Fig. 5.11).

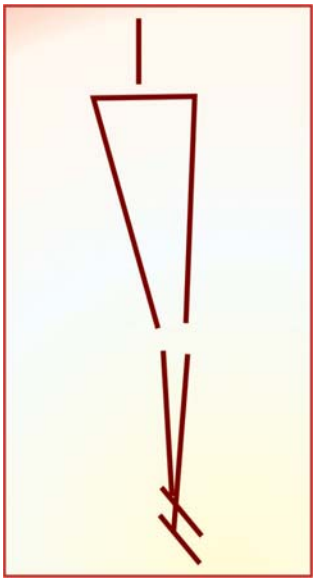


Fig. 5.11: Foot and onfoot standing

Movements
- Hip flexed, adducted, and medially rotated.
- Knee flexion.
- Ankle plantar flexed.

Uses in exercise therapy
- Weight transmission and coordination exercises.

Example
- The posture adopted while walking on hot surface.

By Altering Arm

a. Wing standing
b. Bend standing
c. Reach standing
d. Stretch standing
e. Yard standing
f. Cross-arm standing
g. Heave standing.

***Wing standing*:** Both the hands are placed on the pelvic region of the either side (Fig. 5.12).

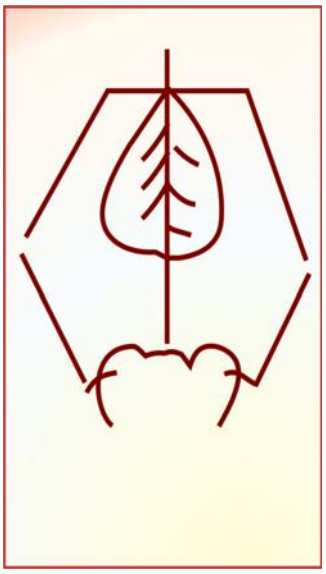


Fig. 5.12: Wing standing

Movements
- Shoulder abducted and medially rotated.
- Elbow flexed.
- Thumb abducted.
- Fingers adducted and flexed.
- Forearm pronated.

Uses in exercise therapy
- To perform trunk bending exercises.
- To perform neck exercises.
- To perform lower limb strengthening and stretching exercises.

Example
- Relaxing position after prolonged walking or jogging.

Bend standing: Elbow is flexed and hands placed on the same side of the shoulder (Fig. 5.13).

Movements:
- Shoulder abducted and laterally rotated.
- Elbow flexed.
- Forearm supinated.
- Fingers flexed.

Uses in exercise therapy
- Shoulder rotation exercises.

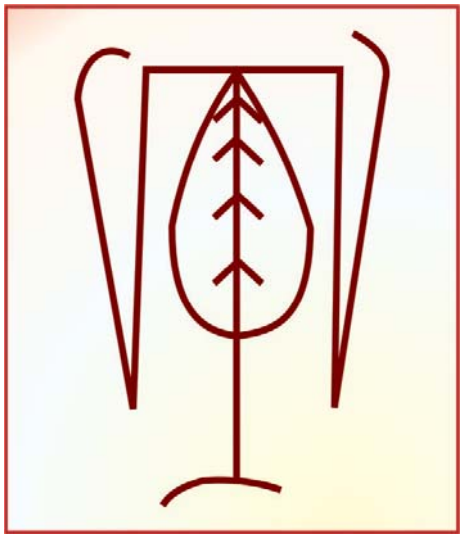


Fig. 5.13: Bend standing

- Trunk bending exercises as well as neck exercises.

Examples
- Policeman fixing the star in his shoulder.
- Removing dust from the shoulder.

***Reach standing*:** The upper limbs are kept parallel and right angle to the body (Fig. 5.14).

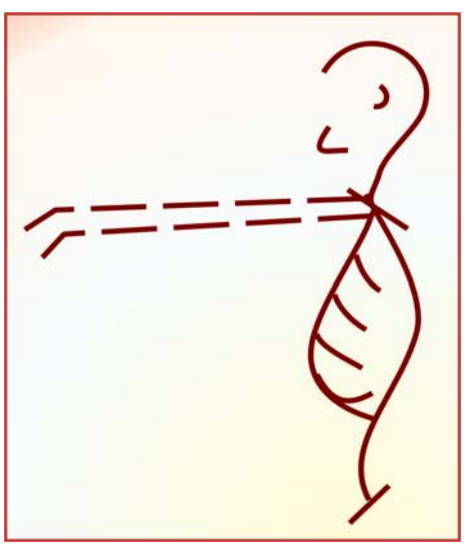


Fig. 5.14: Reach standing

Movements
- Shoulder flexed and elevated.
- Elbow extended.
- Forearm in midprone position.
- Wrist and fingers extended.

Uses in exercise therapy
- To perform wrist exercise.
- Grasping the horizontal bar with the hand can perform sit-up exercise.

Examples
- Position adopted to carry the child.
- Walking style in the dark place to avoid dashing on the objects.

Yard standing: Upper limbs are kept in the sides and perpendicular to the body with palm facing up (Fig. 5.15).

Movements
- Shoulder abducted, laterally rotated and extended.
- Elbow extended.
- Forearm supinated.
- Wrist and fingers extended.

Uses in exercise therapy
- To perform trunk rotation and bending exercises.
- To perform wrist, elbow, and finger exercises.
- To perform arm swinging movements.

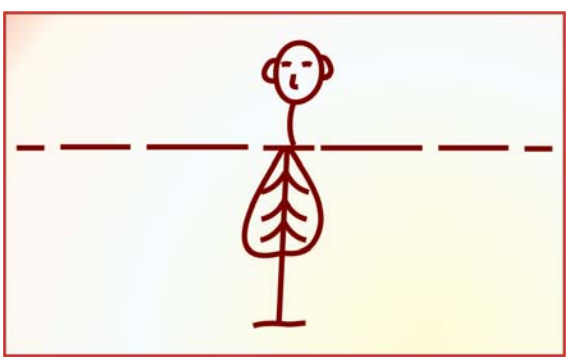


Fig. 5.15: Yard standing

Example
- Balancing while walking on the rope or rod.
- Umpire's wide signaling in cricket.

Stretch standing: Upper limb is totally elevated up and placed parallel to the body line (Fig. 5.16).

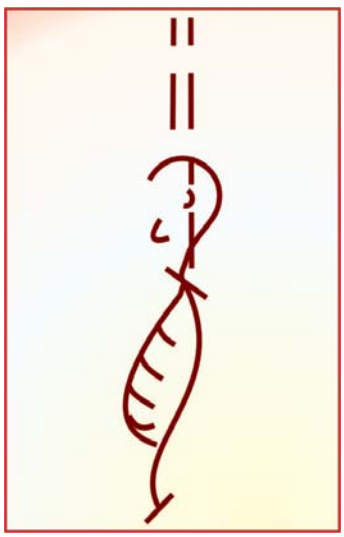


Fig. 5.16: Stretch standing

Movements
- Shoulder flexed and medially rotated.
- Elbow extended.
- Wrist and finger extended.

Uses in exercise therapy
- To perform arm swinging exercises.
- To perform trunk exercises.

Examples
- Repairing the ceiling fan.
- Overhead activities.

***Cross-arm standing*:** Elbow is flexed and hands are placed on the opposite side shoulder (Fig. 5.17).

Movements
- Shoulder adducted and medially rotated.
- Elbow flexed.
- Forearm pronated.
- Wrist and fingers flexion.

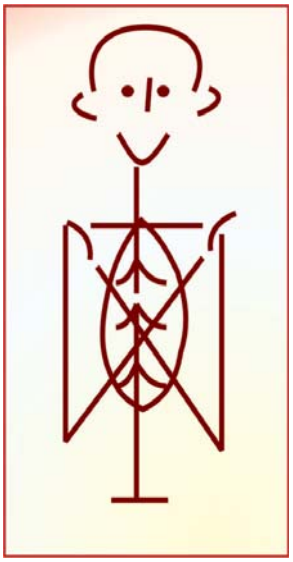


Fig. 5.17: Cross-arm standing

Uses in exercise therapy

- To perform trunk bending and rotation exercises.
- To test the shoulder dislocation.

Example

- Waiters or slavery position.

Heave standing: Arm and forearm kept at right angle and shoulder kept 90° abducted (Fig. 5.18).

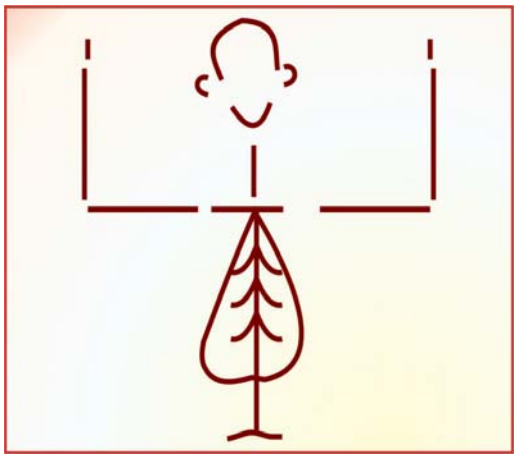


Fig. 5.18: Heave standing

Movements

- Shoulder abducted, extended and laterally rotated.
- Elbow flexed at 90°.
- Wrist and finger extended.

Uses in exercise therapy

- Shoulder rotational movements.
- To perform forearm supination and pronation.

Examples

- Carrying weight over the back by holding with the hand.
- Symbol of surrender.

By Altering the Trunk

a. Relaxed stoop standing.
b. Stoop standing.
c. Fallout standing.

Relax stoop standing: Hip and trunk are flexed totally and the upper limb kept hanging (Fig. 5.19).

Movements

- Hip flexed.
- Trunk flexed.
- Upper limb relaxed and kept hanging.

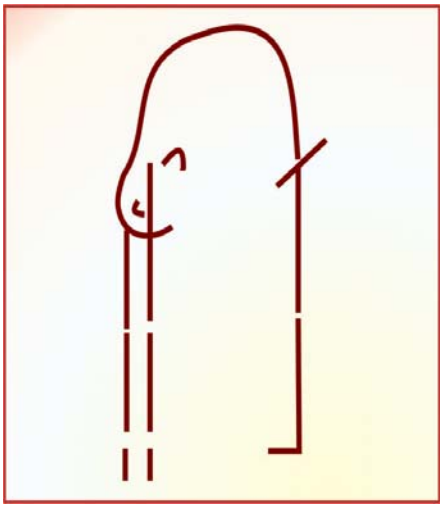


Fig. 5.19: Relax stoop standing

Uses in exercise therapy
- Trunk bending and stretching movement can be performed.
- Stretching the trunk and hip muscles.

Examples
- Sweeping the floor.
- Position adopted while tying the lace or adjusting the shoes.

Stoop standing: Trunk is inclined forward and upper limb placed parallel to the bodyline to this position (Fig. 5.20).

Movements
- Trunk flexed.
- Hip flexed.
- Shoulder adducted, extended and laterally rotated.
- Elbow is extended.
- Finger and wrist extended.

Uses in exercise therapy
- Pendular movements of the shoulder.
- Trunk bending and stretching exercises.

Example
- Rickshaw pulling position.

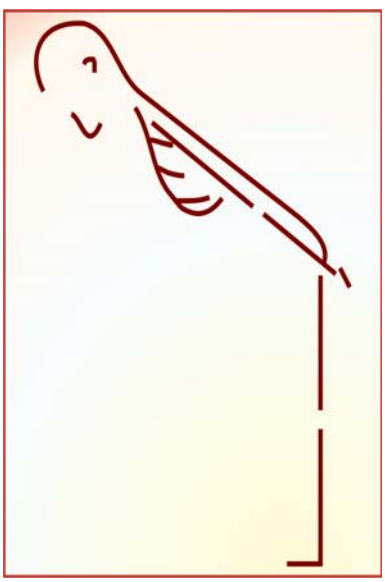


Fig. 5.20: Stoop standing

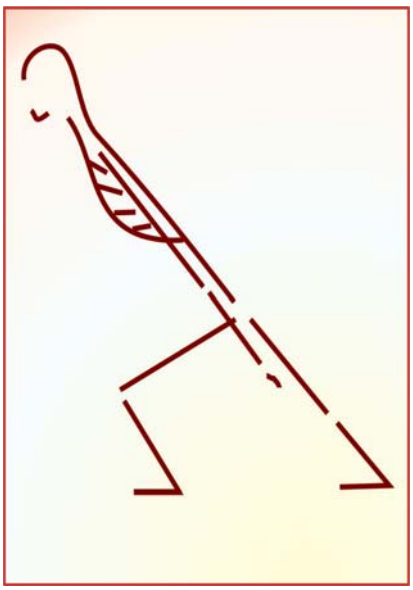


Fig. 5.21: Fallout standing

Fallout standing: One leg kept forward with knee bending, the other leg remains straight and the trunk inclined forward (Fig. 5.21).

Movements
- Forward leg: Hip flexed and knee flexed.
- Backward leg: Hip extended, knee extended and ankle dorsiflexed.

Uses in exercise therapy
- Stretching the hip flexors.
- Strengthening exercises to the forward leg can be performed.

Example
- Pulling the loaded bullockcart.

SITTING

Starting Position—Sitting

The position adopted while sitting on the stool or the chair is considered as the fundamental position of the sitting. The thighs and the legs are relaxed and the foot is resting on the floor. From the trunk to head the position is same as said in standing posture. The base of support is

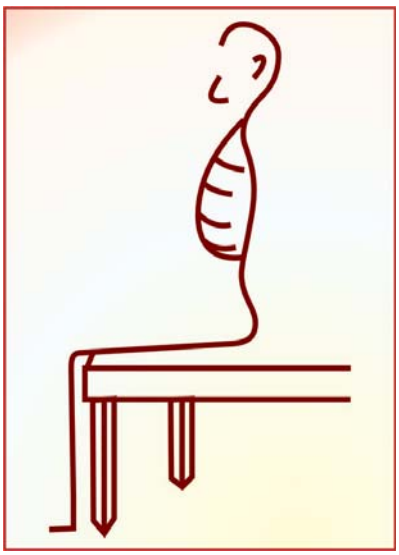


Fig. 5.22: Sitting

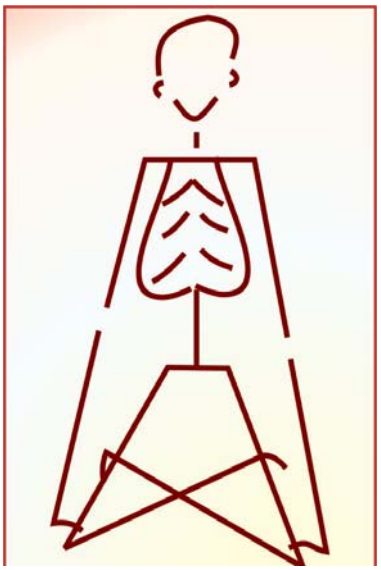


Fig. 5.23: Cross sitting

more, so the COG lies down. Due to the downward movement of the COG the position gets more stability than the standing and the muscle work required is also less (Fig. 5.22).

Muscle Works

There is no muscle work in the lower limb because the stool supports thighs and legs, and the foot is resting on the floor. Remaining parts from the trunk to head the muscle work is same like the standing posture.

Derived Position—Sitting

1. Cross sitting
2. Side sitting
3. Crook sitting
4. Long sitting
5. Stoop sitting
6. Ride sitting
7. Foot sitting (squatting).

Cross Sitting

Both the legs are crossed and the weight is transmitted through both the hips (Fig. 5.23).

Movement

Both the side hips are flexed, laterally rotated and knee flexed.

Uses in exercise therapy

- Breathing exercise and reduce the respiratory distress
- Hip adductor stretching
- Trunk and neck exercise.

Example

- Some floor level activities like eating, cutting vegetables, etc.

Side Sitting

This position is possible either one side of the hip. In right side sitting the right hip remains like the cross sitting the left hip flexed, adducted medially rotated and knee flexed and kept in side. Weight is transmitted on right side (Fig. 5.24).

Uses in exercise therapy

- Progression from prone to sitting in mat activity.
- To perform trunk exercises.

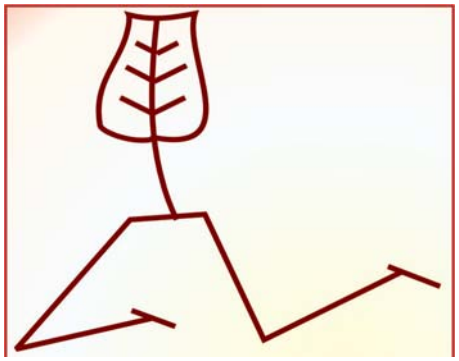


Fig. 5.24: Side sitting

Example

- All floor level activities like cutting vegetables and garland making.

Crook Sitting

Knee and hip are flexed in, and the feet are kept forward while sitting in the floor (Fig. 5.25).

Movements

- Hip flexed,
- Knee flexed, and
- Ankle in neutral position.

Uses in exercise therapy

- To perform mat activities.
- To perform breathing exercises.
- To perform neck and ankle exercises.

Example

Relaxed wall sitting while watching T.V.

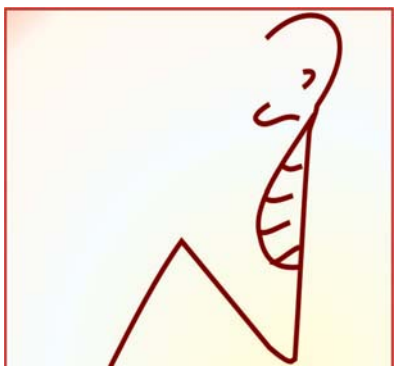


Fig. 5.25: Crook sitting

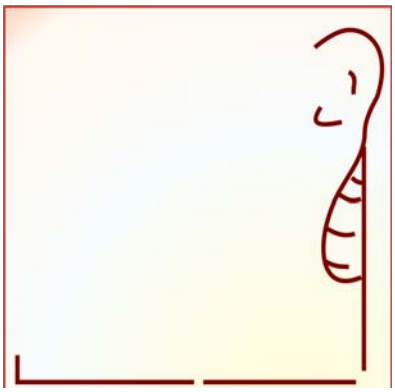


Fig. 5.26: Long sitting

Long Sitting

- Hip is flexed, knee is extended and resting on the floor (Fig. 5.26).

Uses in exercise therapy

- To perform hip rotational movements.
- To perform ankle and knee exercises.
- To perform trunk exercises.

Example

- Traditionally adopted position by the old age people for floor level activities.

Stoop Sitting

Sitting on the stool and the trunk is leaned forward (Fig. 5.27).

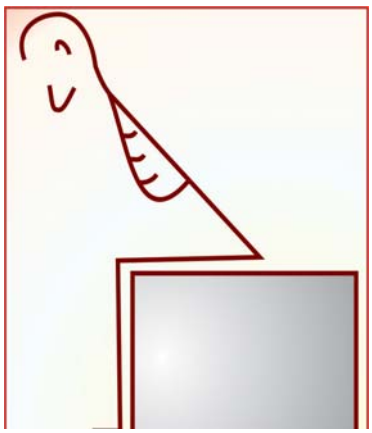


Fig. 5.27: Stoop sitting

Movement
- Trunk flexion.

Uses in exercise therapy
- Used for back and neck massage
- Back muscles relaxation
- To perform breathing exercises.

Example
- Lazy sleeping position in the classroom.

Stride Sitting

Both the hips are abducted and placed in either sides of the stool. If the foot rests on the floor, the position will be more stable (Fig. 5.28).

Uses in exercise therapy
- To perform leg swinging exercises.
- To perform neck and trunk exercises.
- To perform upper limb exercises.

Example
- Bike riding posture.
- Horse riding posture.

Fig. 5.28: Stride sitting

Foot Sitting (squatting)

Sitting on the feet (Fig. 5.29).

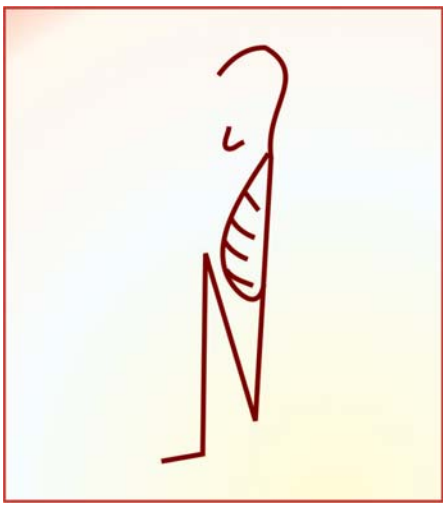


Fig. 5.29: Foot sitting

Movement
- Hip and knees are flexed and weight is transmitted through the feet.

Uses in exercise therapy
- Starting position for sit-up exercises.
- Starting position for running race.

Example
- The position adopted while washing clothes and cleaning vessels.
- Indian style toileting.

LYING

Starting Position—Lying

Lying on the floor or on the plinth, in supine position with arm by the side of the body and legs are kept straight. It is the most stable posture than the any other fundamental starting position due to the lower placement of the COG and the broader base. This position can be adopted for prolonged period than any other starting position (Fig. 5.30).

Muscle Works

In this posture the muscle work is minimal. Maximum muscles are relaxed except some positions:

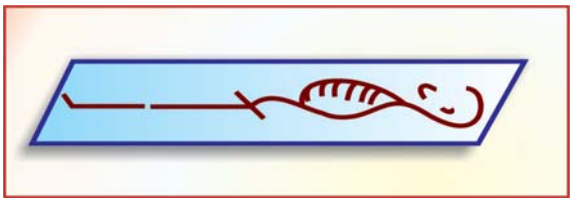


Fig. 5.30: Lying

- Neck side flexors counter balanced to keep the head in neutral position.
- Flexors of the lumbar spine counteract with the spinal extensors to maintain the lumbar lordosis.
- Medial rotators of the hip keep the hip in neutral position.

Uses

It is very much useful position to perform many of the upper limb, lower limb, trunk, neck exercises like strengthening, stretching, aerobic and anaerobic and breathing exercises.

Derived Position—Lying

a. Prone lying
b. Half-lying
c. Crook lying
d. Side lying.

Prone Lying

Anterior portion of the total body is turned towards the couch or floor. This position is inconvenient for maintaining for longer period. All the body parts are relaxed and if the head also gets relaxed, if it turned and kept apart. This position is very much difficult for the respiratory distress and elderly patients (Fig. 5.31).

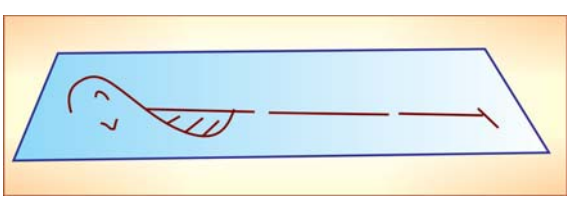


Fig. 5.31: Prone lying

Uses in exercise therapy

- Spinal extensor and neck extensor exercises can be performed.
- This position can be used for back massage.
- Some of the upper and lower extremity exercises can be performed.

Example

Toppled position of getting blessing from the elders.

Half-lying

Same like the supine lying and upper portion is lifted and kept inclined. Some amount of spinal muscle work may be present in this posture (Fig. 5.32).

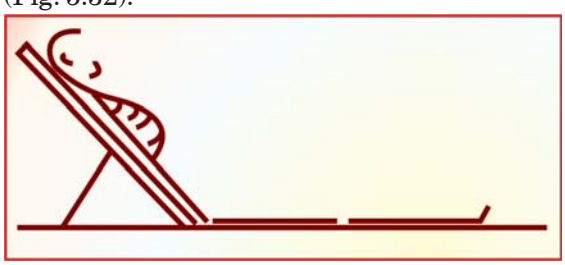


Fig. 5.32: Half-lying

Uses in exercise therapy

- To practice breathing exercise and postural drainage.
- To perform Frenkle's exercise.
- To perform upper limb, lower limb, and trunk exercises.

Example

- Relaxed position to adopt while reading book or watching TV.

Crook Lying

Modifications are made in lower limb in the supine lying posture. The hip and knee are flexed, and the feet is kept forward (Fig. 5.33).

Uses in exercise therapy

- Abdominal muscle strengthening exercises can be performed.
- Pelvic bridging exercises can be performed.

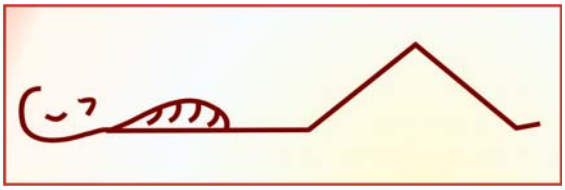


Fig. 5.33: Crook lying

Example

- Relaxing position after yoga exercises.

Side Lying

Lying one side of the body. It is most inconvenient to maintain for longer period. The upper extremity which is placed under the body will be more painful and positioning the lower limb also very much difficult. Upper extremity, which is below the body, is flexed and kept under the head, and the lower limb which is up to be placed forward to reduce the inconvenient (Fig. 5.34).

Uses in exercise therapy

- Many of the upper limb and lower limb exercises can be performed.
- Breathing exercises and postural drainage can be done.

Example

- Daily-unknown activity while sleeping.

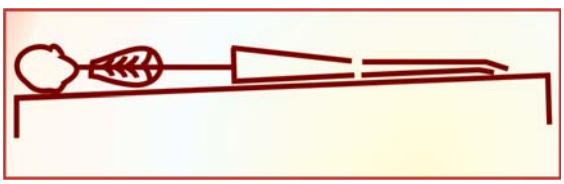


Fig. 5.34: Side lying

KNEELING

This position is like the fundamental position of standing but the weight is transmitted through the knee joint due to the right angle alignment of the knee to the body. The leg is resting on the floor and the ankle is plantar flexed. It is the very much difficult position to maintain for longer period. Even though the COG falls down and the larger BOS, it is inconvenient to adopt due to the weight transmitted through the knee joint (Fig. 5.35).

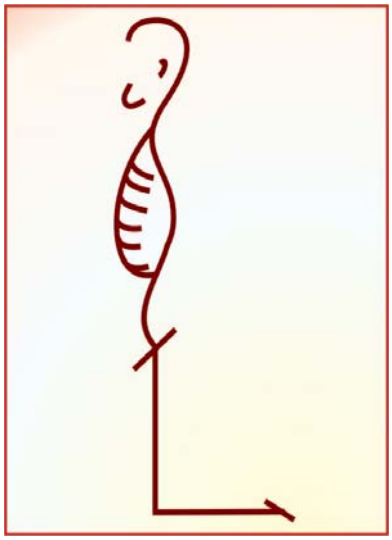


Fig. 5.35: Kneeling

Muscle works

- The leg is relaxed except the plantar flexors of the ankle, which keeps the ankle in plantar flexion state.
- Hip flexors, extensors counteracts with each other and keeps in vertical position and prevents the pelvic tilt.
- Remaining muscle is as said in standing posture.

Uses in exercise therapy

- Many of the upper limb and trunk exercises can be performed.
- To perform the mat activities.
- To perform coordination and balancing exercises.

Example

- Christians prayer position.

Derived Position—Kneeling

1. Half-kneeling

2. Kneel sitting
3. Prone kneeling
4. Inclined prone kneeling.

Half-kneeling

It is like the kneeling position and weight is transmitted through one side knee. Another side hip is flexed 90°, the thigh and leg is kept right angle to each other and the foot is placed on the floor forward (Fig. 5.36).

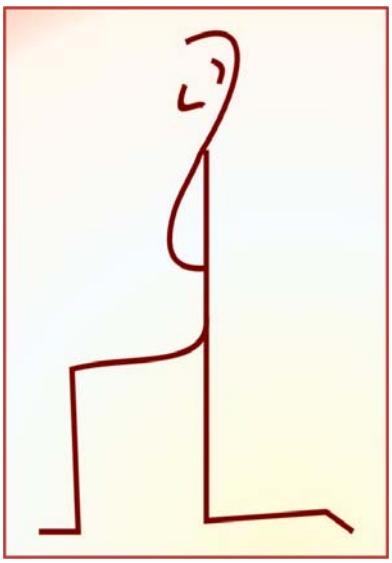


Fig. 5.36: Half-kneeling

Movements

- Forward lower limb: Hip flexed 90°, knee flexed 90°.
- Kneeling lower limb: Hip is in neutral position, knee flexed 90°.

Uses in exercises therapy

- To perform the balancing and coordination exercises.
- To perform trunk bending and neck exercises.
- To perform upper extremity strengthening and stretching exercises.
- To perform the mat activities.

Example

- To practice some of yogic exercises.

Kneel Sitting

Sitting on the heel by flexing the hip and knee (Fig. 5.37).

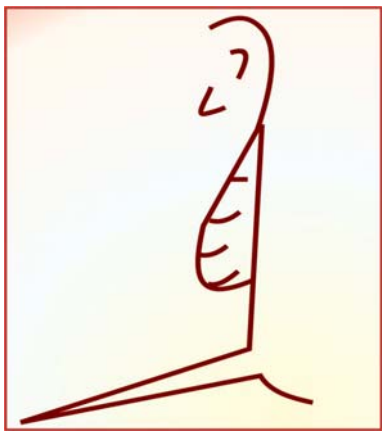


Fig. 5.37: Kneel sitting

Uses in exercise therapy

- To perform trunk bending and stretching exercises.
- To perform neck exercises.
- To perform the stretching and strengthening exercises for the knee and hip muscles.

Example

- Playing posture adopted by the child.
- To perform some of the yogic exercises.

Prone Kneeling

It is otherwise called as quadruped position or animal position. Trunk is inclined forward and is stabilized by the upper limb by placing on the floor, remaining are same like kneeling (Fig. 5.38).

Movements

- Trunk forward bending.
- Shoulder flexed, elevated and medially rotated.
- Elbow extended.
- Wrist and finger extension.

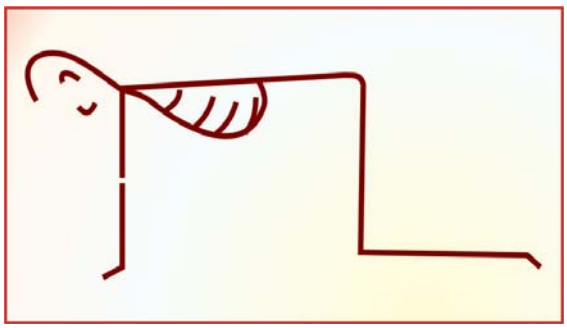


Fig. 5.38: Prone kneeling or quadruped position

Uses in exercise therapy
- To perform mat activity.
- To perform coordination exercises.
- Cat and camel exercises.

Example
- Child crawling position.

Inclined Prone Kneeling

This is the modified variety of quadruped position. In this quadruped position the head also inclined forward and placed on the upper limb, which is flexed and kept on the floor (Fig. 5.39).

Movements
- Trunk forward bending.
- Shoulder abducted, flexed and medially rotated.
- Elbow flexed.

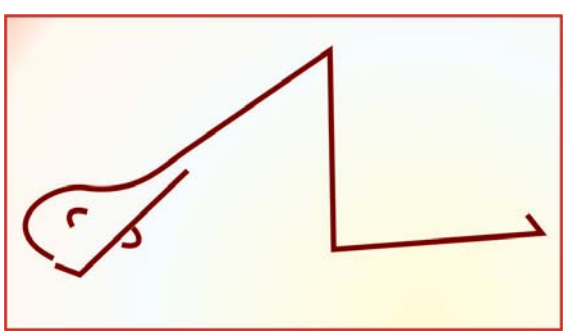


Fig. 5.39: Inclined prone kneeling

Uses in exercise therapy
- To perform breathing exercises and postural drainage technique.

Example
- Muslim *Namaz* position.

HANGING

Total body is suspended by grasping a horizontal bar with the hand (Fig. 5.40).

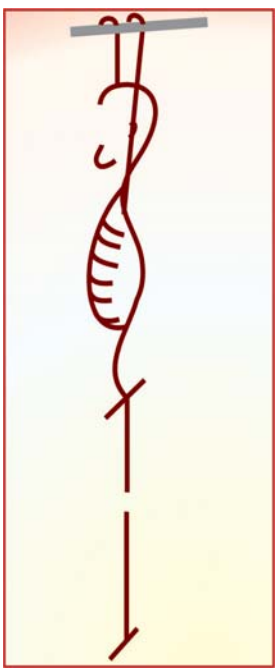


Fig. 5.40: Hanging

Movements
- Shoulder flexed, adducted and medially rotated.
- Elbow is extended.
- Fingers flexed and grasping the rod.

Muscle works
- Adductor and medial rotators of the shoulder work strongly.
- Flexors of elbow carry more weight and also strain.

- Finger flexors work strongly and grasping the bar.
- Adductors of hip keep it in adducted posture.
- Plantar flexors keep the ankle in plantar flexed position.
- Trunk, knee and remaining muscles of the hip is free from the work and movement.

Uses in exercise therapy

- To perform total body swinging movements.
- To perform upper limb strengthening and body-building exercises.
- To perform stretching exercises.

Examples

- Mostly helpful in gymnastic activities.
- Bar exercises.

Derived Position: Hanging

Half-hanging

Same like hanging, but the body is hanging with one side upper limb support. It is also a difficult posture to maintain for longer period. Total body weight is carried out by one side upper limb so that the shoulder, elbow and muscles are facing more strain.

Uses in exercise therapy

It is the most advanced strengthening program for the upper extremity. Generally, it is helpful for the body-builders and gymnastic peoples.

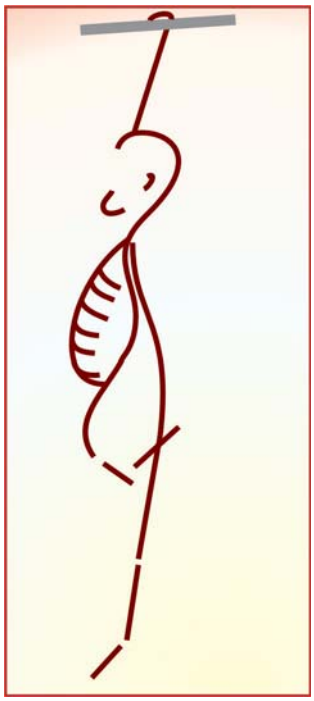


Fig. 5.41: Half-hanging

Example

- Normally, it is used in gymnastic activities.

6
CHAPTER

Relaxation

DEFINITION

If the muscles are free from tension or rest are said to be relaxed.

TYPES

- Whole or total body
- Mental
- Local.

Whole or Total Body Relaxation (Fig. 6.1)

Total body relaxation can be done by positioning the person in some resting position, normally during the lying position only the postural tone of the muscles will be less. So, the alternation is made in the lying posture to attain the maximum general body relaxation. All the derived position from the lying is used for achieving the relaxation of an individual depends on the situation. The person has to be positioned in the firm mattresses or in the spring mattresses; so that the mattresses used with mold depend on the body contours of the patient.

Supine Lying

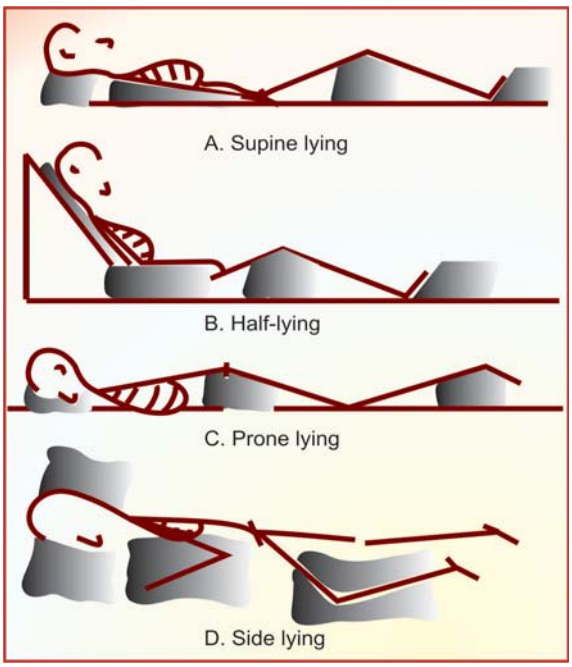
- The anterior portion of the body facing up or lying on the back.
- One pillow is placed under the head to prevent rotating either side.
- One pillow under the knee, which prevents the hamstring tension, reduces the lordotic curvature over the lumbar region, reduce the abdominal muscle and iliofemoral ligament tension.
- Both the arms are abducted and placed on the pillows inside.
- Ankle is positioned in neutral position by placing sandbags.

Half-lying

- This is similar like the supine lying and the head end is lifted up. This position is convenient for the respiratory distress patients and elderly patients because this position reduces the diaphragmatic tension by reducing the abdominal pressure.
- One pillow is placed under the head extended up to the thoracic region supports the upper trunk.
- One pillow is placed under the knee to reduce the hamstring, iliofemoral ligament and abdominal tension.
- Ankle is positioned in neutral position by placing the sandbags.

Prone Lying

- Posterior portion of the body facing up or lying on the front portion of the body.
- This position will be difficult for the respiratory distress and elderly patients to maintain for longer period.
- One pillow is placed under the hips and the lower abdomen to reduce the abdominal pressure by which we reduce the diaphragmatic tension.
- Small tension under the ankle is placed for straight alignment.



Figs 6.1A to D: Relaxed positioning

Side Lying

- The person lying on his one side of the body.
- One pillow under head and neck, which supports and aligns with the body. The pillow should not be too high.
- Uppermost lower extremity hip and knee are flexed and placed on the pillow, which reduces the hip rotators and lower trunk muscular tension.
- Uppermost upper limb shoulder and elbow flexed and placed over the pillow which reduces the shoulder girdle and rotators of the shoulder muscle tension.

The whole body relaxation does not only depend on the position or the support which we give to the patients also depends on the surrounding too. The patient may feel comfort with the room temperature, the dress the patient wears, lighting and air-circulation. If the climate is chill, the mild warm temperature has to be maintained for the soothing effect and during hot climate, chill whether should be maintained by the air-conditioner or air cooler. The tight clothing, corset, belt and the irritable materials should be removed which causes the inconvenient to achieving the relaxation, the fresh air circulation has to be made and there should be good lighting in the room which does not irritate the vision of the patient.

Mental Relaxation

Mental relaxation plays the main role while treating the patient and to render the good service. The mental relaxation can be achieved with help of the above mentioned comfortable measures and also some other factors like psychological fear to the treatment, coloring of the room, peaceful mentality. The coloring of the room has to be perfectly done, the selection of the color place the main role in the alteration of the mind. Normally, mild colors give the mental peaceness, so the dark colors should be avoided. Not only the coloring of the wall but also the curtains, the clothes that we use in the clinic set-up. The patient should have confident with the treatment, which he gets from the therapist. The therapist has to gain the confident of the patient by explaining about the condition, treatment procedure, and effect of the treatment and necessity of treatment. The psychological state of the patient much more important factor to treat an individual

effectively. Health counseling may be effective and helps to gain the confidence of the patient. The noisy surrounding should be avoided because the louder sound may cause the mental alteration and may leads to frustration. The therapist's manner should be courteous, pleasant and his voice low-pitched and clear. The atmosphere of the room should be pleasant, sometimes low-pitched continuous "hum" can be used to smoothen the mind.

Local Relaxation

Relaxing the particular part or segment of the body is called as local relaxation. It can be achieved by massage, relaxed passive movement, supporting the part and by applying the pain relieving modalities. Massage and relaxed passive movement gives the soothing effects to the patient, increases the blood circulation and increases the venous drainage. If the patient has pain over part or segment of the body, the pain relieving modalities like wax bath, hot water fermentation, IFT, SWD, and ultrasound can be used. Whenever the patient gets relieve from the pain, he feels relaxation.

7
CHAPTER

Pelvic Tilt

DEFINITION

The pelvic motion along with the hip and the vertebral column makes the normal sinusoidal curve in the Gait cycle, these pelvic motions are called as "Pelvic tilt". These pelvic tilts may occur due to some pathological problems also.

The pelvic may be inclined tilted in below mentioned ways:

1. Anterior pelvic tilt
2. Posterior pelvic tilt
3. Lateral pelvic tilt
4. Pelvic drop
5. Pelvic rotation.

ANTERIOR AND POSTERIOR PELVIC TILTS (TABLE 7.1)

Anterior and posterior pelvic tilts occur in the sagittal plane and the coronal axis. Anterior and posterior pelvic tilts can be measured by the following ways:

Lumbosacral Angle

The angle made by the line parallel to the ground and the line along the base of the sacrum. Normal lumbosacral angle should be 30°. If it is increased said to be anterior pelvic tilt and if decreased called posterior pelvic tilts.

$$AT > 30° > PT$$

Pelvic Inclinometer

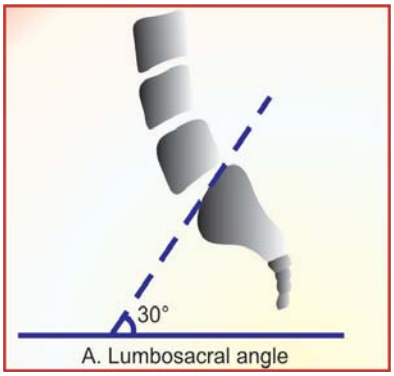
One arm of the pelvic inclinometer placed over the pubic symphysis and another over the PSIS. In normal pelvic tilt, it is 30° change in which said to be anterior or posterior pelvic tilt.

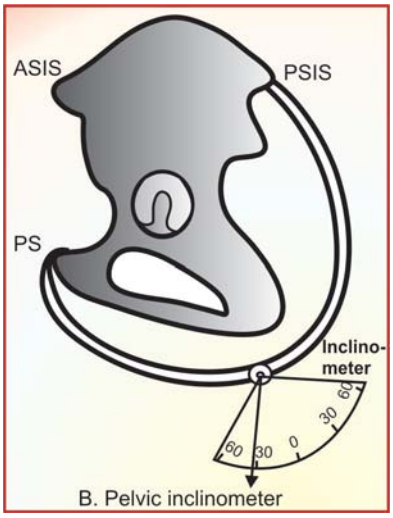
Vertical Line

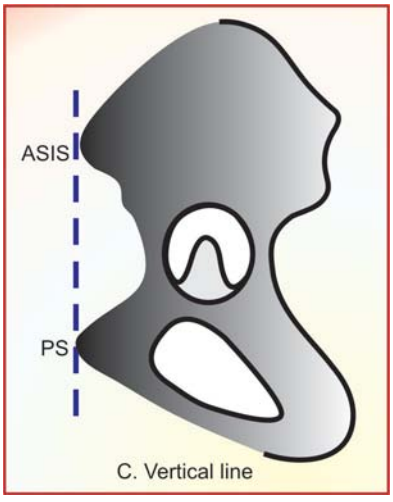
The vertical line drawn from the ASIS to the pubic symphysis aligns in the same line, the alternation in which said to be anterior or posterior pelvic tilt (Fig. 7.1).

Anterior Pelvic Tilt

- ASIS moves anteroinferiorly and down wards.
- Pubic symphysis moves posteriorly and moves closure to the femur.
- ASIS aligned horizontal with the PSIS and vertical line with the symphysis pubis in normal aligned pelvic, it changes in the anterior tilt.





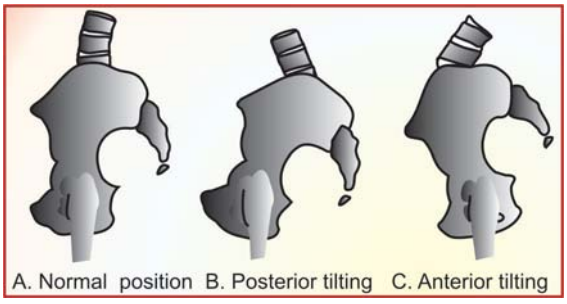


Figs 7.1A to C: Measuring the pelvic tilt

- Sacral angle increases and the lumbar lordosis and thoracic kyphosis also increases.
- Abdominal muscles and the hip extensors muscles are responsible for preventing the anterior pelvic tilt.
- Contraction of the hip flexors and spinal extensor results in the anterior pelvic tilt.

Posterior Pelvic Tilt

- ASIS moves posteriorly.
- Pubic symphysis moves away from the femur instead of femur moves from the pubic symphysis.
- Spinal extensors and hip flexors are responsible for preventing the posterior pelvic tilt.



Figs 7.2A to C: Anterior and posterior pelvic tilts

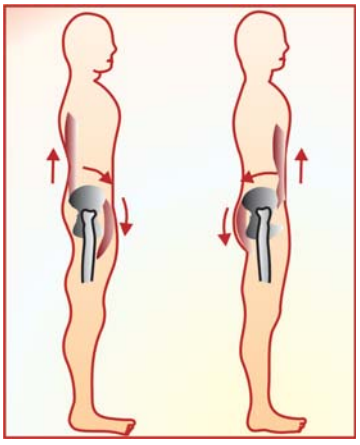


Fig. 7.3: Muscles responsible for pelvic tilt

- Contracture of the hip extensors the spinal flexor results in the posterior pelvic tilt.
- Sacral angle decreases and the lumbar lordosis also decreases (Figs 7.2 and 7.3).

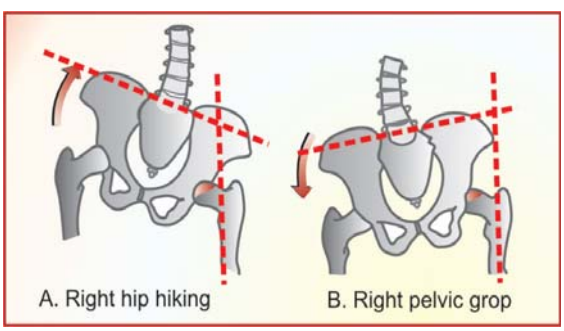
LATERAL PELVIC TILT AND DROP

- It occurs in the frontal plane and the AP axis.
- Both the ASIS aligned in the horizontal line in the normal pelvic. If any changes occur in these alignment said to be lateral tilt or drop.
- Possible during the unilateral as well as bilateral stance.
- In unilateral stance one hip is fixed and another is freely moving and results in drop or hike.

Hiking

In normal person the hip hiking occurs while clearing the foot from the ground. This is needed from pressure relief during prolong sitting. Also it is helpful when the patient walks with the long plaster cast or braces. This movement support to clear the foot from the ground during swing phase.

- During hiking ASIS moves upwards and medially.
- Spine goes for flexion in the same side.
- Hip goes for abduction in the hiking side.
- Hiking occurs due to the contraction of the quadratus lumborum and the spinal side flexors (Fig. 7.4).



Figs 7.4A and B: Hip hiking and pelvic drop

Dropping

- ASIS moves inferiorly and medically.
- Spine goes for opposite side flexion.
- Hip goes for adduction in the drop side.
- Pelvic drop occurs due to the opposite hip abductors weakness. This sign is called as Trendelenburg's sign.
- Both the sides abductor paralysis leads to wadding type of gait otherwise called as "Duck walking".
- In the bilateral stance, if the weight is transferred to the right side, dropping occurs in the same side. During the right side dropping the hip goes for adduction in the tilted side and abduction in the opposite side.

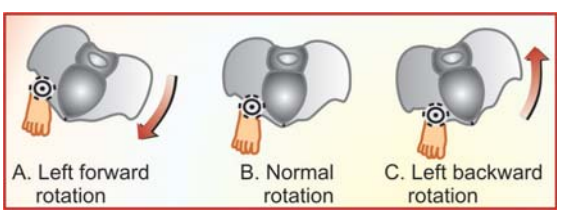
PELVIC ROTATION

- Pelvic rotation occurs in the transverse plane and the vertical axis.
- Pelvic rotation occurs when the swinging leg moves forward and backward on the supported or stance leg.

Examples:

- In normal walking the forward motion in the right side leg results in the right side pelvic forward rotation, left side upper limb swings forward and the stance or weight-bearing hip goes for medial rotation.
- In case of backward motion of the right leg results in the backward rotation of the pelvic, right upper limb swings forward and the stance hip or weight-bearing hip goes for a lateral rotation (Fig. 7.5).

There should be a combination of the pelvic, hip and the spinal movements to maintain the proper gait and the proper sinusoidal curve.



Figs 7.5A to C: Pelvic rotation

Table 7.1 Pelvic tilt in short view

Sr. no	*Pelvic*	*Vertebral column*	*Hip*	*Arm*
01	Anterior tilt	Hyperextension	Flexion	-
02	Posterior tilt	Flexion	Extension	-
03	Lateral tilt (hike)	Same side flexion	Abduction at the same side	-
04	Drop	Opposite side flexion	Adduction at the same side	-
05	Rotation (forward)	Opposite side	Medial rotation at opposite side or weight bearing side	Opposite side arm goes forward
06	Backward rotation	Opposite side	Lateral rotation at weight bearing side.	Opposite side arm goes backwards.

So, during the normal walking itself there is anterior tilt, posterior tilt, lateral tilt, drop and rotations present to propel the body forward. These tilts are altering the body segment during the normal walking and making convenient or easier the walking pattern and reducing the strain in the weight transmission. If any pathological disturbance occurs there will be marked and visible tilts seen. These pathological tilts or drops can be cured by the proper treatment that is by the regular strengthening or stretching program.

8

CHAPTER

Active and Passive Movements

INTRODUCTION

The exercise, which is needed for the treatment purpose, is called as therapeutic exercise. The person performing the exercises in gym and jogging are to build the body and for healthy living. But the therapeutic exercises are the exercises, which are performed to come out from ones ailment or disease. These therapeutic exercises are totally different from the body-building exercises. The main goal of the therapeutic exercise is preparing or making the patient independent or symptom-free movements. It brings back the diseased or injured patient to the normal state, and it plays the major role in the rehabilitation of an individual. To perform the therapeutic exercise one should have thorough knowledge on anatomy, physiology, orthopedic, neurology, kinesiology, pathology, cardiopulmonary and some of the physiotherapy related medical fields. It is believed that the perfect assessment of the disease is the 75 percent of the treatment. The perfect assessment to be made before starting any sort of the therapeutic maneuver. Stretching, strengthening, coordination exercises, mobilization and manipulation, gait correction are the some of the therapeutic exercises used for treating the ailment of the patient.

TYPES OF MOVEMENTS

There are two types of movements.

1. Active movement
   - i. Assisted
   - ii. Free
   - iii. Assisted and resisted
   - iv. Resisted.

2. Passive movement
   - i. Relaxed passive movement
   - ii. Passive manual mobilization techniques
   - iii. Mobilization
   - iv. Manipulation
   - v. Stretching.

ACTIVE MOVEMENTS (ACTIVE—BY HIS /HER OWN)

The movement, which is done by the patient himself, is said to be active movements. Active movements are the voluntary action of the muscles. This may be classified into four varieties.

1. Assisted
2. Free
3. Assisted and resisted
4. Resisted.

Assisted Exercise

If the strength or the coordination of the muscle is insufficient to perform an activity, the external force is utilized to compensate the lack. The muscle has the strength or endurance but is not sufficient to perform an activity or control an action.

Assisted exercise → Manual → Active
Manual → Passive
Assisted exercise → Mechanical

Types of Assisted Exercises

The assisted exercises can be performed manually and mechanically again the manual assisted exercise having the two divisions, i.e. active and passive.

Active assistance: The patient himself can assist with his opposite extremity to perform the assisted exercise.

For example,

a. The opposite leg is used by the patient to increase the flexion movement of the knee in long sitting or prone lying.
b. Upper limbs are used to move the lower limb or opposite side upper limb.

This type of active assisted exercise is very much helpful for the home programming exercise. The main advantage is the patient, he himself only knows the pain limit and availability range of movement. So, that he can perform the exercise conveniently within the pain limit.

Passive assistance: It is classified into:

1. Manual assisted exercise
2. Mechanical assisted exercise.

Manual assisted exercise: The passive assistance may be given by the therapist or by any of the medical professionals or sometime by the patient's relatives and friends. This type of assisted exercise is maximum passive in nature. The patient has to try to perform the movement up to his ability. In passive movement, there will not be a muscle work but in assisted exercise the muscle will be acting throughout the movement.

Mechanical assisted exercises: The assisted exercise is done with the help of the mechanical devices are called mechanical assisted exercises. Suspension therapy, pulleys and springs are the some of the examples for the mechanical assistance. The same can also be used for the resisted exercises.

Principles

Range: The assistance given is changeable depends on the range. Normally, in the beginning and end range, the muscles strength will be less while comparative with the middle range. So, that the assistance provided should be more in the beginning and end range than the middle range.

Command: Some command is needed to activate the patient and perform the effective movement the command gives perfect guideline to the patient to practice an activity.

Concentration: Concentration of the patient is the must in the assisted exercises otherwise the movements will be passive in character. Therapist has to make the patient to concentrate on the treatment well for effective performing the assisted exercises.

Speed: Speed determine the assisted exercises more, if the speed is increased it shows the passive character and also the patient cannot cop up the movement.

Repetition: The movement has to be repeated, so that the joint range and the muscle power can be improved.

Uses

- Increase the ROM of the joint.
- Increase the strength, power and the endurance of the muscles.

- It breaks the adhesion formation around the joint.
- It reduces the spasm of the muscles.
- It stretches the tightened soft tissue.
- It reminds the coordinated movement of the joint or a muscle.
- Increase the blood circulation and venous return to the joint and muscle.

Free Exercise

These are the exercises, which are performed by the patient himself without any assistance and resistance by the external force except the gravity. There will not be any of the manual or mechanical assistance or resistance given in this type of exercise. It is much more useful for the home program schedule. The patient can perform without depending on anybody. But the same has the more disadvantage also. There is the possibility to perform the improper or irrelevant movements and accessory movements, which results in the wrong or the insufficient neuromuscular activation. So, that there should be proper supervision or proper guidance to the patient to perform the free exercises. There are two types of free exercises.

1. Localized
2. General body.

Localized: The localized free exercises are planned and formed to perform to improve one particular joint range or to increase the strength power and endurance of the one group or particular muscles.

Examples:

- Exercise to knee joint.
- Free exercises to shoulder flexor.

General body: These types of free exercises are formed to increase the joint range in multi-joints or to increase the strength of many group or the total body muscles.

Examples: Jogging relaxed walking.

Characteristics of the Free Exercises

There are two types of characteristics of the free exercises namely subjective and objective.

Subjective: It means performing the movements within the perfect anatomical range and pattern. Patient has to concentrate on the perfection of the movement, which he performs.

Objective: There will be some goal to achieve in the exercise program, but not spoiling the perfect pattern and anatomical range movement.

Example: Bending and touching the great toe with the middle finger. Here the goal is set to touch the toe.

Uses

- Increases the joint range.
- Increases the muscle strength, power and endurance.
- Increases the neuromuscular coordination.
- Increases the circulation and venous drainage.
- Increases the relaxation of the muscle by the swinging movements and the pendular movements.
- Repeated active movement breaks the adhesion formation and elongates the shortened soft tissues.
- Regulating the cardiorespiratory function, and the active exercise increases the respiratory and venous return so that the O_2 supply to muscles and blood circulation to the muscle increases.

Resisted Exercises

The activities, which are performed by opposing the mechanical or manual resistance is called as resisted exercises.

Types of Resisted Exercises

Resisted exercises are of two types namely,

1. Manual
2. Mechanical

Manual resisted exercises

In the manual resisted exercise, the resistance can be given by therapists, some other medical professionals and relatives or friends. The resistance also can be applied by the patient himself with his opposite extremity, otherwise it may be taught to the patient's attenders like his relatives or friends. This will be helpful for the home exercises. These exercises can be operated by the following individuals:

1. The therapist
2. Patient himself
3. Any other medical professionals
4. Relatives and friends.

Mechanical resisted exercise

If the mechanical devices are used to oppose the active movement of a person is called as mechanical resisted exercise.

Mechanical resisted exercises can be performed by the followings:

1. Weights
2. Springs
3. Pulleys
4. Water

Examples: Weights, springs, pulleys and water are needed for the resisted exercise.

The resisted exercise increases the muscle strength and the muscle bulk earlier than any other exercise program. These resisted exercises can be stated when the muscle power is 2., i.e. from gravity eliminated position.

We can increase the resistance by altering the below mentioned factors.

- By altering the leverage
- By increasing the weight
- By altering the speed
- By changing the duration.

By altering the leverage: The resistance of an object felt by the muscle differs and depends on the position of the fulcrum. If the application of the resistance is near from the fulcrum, the resistance will be less. It is the reverse if the application of the resistance is far away from the fulcrum.

Example: The resistance offered by the application of the resistance over the elbow region for the shoulder flexion is less while comparing with application of the resistance over the wrist region.

By increasing the weight: While performing the resisted exercise with the particular amount of weight for a particular period of time the muscle group able to achieve the full range of contraction. If the muscle power increases, the person feels the insufficient with the same weight. So, in that circumstance proportionally weight has to be added to increase the resistance to the movement.

By altering the speed: The muscle can contract most efficiently when it moves with natural speed. The increasing and decreasing the speed may alter the effect of resistance. The speed of the contraction increases the effect of the resistance in the concentric muscle work. Reducing the speed increases the power of contraction in the eccentric contraction. These varieties in speed are as under:

- Natural speed
- Reduced speed
- Increased speed.

Natural Speed

If the movement is performed in the natural speed requires the less effort of the muscle and also it may vary with the individuals. Generally, all the exercise performed to the natural speed is the beneficial and effective.

Reduced Speed

If the speed is decreased the greater muscle work is required to perform the full ROM. During the reduced speed exercise, the gravity exerts more resistance on the muscles.

Increased Speed

The increased speed exercise needs the greater muscular effort. In the more speed exercise the

full ROM may be sometimes neglected. It may lead to trick movement or inaccurate movement.

Generally, relaxed passive movement has to practice in the slow speed, i.e. decreased speed and the active movements have to be performed in the natural speed.

By changing the duration: The repeated contraction of the muscle leads fatigue. The fatiguability reduces the efficiency of muscle contraction and increases the effect of the resistance.

Uses of Resisted Exercises

1. Resisted exercises increase the strength of the muscle earlier. The weak muscle can be strengthened much earlier than the any other exercise regimen. This can be started from the muscle power 2 onwards. Strength of the muscle is directly proportional to the tension created inside the muscle. The resisted exercise can create the more amount of intramuscular tension.

   Strength α Tension
2. Increases the endurance of the muscle.
3. Powerful muscle contraction increases the blood flow of the muscle fiber and it gets nutrition and the O_2.
4. Resisted exercise increases the muscular power. Power is related to the strength of the muscle and the speed.

   Power = Force × Distance / Time

The force creating the particular motion or the movement of the body lever for the particular duration is meant as power.

The force or tension created inside the muscle is high in restricted exercise. Some theories are explained about the power, which is the high intensity of muscle activity. High intensity exercise carried out over a short period of time called as anaerobic power, lower intensity exercise carried out for a longer period of time is called as aerobic exercise.

Type II (Phasic, fast twitch)—Anaerobic muscle fiber

Type I (Tonic, slow twitch)—Aerobic muscular fiber.

The strenuous exercise increases the body heat and the resisted exercise too. It stimulates the vasodilator center and dilates the blood vessels. As a result the muscles are getting good blood supply and nutrition. The body-builders are mostly performing the resisted exercise to build the muscle bulk.

Progressive Resisted Exercise

While performing the resisted exercise with the weights, it is very much difficult to find out how much weight has to be used and how many repetitions to be done by the injured patients after recovering. At the same time, if the more weight is lifted more time, the muscle gets fatigue or sometime possibility for microtears. To come out of this situation De Lorme and Watkins are formed one exercise regimen in 1945 to improve the muscle strength, power and endurance. As per this regimen the weight is gradually increased and also he explained about how many repetition to be practiced. One should know about repetition maximum (RM) before entering into the exercise regimen.

Repetition Maximum

The maximum amount of the weight a person can lift throughout the range of motion exactly 10 times. Some authors recommended the lifts between 6-15 considering as the repetition maximum.

The exercise regimens may vary depends on the condition or the disease and from one patient to another. At present 3 types of progressive resisted exercise regimens are available.

1. DeLorme and Watkins
2. MacQueen
3. Zinovieff (Oxford technique).

De Lorme and Watkins

10 times with 1/2 10 RM.
10 times with 3/4 10 RM.
10 times with 10 RM.

Progression

i. 30 times weekly 4 sessions
ii. Every week 10 RM progression.

a. *For example*
Consider 10RM—1 kg
First week.
1/2 of 10 RM—1/2 kg.
3/4 of 10 RM—3/4 kg
Full of 10 RM—1 kg

Exercise regimen is
10 times with 1/2 kg
10 times with 3/4 kg
10 times with 1 kg

Second week
Progression 10 RM
= 10 RM + 10 RM
= 1 kg +1 kg
= 2 kg

Exercise Regimen is
10 times with 1 kg
10 times with 11/2 kg
10 times with 2 kg
Third week program: 10 RM added in the second week weight.

b. In this exercise regimen, the weight is increased, i.e. first with 1/2 kg followed by 3/4 kg and 1 kg.

c. Each and every session the patient has to lift the above said three types of weights 10 times each. So, that daily 30 times lifting been done.

d. In each and every session 30 times the exercise should be done with 2 breaks by the patient.
i.e. 10 times 1/2 10 RM (1/2 kg) → Break → 10 times with 3/4 10 RM (3/4 kg) → Break→ 10 times 10 RM (1 kg)

e. Weekly 4 sessions the exercise has to be practiced. *For example*, Monday, Wednesday, Friday, Sunday (i.e. every alternative day's) exercise has to be practiced and remaining days, i.e. Tuesday, Thursday, Saturday given rest.

MacQueen

10 times with 10 RM
10 times with 10 RM
10 times with 10 RM
10 times with 10 RM

Progression

i. 40 times 3 sessions weekly.
ii. Every 1-2 weeks progression 10 RM

a. *For example*
Consider 10 RM = 1 kg
First week
10 times with 1 kg
10 times with 1 kg
10 times with 1 kg
10 times with 1 kg
Second week
Progression 10 RM
Second week 10 RM = 10 RM + 10 RM
= 1 kg + 1 kg
Second week 10 RM = 2 kg
Third week – progression 10 RM from the second week weight.

b. One kg weight is lifted 40 times with 3 breaks per each session. In this regimen no change of weight between each and every breaks. Same weight is used throughout one session.
10 times with 1 kg → break → 10 times with 1 kg → break → 10 times with 1 kg → break → 10 times with 1 kg.

c. The exercise has to be carried out 3 sessions weekly. *Example:* Monday, Thursday, Sunday (i.e. two days) once has to be practiced and remaining four days rest.

Zinovieff (Oxford technique)

10 times with 10 RM
10 times with 10 RM minus 1 lb
10 times with 10 RM minus 2 lb
10 times with 10 RM minus 3 lb
10 times with 10 RM minus 4 lb

10 times with 10 RM minus 5 lb
10 times with 10 RM minus 6 lb
10 times with 10 RM minus 7 lb
10 times with 10 RM minus 8 lb
10 times with 10 RM minus 9 lb

Progression

100 times 5 sessions weekly
10 RM progression daily.

a. *For example*

Consider 10 RM = 20 lb
10 times with 20 lb
10 times with 19 lb
10 times with 18 lb
10 times with 17 lb
10 times with 16 lb
10 times with 15 lb
10 times with 14 lb
10 times with 13 lb
10 times with 12 lb
10 times with 11 lb

Second day
Progression 10 RM daily
Second day 10 RM = 10 RM + 10 RM
= 20 lb + 20 lb
= 40 lb
10 times lift with 40 lb
10 times lift with 39 lb
10 times lift with 38 lb
10 times lift with 37 lb
10 times lift with 36 lb
10 times lift with 35 lb
10 times lift with 34 lb
10 times lift with 33 lb
10 times lift with 32 lb
10 times lift with 31 lb

Third day progression 10 RM from the second day weight.

b. Each and every 10 lifts break has to be given the 1 lb also reduced for each 10 lifts. Finally, the patient will be performing 100 lifts per section.
10 lifts with 20 lb→ break→ 10 lifts with 19 lb→ break → 10 lifts with 18 lb → break → 10 lifts 17 lb → break →10 lifts with 16 lb→ break→ 10 lifts with 15 lb→ break → 10 lifts with 14 lb → break → 10 lifts with 13 lb → break → 10 lifts with 12 lb→ break→ 10 lifts with 11 lb.

c. Every week 5 sessions of exercises are carried out. *Example,* Monday to Friday the exercises will be performed and remaining two days given rest before starting next week exercise regimen.

PASSIVE MOVEMENT

The movement, which is performed with the help of the external force whenever the muscles fail to perform the movement by its own.

Types of Passive Movements

1. Relaxed passive movement
2. Passive manual mobilization
   - Mobilization of the joints
   - Manipulation of the joints and soft tissues
   - Stretching of the soft tissues.

Specific Classification of Passive Movements

Passive movements are classified into the following two types:

i. Manual passive movements
ii. Mechanical passive movemetns

Manual Passive Movements

The passive movements performed by the therapists or any other medical professionals are called as manual passive movements. Some time it shall be performed by the patient's attenders like his relatives and friends.

Mechanical Passive Movemetns

The passive movements which are performed by the mechanical devices are called as mechanical passive movements. Depends on the type of passive movement the device may vary.

Example

- Continuous passive mobilizer (CPM)—Used for relax passive movement and joint mobilization, joint stretches, etc.
- Springs, weights, pulleys, splints, plaster cast—stretching and mobilization.

CHAPTER 9

Relaxed Passive Movement

DEFINITION

This is the smooth, rhythmical and accurate anatomical movement performed by the therapist within the pain-limited range.

PRINCIPLES

Relaxation

Patient has to be positioned in relaxed manner before starting the treatment procedure. During the relaxed state there will not be any muscle work and the total body part will be fully relaxed and also the patient can cooperate for the treatment. If the patient feels inconvenient by the position, he cannot cooperate for the treatment. So, the position of the patient is strictly noticed before giving the treatment and also the position should not be changed during a treatment process. The therapist's position also plays an important role to treat the patient. The therapist has to adopt the walk standing position while treating the patient.

Fixation

The proximal joints to the joint to be moved should be fixed. Otherwise trick movement may occur. To prevent it and localize the movement the proximal joints have to be fixed or stabilized.

Traction

The long axis traction given to increase the space between the articular surfaces. It reduces the intra-articular friction as well as breaks the adhesion formation in the joint. Free passive movement can be performed due to the less friction effect done by the long axis traction.

Range

The movement performed within the pain-limited range. In that joints care must be taken to avoid the movement exceeding the anatomical movement in the stiff joint the movement has to be done bit forcefully to break the adhesions as well as to maintain the muscle property.

Speed and Duration

Speed should be rhythmical, smooth and same speed should be maintained throughout the movement. There should not be jerky movement, the movements performed number of times may vary depends on the condition we treat.

Sequence

The sequence to be decided before treating the patients, while treating the flaccid conditions the movement should be proximal to distal, in spastic as well as to increase the venous and lymphatic drainage the movement has to be performed from distal to proximal.

INDICATIONS

- The patients who cannot perform active movements.
- The patients who cannot perform full range of movements.
- For the prolonged bed-ridden patients mainly to prevent DVT, maintain the muscle property and increase the venous drainage as well as lymphatic drainage.
- To break adhesion formation through that joint range can be increased.
- Unconscious patients.
- For relaxation.
- Edematous limb.

CONTRAINDICATIONS

- Recent fractures
- Recent dislocations
- DVT
- Malignant tumor
- Psoriatic arthritis
- Recently injuries and inflammation
- Precaution must be taken for the flial joints
- Hemarthrosis
- Early burns
- Immediately after any joint surgery or repair
- Hemophilic joints
- Patients with external appliances
- Patients with POP plaster cast.

EFFECTS AND USES

- Maintains the muscle properties
- Increases the ROM
- Increases the venous and lymphatic drainage
- Breaks the adhesion formations in the joints
- Prevents the DVT
- Induces the relaxation.

PROCEDURE OF RELAXED PASSIVE MOVEMENT (FIG. 9.1)

The therapist has to adopt the walk stand position and should face the patient's face. So, that he can observe the patient's reaction while performing movement.

Right side is taken as an example and explained in detail about to the passive movements to be performed for each and every joint and action.

Upper Limb

Shoulder Joint

Flexion

Position of the patient: Supine lying.

Fig. 9.1: Relaxed passive movement of flexion of shoulder

Position of the therapist: Standing beside the patient and facing the patient's face.

Holding:

- Left hand of the therapist restricts the wrist and carpometacarpal movement of the patient.
- Therapist's right hand should grasp the lower part of the arm of the patient.

Procedure: Mild long axial traction is given and the movement is performed. The traction should be maintained throughout the movement, beginning stage traction is applied by the right hand and above 90° the traction is maintained by the left hand of the therapist. Perform the movement up to the available range.

Extension (Fig. 9.2)

Position of the patient: Side lying.

Position of the therapist: Standing back to the patient and facing the shoulder joint.

Holding:

- Forearm and elbow is placed over the right side forearm of the therapist by flexing the elbow of the patient and wrist movement is restricted by the therapist's hand.
- Left hand of the therapist stabilizes the shoulder joint of the patient.

Fig. 9.2: Relaxed passive movement of extension of shoulder

Procedure: It is not possible to apply the long axial traction. Therapist's right hand is performing the extension movement of the shoulder.

Abduction (Figs 9.3 and 9.4)

Position of the patient: Supine lying:

Position of the therapist: Standing beside the patient and facing the patient's face.

Fig. 9.3: Relaxed passive movement of abduction of shoulder (starting stage)

Fig. 9.4: Relaxed passive movement of abduction of shoulder (end stage)

Holding:

- Patient's elbow is flexed (90°).
- Patient's wrist is grasped by the left hand of the therapist.
- Dorsal aspect of the elbow and the lower part of the arm is grasped by the therapist's right hand (Figs 9.5 and 9.6).

Fig. 9.5: Relaxed passive movement of medial rotation of shoulder

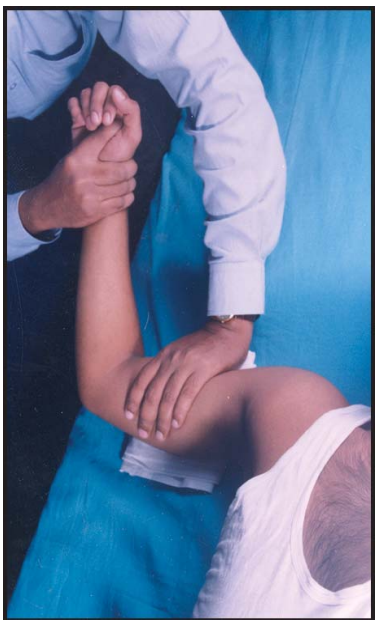


Fig. 9.6: Relaxed passive movement of lateral rotation of shoulder

Procedure: Therapist's both hand is performing the abduction movement of the shoulder. In the final range to gain the maximum abduction range, the lateral rotation of the shoulder is done.

Medial and lateral rotation

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing the patient's shoulder.

Holding:

- Patient's shoulder is abducted for 90° and the elbow also flexed for 90°.
- Therapist's left hand grasping the lower end of the humerus of the patient.
- Therapist's right hand grasping the wrist and the hand of the patient.

Procedure: The long axial traction is applied and the medial and lateral rotation movement of the shoulder is performed by the therapist.

Elbow Joint

Flexion and extension (Fig. 9.7)

Position of the patient: Supine lying:

Position of the therapist: Standing beside the patient and facing the patient's elbow.

Fig. 9.7: Relaxed passive movement of flexion and extension of elbow

Fig. 9.8: Relaxed passive movement of supination and pronation of forearm

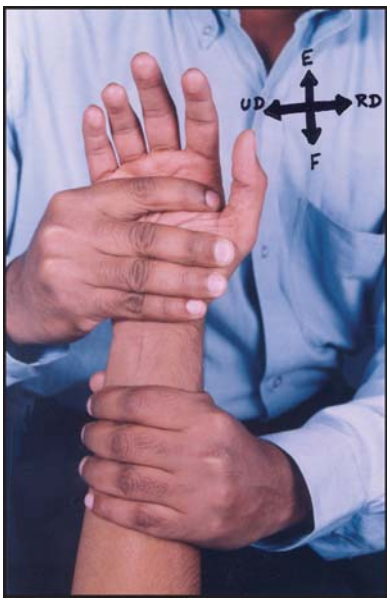


Fig 9.9: Relaxed passive movement of flexion, extension, ulnar and radial deviation of the wrist

Holding:

- Therapist has to fix the arm of the patient with the couch by his left hand.
- Therapist's right hand grasps the wrist and hand of the patient.

Procedure: Therapist's right hand is performing the elbow flexion and extension.

Forearm Joint

Supination and pronation (Fig. 9.8)

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing him.

Holding:

- Wrist and hand is grasped by the therapist's right hand.
- Arm is fixed with the couch by the therapist's left hand.

Procedure: It is impossible to apply traction in this technique. Therapist's right hand is performing the supination and pronation movement in the available range.

Wrist Joint

Flexion and extension (Fig. 9.9)

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing him.

Holding:

- Lower part of the forearm is holding by the therapist's left hand.
- Right hand of the therapist grasping the MCP and PIP joints.

Procedure:
With mild long axial traction the flexion and extension movements are performed by the therapist's right hand in available range.

Ulnar and radial deviations

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing him.

Holding:

- Lower part of the forearm is holding by the therapist's left hand.
- Right hand of the therapist grasping the MCP and PIP joints.

Procedure:
With mild long axial traction the ulnar and radial deviation movements are performed by the therapist's right hand in available range.

Thumb Joint (Carpometacarpal joint)

Flexion, extension, abduction, adduction, opposition (Fig. 9.10)

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing him.

Fig. 9.10: Relaxed passive movement of flexion, extension, abduction, adduction and opposition movement of the thumb

Holding:

- Therapist's right hand grasping the palm of the patient.
- Left hand holding the thumb of the patient.

Procedure : With mild long axis traction all the thumb movements can be performed with the therapist's left hand (flexion, extension, abduction, adduction, opposition).

Metacarpophalangeal Joint (Fig. 9.11)

Flexion, extension, abduction, adduction

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing him.

Holding:

- Therapist's right hand grasping the palm of the patient by leaving the MCP joint.
- Left hand of the therapist holding the finger of the patient in extension.

Procedure: With mild long axis traction flexion and extension of the metacarpophalangeal

Fig. 9.11: Relaxed passive movement of flexion, extension, abduction and adduction of MCP joint

Fig. 9.12: Relaxed passive movement of flexion and extension of interphalangeal joint

Fig. 9.13: Relaxed passive movement of flexion of hip

movement is performed by the left hand of the therapist (Flexion, extension, abduction, adduction).

Interphalangeal Joint (Fig. 9.12)

Flexion and extension

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing him.

Holding:

- Left hand fingers of the therapist stabilize proximal part of the joint.
- Distal part of the joint is grasping by the right hand fingers.

Procedure: With mild traction flexion and extension movements are performed in available range by the therapist's right hand.

Lower Limb

Hip joint (Fig. 9.13)

Flexion

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing him.

Holding:

- Therapist's right palm grasping the calcaneum of the patient.
- Therapist's left hand grasping the posterior part of knee and the thumb is kept lateral side of the knee.

Procedure: It is impossible to apply long axial traction. Knee and hip flexion movements performed together to achieve full range of hip flexion by reducing the hamstring and rectus-femoris tension. While performing movement the therapist's left hand from the posterior part of the knee gradually moved and comes to anterior side of the knee. Vice versa while coming to neutral.

Extension (Fig. 9.14)

Position of the patient: Side lying.

Position of the therapist: Standing back to the patient and facing him.

Holding:

- Patient's knee is flexed 90°.
- Patient's leg is placed on the therapist's forearm of the right hand and the palm is grasping the knee joint.
- Therapist's left hand stabilize the pelvic of the patient.

Fig. 9.14: Relaxed passive movement of hip extension

Procedure: Therapist's right hand is performing the extension movement of the hip.

Fig. 9.15: Relaxed passive movement of hip abduction and adduction

Abduction and Adduction (Fig. 9.15)

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing him.

Holding:

- Right hand of the therapist grasping the lower part of leg.
- Therapist's left hand grasps the posterior part of the knee joint.

Procedure: Without traction the abduction and adduction movement is performed within the available range by the therapist's both hands.

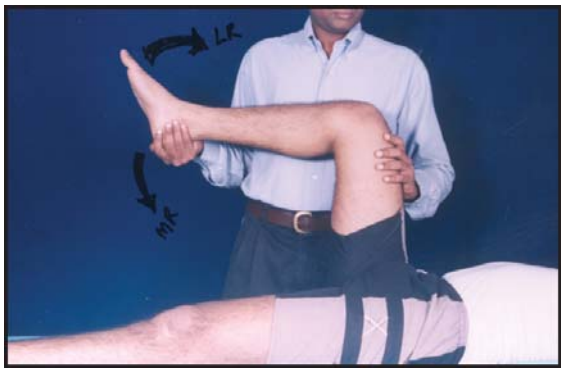


Fig. 9.16: Relaxed passive movement of hip medial and lateral rotation

Medial and lateral rotation (Fig. 9.16)

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing the hip joint of the patient.

Holding:

- Patient's knee and hip are kept in 90° flexed position.
- Left hand of the therapist grasping the lower part of femur.
- Right hand grasps the lower part of the leg of the patient.

Procedure: Movement is performed without any traction by the therapist's right hand within the available range.

Knee Joint

Knee flexion and extension can be performed as said in flexion of hip.

Patellofemoral Joint

As said in the mobilization chapter.

Ankle Joint

Plantar and Dorsiflexion (Fig. 9.17)

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing the ankle joint of the patient.

Fig. 9.17: Relaxed passive movement of ankle plantar and dorsiflexion

Fig. 9.18: Relaxed passive movement of midtarsal inversion and eversion

Holding

- Patient's knee joint is flexed.
- Leg is supported by the therapist's left side forearm and the same side hand grasps the lower part of the leg.
- Right palm of the therapist grasping the calcaneum of the patient and the forearm is placed over the ball of the metatarsals.

Procedure: The therapist's right hand and the forearm perform the plantarflexion and Dorsiflexion movement. Knee joint is flexed for reducing tension in the gastrocnemius muscle.

Midtarsal Joint

Inversion and eversion (Fig. 9.18)

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing the foot of the patient.

Holding:

- Therapist's left hand grasps the lower part of the leg.
- Right palm of the therapist grasping the calcaneum of the patient the forearm is placed over the ball of the metatarsals.

Procedure: Therapist's right hand is performing the inversion and eversion movement.

Metatarsophalangeal Joint (Fig. 9.19)

Position of the patient: Supine lying.

Fig. 9.19: Relaxed passive movement of metatarsophalangeal flexion and extension

Position of the therapist: Standing beside the patient and facing the foot of the patient.

Holding:

- Left hand of the therapist grasps the metatarsals.
- Right hand of the therapist grasps the proximal phalanx.

Procedure: Right hand of the therapist performing all the movement (flexion, extension, abduction and adduction) for all toes together in same time with recommended traction.

Fig. 9.20: Relaxed passive movement of neck

Interphalangeal Joint

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing the interphalangeal joint of the patient.

Holding:

- Left hand of the therapist grasps the proximal articular segment.
- Right hand grasps the distal articular segment.

Procedure: Therapist's right hand is performing the flexion and extension movement of the interphalangeal joint.

Neck (Fig. 9.20)

Position of the patient: Supine lying.

Position of the therapist: Standing back to the patient's head.

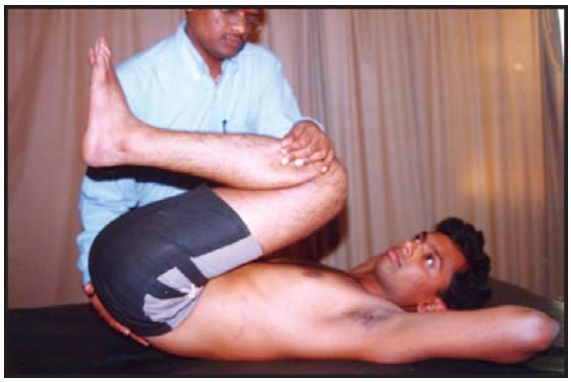


Fig. 9.21: Relaxed passive movement of lumbar flexion

Holding: Therapist is grasping the occipital region with both the hands with thumb abduction.

Procedure: With mild traction flexion, extension, side flexion and rotational movements are performed by therapist's both hands.

Lumbar Flexion (Fig. 9.21)

Position of the patient: Crook lying.

Position of the therapist: Standing besides the patient.

Holding:

- Left hand of the therapist grasping the sole of the patient.
- Right hand of the therapist is placed on the thigh.

Procedure: Heel is lifted up until the knee touches the chest of the patient. To attain maximum flexion range right hand placed under the sacrum and lifted up.

Lumbar Extension (Fig. 9.22)

Position of the patient: Prone lying.

Position of the therapist: Standing besides the patient.

Fig. 9.22: Relaxed passive movement of lumbar extension

Holding:

- Patient's knee joint is flexed.
- Therapist's right hand grasp the thighs of the patient.
- Therapist's left hand stabilizes the upper trunk.

Procedure: Both the thighs are lifted up until the anterior rotation of the pelvic occurs.

Lumbar Rotation (Fig. 9.23)

Position of the patient: Crook lying.

Fig. 9.23: Relaxed passive movement of lumbar rotation

Position of the therapist: Standing beside the patient.

Holding:

- Therapist's right hand placed over the right thigh of the patient.
- Left hand prevents the upper trunk motion by applying the counter force over the right shoulder region.

Procedure:

With right hand right thigh is pushed away from therapist's side same time left hand applies the counter force on the right shoulder region.

10
CHAPTER

Peripheral Joint Mobilization

INTRODUCTION

The contribution in the field of orthopedic medicine by the physiotherapy is highly commendable. When the orthopedic examination reveals the joint hypomobility or decreased ROM, there the mobilization plays its major role. There are two types of mobilizations: (a) Joint mobilization (b) Soft tissue mobilization.

This chapter discusses about the joint mobilization techniques in the introductory level. The therapist should have the knowledge about the anatomy, kinematics, and ortho, neuro, and musculoskeletal disorders to perform the effective mobilization techniques.

DEFINITION

It is a slow, repetitive, rhythmical, oscillatory arthrokinematic and osteokinematics movement done by a therapist within the available range and using various grading under the patient's control.

KINEMATICS

Kinematics is the descriptions of motion and includes the time, space and mass aspects of a moving object. It is of two types:

1. Arthrokinematics
2. Osteokinematics.

Arthrokinematics

Definition: *Arthro*— Joint, *Kinematics*—motion. The movement, which occurs in the joint surface, is called as an "arthrokinematics".

- The articular surface undergoes for movement and the other remains stable.
- These arthrokinematic movements are called as "joint play movements".

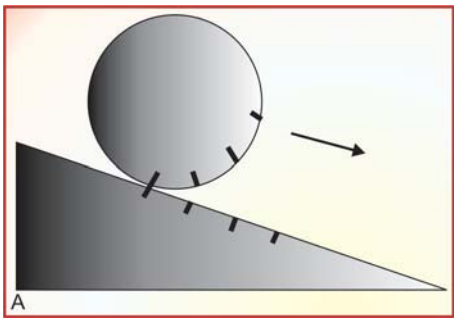
Types of Arthrokinematics Movements

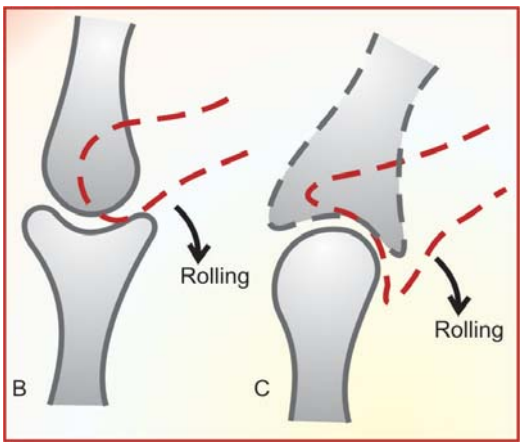
It is of the following types:

1. Rolling
2. Sliding (Gliding)
3. Spinning
4. Traction
5. Compression.

Rolling

- Rolling occurs when the new equidistant point of moving surface comes into contact with the new equidistant points on the stable surface.
- It occurs between the flat and curved surface. For example, ball rolling on the floor (Fig. 10.1).
- Convex surface moves on concave surface or vice versa.





Figs 10.1A to C: A. Ball is moving on flat surface, B. Convex surface is moving on concave surface, and C. Concave surface is moving on convex surface

- Joint surfaces are incongruent.
- Rolling results in angular motion.
- If pure rolling occurs in any physiological movement, it results in compression of the joint capsule towards the bony movement.
- Rolling combines with the gliding, spinning during the physiological movement.
- Direction of the rolling will be towards the physiological movement.

Gliding

- Gliding occurs between the surfaces when the same point of the moving surface comes into contact the new point on the stable surface.
- Gliding occurs between either the flat or curved surfaces. *For example*, square box is moving on oblique floor (Fig. 10.2).

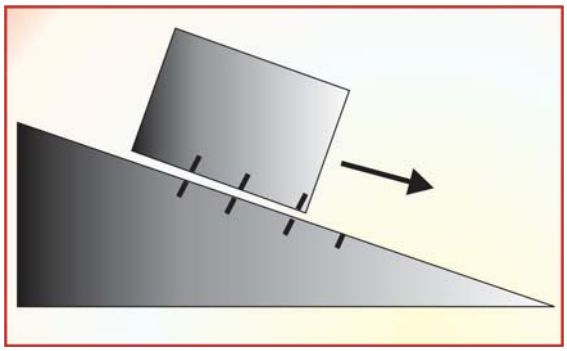


Fig. 10.2: Square box is moving on flat surface

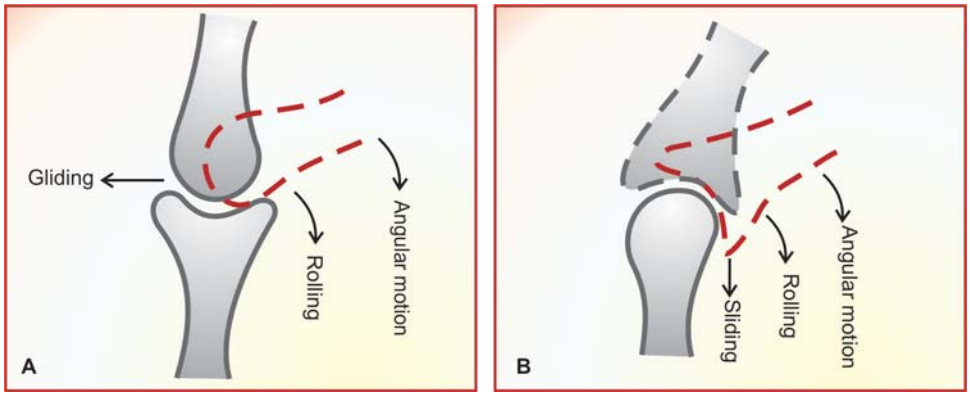
- Joint surfaces are congruent.
- Pure gliding is impossible in human joints because there are no complete congruent surface joints.
- Direction of gliding depends on whether the moving surface is concave or convex.
- Direction of gliding will be towards the physiological movement if the concave surface moves on the convex surface.
- Direction of gliding will be opposite to the physiological movement if the convex surface moves on the concave surface.

CONVEX-CONCAVE RULE

- More the congruent surface, more the sliding occurs and more the incongruent surface, more the rolling occurs.
- While concave surface moves on convex surface gliding rolling occurs towards the angular movement.
- While convex surface moves on concave surface rolling occurs towards the angular movement and gliding occurs opposite to that (Fig. 10.3).

Note: While practicing mobilization technique gliding movement has to be selected, based on the physiological movement.

1. In a joint if upward movement is restricted and the moving bone surface is convex then the treatment direction is downward (Fig. 10.4).



Figs 10.3A and B: A. Convex surface is moving on concave surface—rolling, angular motion in one direction and the sliding in another side, B. Concave surface is moving on convex surface—rolling, angular motion, sliding occurs in the same direction

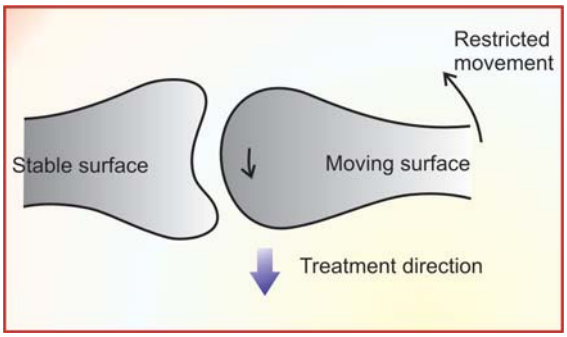


Fig. 10.4: Treatment direction

2. In a joint if upward movement is restricted and the moving bone surface is concave then the treatment direction is upward (Fig. 10.5).

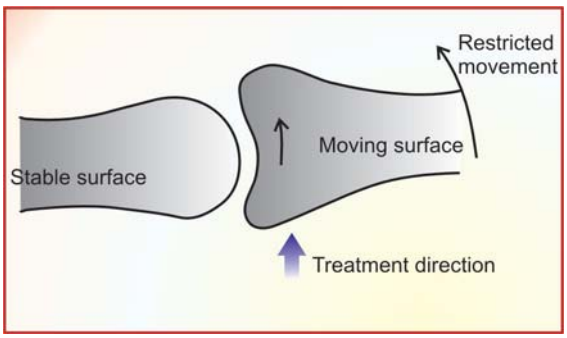
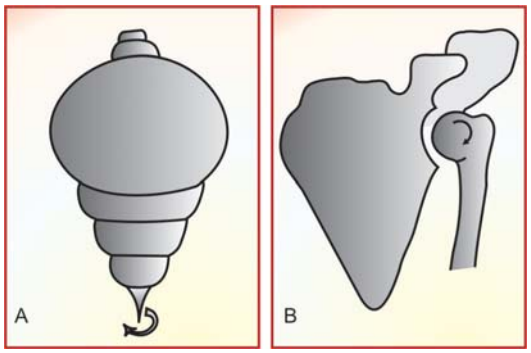


Fig. 10.5: Treatment direction

Spinning

- Moving surface rotates on the stable surface.
- Rotation occurs in the stationary mechanical axis.
- Spinning results in rotatory movement.
- Spinning surface creates an arc of a circle.
- It combines with the rolling and gliding and results in rotatory type of physiological movements.

Example: Radio-humeral joint pronation and supination movement.



Figs 10.6A and B: A. Top is spinning on the floor, and B. Head of the humerus spinning on the glenoid cavity of the scapula

Traction

- Articular surfaces are drawn or pulled apart.

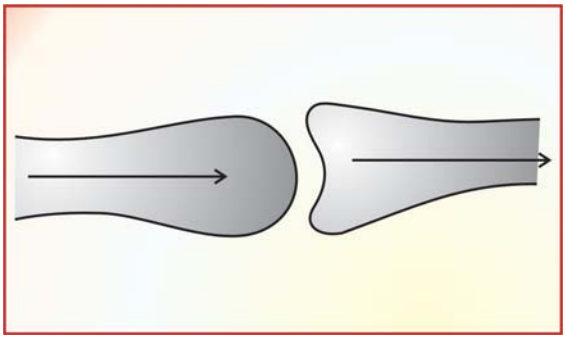


Fig. 10.7: Distraction

- Normally distal bony surface is pulled apart at right angle.
- Movement takes place perpendicular to and away from the treatment plane.
- The joint space increases during traction.
- It reduces the joint friction.
- Enhances the joint play movement (Fig. 10.7).

Compression

- Articular parts are pushed towards each other.
- Distal articular bone surface moves towards the proximal articular bone surface.
- Movement perpendicular to and towards the treatment plane.
- More common in the weight bearing joints.
- Articular surface will be having more contact with each other.
- Squeezing of the synovial fluid takes place during compression.
- Over compression leads to joint structure deterioration (Fig. 10.8).

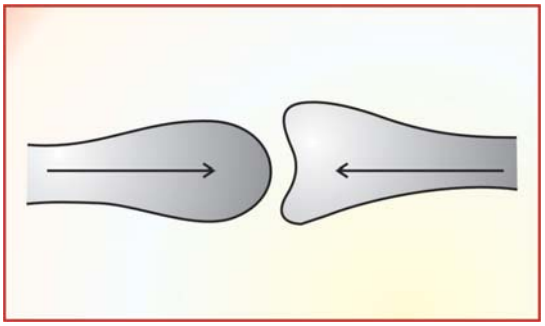


Fig. 10.8: Compression

OSTEOKINEMATICS

Definition

Osteo—Bone, *Kinematics*—Movement/motion. The movement occurs in the bone rather than the joints surface is called as "physiological movement". Normally, particular joint ROM mentioned as physiological ROM. The physiological movement may differ from one joint to another due to the structure of the bony alignment and the structure of the soft tissues around the joint. Some joint has uniaxial movement, some has biaxial and some has triaxial. Due to some pathological disturbance some joints may have more mobility is called "hypermobile joints". It is due to the laxity of the ligaments, reduced tension in the joint capsule and the soft tissues around the joint. Mobilization techniques are totally contraindicated for this variety. The joints, which have less mobility, are called "hypomobile joints". It is due to spasm of the ligaments, muscles, capsule or any other soft tissues around the joint and sometime may be due to adhesion formation. This type of joints has to undergo for the mobilization treatment.

These osteokinematics movements are the visible movements and are determined by the invisible arthrokinematics movements. It is believed that the arthrokinematic movements are very much needed for the effective osteokinematic movements. Where the joint play movements are lacking the joints said to be hypomobile. Because reduction of joint play in articular surface reduces the physiological movement and vice versa in the hypermobile.

Manual Grading of Movement

The joint movement can be graded by the below mentioned scale. Amount of the motion from the resting position can be measured by the goniometer. If the joints are hypermobile or hypomobile there shall be some change of normal joint ROM.

Grade –0 – No movement (stiff joint)
Grade –1— Considerable limited movement
Grade –2— Slightly limited movement
Grade –3 – Normal
Grade –4 – Slightly increased movement
Grade –5 – Considerable increased movement
Grade –6 – Unstable (or) flial joint.

This scale has three (3) categories.

- 0, 1, 2 labeled as hypomobile
- 3 normal
- 4, 5, 6 labeled as hypermobile.

Osteokinematic movements are:

- Flexion
- Extension
- Abduction
- Adduction
- Medial rotation
- Lateral rotation
- Circumduction
- Supination
- Pronation
- Opposition
- Inversion
- Eversion
- Plantar flexion
- Dorsiflexion
- Forward bending
- Backward bending
- Lateral bending, etc.

These osteokinematic movements are classified into two motions.

1. *Rotatory motion* (Fig. 10.9)
   - Otherwise called as angular motion.
   - Movement of an object around a fixed axis known as rotatory motion.
   - Each segment moves through the same angle, same time at a constant distance.
2. *Translatory motion* (Fig. 10.10)
   - Each segment or object moves in straight line.
   - Each segment moves through same distance at the same time in parallel path.
   - If the movement occurs in straight line is called as "linear motion".

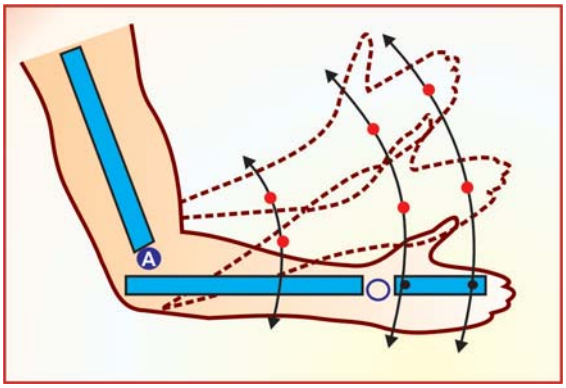


Fig. 10.9: Rotatory motion

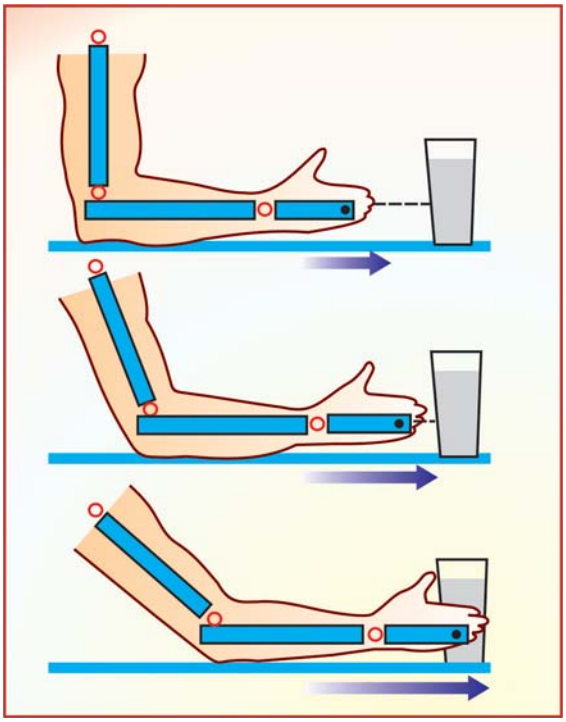


Fig. 10.10: Translatory motion

   - If it occurs in curved pathway is called "curvilinear motion" (Fig. 10.11).

To perform osteokinematic movement there should be an axis and a plane.

Fig. 10.11: Curvilinear motion

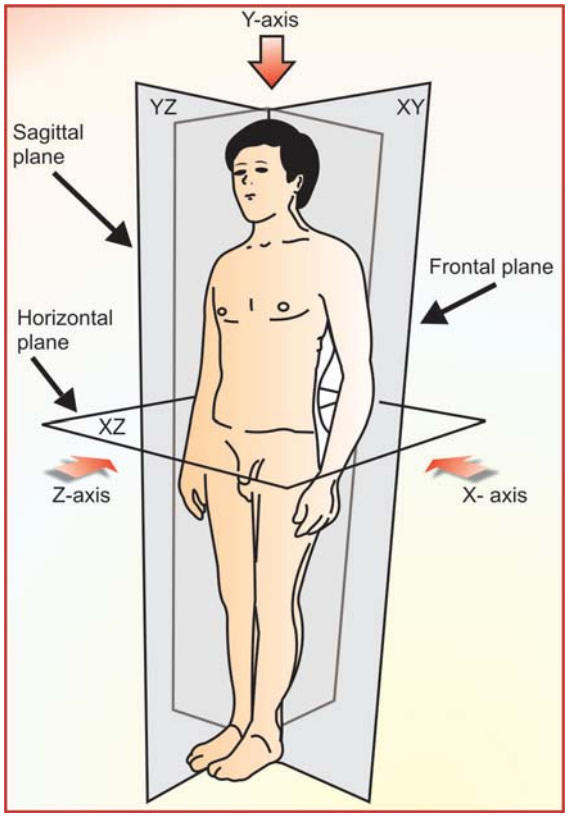


Fig. 10.12: Axes and planes

PLANES AND AXES (FIG. 10.12)

Planes

Planes are the space or surface where the movements take place.

Axis

An axis is the point by which the movements take place. The anatomical position (standing erect with the head, toes and the palm of the hand facing forwards and the finger extended.) is the correct position to discuss about the planes and axes. The imaginary planes are made to each other perpendicular in the human body. These are called as "Cardinal planes". They are:

1. Frontal plane (Coronal plane)
2. Sagittal plane (A-P plane)
3. Transverse plane (Horizontal plane).

1. *Frontal plane*
   - The plane, which divides the body into equal front and back parts.
   - This plane passes through the coronal suture of the skull.
   - Movement occurs in X-Y plane.
   - Movement occurs in **sagittal axis** or **A-P axis**.
   - Movements possible are abduction and adduction.

2. *Sagittal plane*
   - The plane, which divides the body into equal right and left parts.
   - Movement occurs in Y-Z plane.
   - This plane passes through the sagittal suture of the skull.
   - Movements possible are flexion and extension.
   - Movement occurs in **frontal axis** or **coronal axis.**

3. *Transverse plane*
   - The plane, which divides the body into equal upper and lower parts.
   - Movement occurs in X-Z plane.
   - Movements possible are medial and lateral rotation.
   - Movement occurs in **vertical axis.**

POSITION OF THE JOINTS

It deals about the position of the articular surfaces of the joint and its merits and demerits. The particular position of the joint has its own characteristics, values and properties. The therapist uses some position for examination, some for relaxation, and some for treatment purposes. They are:

1. Loose packed position
2. Zero position
3. Actual resting position
4. Tightly packed position (close packed).

Resting Position (Loosed packed position)

Joint structures are most relaxed in this position. Contacts between the joint surfaces are lesser, so more space is available for the accommodation of the synovial fluid and more joint play movement also easily felt. For example, the shoulder joint is totally relaxed and more joint play is felt in 30°-40° abducted position (See Table 10.1).

Zero Position (Starting position)

This is the starting position of the joint. While measuring the ROM by the goniometer, the zero position is taken as starting point of the measurement. For example, to measure the shoulder joint movements like flexion, extension, adduction, abduction with goniometer, the zero position we adopt is the arm kept by the side of the chest wall, and for the medial and lateral rotations the adopted position is the shoulder in 90° abduction with elbow in 90° flexion.

Actual Resting Position

An alternative resting position is adopted, since the resting position may not be obtained effectively in some pathological and painful conditions of the joint. For example, in post-traumatic stiffness, it is impossible to place the joint in resting position. So that alternative position is adopted to reduce the torque of the joint. This position is meant as actual resting position. These actual resting positions are useful for testing and treating the pathological joint conditions. While, choosing the actual resting position, an attempt should be made to find out the loosest position of the joint.

Close Packed Position (Tightly packed position)

The joint structures are maximum taut in this position. The articular surfaces are having maximum congruency between each other and also the joint play movement will be very much difficult in this position. The close packed position is usually at the extreme end of the ROM, during this position the synovial fluid moves to the other side as the synovial membrane gets compressed. This movement of the synovial fluid helps the capsule in getting extra nourishment. It is essential for the therapist, to have a sound knowledge about the close packed position of all the joint to avoid any of the mobilization techniques in this position (See Table 10.2).

PHYSIOLOGY OF JOINT MOTION

Nutrition

Joint articular surfaces are avascular and it receives the nutrition from synovial fluid. The synovial fluid circulates inside the capsule to supply the nutrition to the articular surfaces. The synovial fluid movement occurs by the compression of the articular cartilage and capsule. During the loading and unloading as well as the motion of the joint causes the synovial fluid movement inside the synovial

Table 10.1: Resting position

Joints	*Position*
Shoulder	Slightly abduction of the shoulder 35° to 55°
Sternoclavicular joint	Clavicle is horizontal position
Acromioclavicular joint	Clavicle is in horizontal positon
Scapulothoracic joint	Clavicle is in horizontal position and scapula is positioned from 2 to 7 ribs
Humeroulnar	70° flexion 10° supination
Humeroradial	Full extension supination
Proximal radiaoulnar joint	35° supination 70° flexion
Distal radioulnar joint	10° supination
Wrist	Neutral with slight ulnar deviation
1st carpometacarpal joint	Midway between the flexion extension abduction and adduction
Metacarpophalangeal	Slight flexion
Interphalangeal joint	PIP 10° flexion, DIP 30° flexion
Hip	30° flexion 30° abduction slight external rotation
Knee	25° flexion
Patellofemoral	Full extension of knee
Proximal tibiofibular	25° knee flexion 10° plantar flexion
Distal tibiofibular	10° plantar flexion 5° inversion
Ankle	10° plantar flexion midway between inversion and eversion
Subtalar	Midway between inversion eversion with10° plantar flexion
Midtarsal	Midway between supination pronation with 10° plantar flexion
Tarsometatarsal	Midway between supination and pronation
Metatarsophalangeal	Midway between supination and pronation abduction and adduction
Interphalangeal joint	Slight flexion

Table 10.2: Closed packed position

Joints	*Position*
Shoulder	Maximum abduction and external rotation
Sternoclavicular joint	Arm maximum elevated
Acromioclavicular joint	Shoulder 90° abduction
Scapulothoracic joint	None
Humeroulnar	Full extension supination
Humeroradial	90° flexion 5° supination
Proximal radioulnar joint	Full extension and 5°supination
Distal radioulnar joint	5° supination
Wrist	Full extension
1st carpometacarpal joint	Full opposition
Carpometacarpal (2nd-5th)	None
Metacarpophalangeal	1st—Maximum extension 2nd-5th—Maximum flexion
Interphalangeal joint	Maximum extension
Hip	Maximum extension, medial rotation and abduction
Knee	Maximum extension and external rotation
Patellofemoral	Knee full extension
Proximal tibiofibular	None
Distal tibiofibular	None
Ankle	Maximum dorsiflexion
Subtalar	Full eversion
Midtarsal	Full supination
Tarsometatarsal	Full supination
Metatarsophalangeal	Full extension
Interphalangeal joint	Full extension

cavity. The joint mobilization techniques also doing the same as said above mechanism. So that the articular surface will be getting good nutrition supply. Immobilization of the joint may result in atrophy of the articular cartilage, synovial membrane, and formation of adhesion. This can be cured by the mobilization techniques.

Extensibility

Joint mobility maintains the extensibility and tensile strength of the articular tissues. If the joint is immobilized, the ligaments, tendons and cartilages loose its extensibility property, which leads to joint stiffness and hypomobile. Normal joint movement prevents the contracture, shortening, and thickening of the tissues. The mobilization techniques are also helpful to prevent the contracture and thickening of the soft tissues and improve the extensibility property of the soft tissues.

Joint Receptors

Joint receptors transmit the impulses to the afferent nervous system from the joint. The joint receptors give the awareness of the position and movement of the joints. Injury, disease or immobilization of the joint may cause the lack of functioning of the joint receptors. There are four types of joint receptors (Table 10.3).

Table 10.3: Different types of joint receptors

Type I	
Name:	Ruffini
Quality:	Postural
Stimulus:	Activated by the postural faults Activated by the stress of the joint capsule Activated by traction and oscillatory techniques
Characteristics:	Low threshold and slow adaptive Located mainly around the knee, hip, and shoulder
Location:	Superficial joint capsule, periosteum, ligaments and tendons
Response:	It provides static position, speed and velocity of the movement
Type II	
Name:	Pacini or paciniform
Quality:	Dynamic
Stimulus:	Activated by the changes in joint motion Activated more with oscillatory techniques than traction
Characteristics:	Low threshold, rapid adaptive
Location:	Deep layer of capsule Mainly in lumbar spine, hand, foot, jaw
Response:	Provides joint motion sense
Type III	
Name:	Golgi or Golgi mazzoni
Quality:	Inhibitive
Stimulus:	During end range stretch
Characteristics:	High threshold, very slow adaptive Activated by joint mobilization technique
Location:	Inner layer of joints, ligaments and tendons
Response:	Sense of direction of movement Regulation of muscle tone
Type IV	
Name:	Non-myelinated free nerve endings
Quality:	Nociceptive
Stimulus:	Noxious mechanical stress or biomechanical stress
Characteristics:	High threshold and non-adaptive
Response:	Produces tonic contraction
Location:	Located in most tissues like blood vessels, synovial layer of the capsule, fat pads, ligaments, tendons and periosteum

Contd...

Table 10.3: *Contd...*

EFFECT OF PATHOLOGICAL CHANGES OF THE JOINT

Each and every structure of the joint is much more important for the total functioning of the joint. Defect in any of the structure leads to improper functioning of the joint.

Disease

Joint diseases like RA, OA, TB arthritis, psoriatic arthritis, ankylosing may cause some deformation of the some joint structures results in the improper, imperfect movement of the joint. For example, in RA the synovial membrane gets affected, so that there is alteration in the synovial fluid secretion. Joint lubrication altered and the joint structures may not get proper nutrition. Lack of nutrition may cause deformation of the joint structures. In osteoarthritis erosion or degeneration of the cartilages occurs. So, there will be restricted movement and painful movement. If the disease progresses results in contracture of the muscles, weakness of the muscles, ligaments tightness, osteophytic formation over the articular surfaces, osteoporotic changes in the articular surface, makes the joints immovable.

Injury

Injury of the joint structure causes the improper movement and improper gait pattern. Loading and unloading of the joint will be painful. If the synovial membrane injured, it secretes more synovium. Lacking of the stability comes due to the ligament injury. Injury of capsules and cartilages results in lacking of loading and unloading. Any tendon injury may cause the lack of movement over the joint. So, depends on the structure injured the outcome of the effect may differ. But the net result will be improper or lack of movement of the joint.

Immobilization

Immobilization may be imposed by the plaster cast, bedrest, and fear of pain. Due to the non-mobility of the joint causes many changes over the joint structures. Normally, after immobilization, contracture develops in the surrounding soft tissues, so that after the immobilization of joint, it is impossible to attain normal range of motion (Table 10.4).

Table 10.4: Effect of immobilization

Sl.No	*Structure*	*Changes*
1.	Bone	Osteoporosis
2.	Ligaments	Osteoclastic activity leads to weakness of the ligaments. Decreased matrix compound, degenerative changes in the ligaments lead to deterioration of biomechanical activities.
3.	Cartilage	Decreased proteoglycans, decreased water content, decreased thickness, increased stiffness.
4.	Capsule	Decreased proteoglycans, increased water content, atrophy of the capsule.
5.	Tendon	Decreased collagen content, atrophy, size of the collagen fiber decreases.
6.	Synovium	Proliferation of fibro-fatty connective tissue and formation of adhesion.

These are the changes occur in the surrounding tissues of the joint. It may result in reduced ROM. Sometimes muscles may go for weakness or contracture due to the immobilization. So that the joint cannot function normally.

Overuse

Prolonged standing, sitting or attaining one particular posture or attaining one particular movement may create some strain and stress of the surrounding structures of the joint. Continuous loading of a joint tissue that is deformed earlier may not get the time to recover. So that the tissue may be more prone to get overuse injury or syndrome. Normally, the cartilages, which is the most important connective tissue for loading of a joint. If the deforma-

tion and degeneration changes occur in the cartilage, the permeability of the cartilage will get decreased. It is believed that the overuse of the joint may results in osteoarthritis.

INDICATIONS

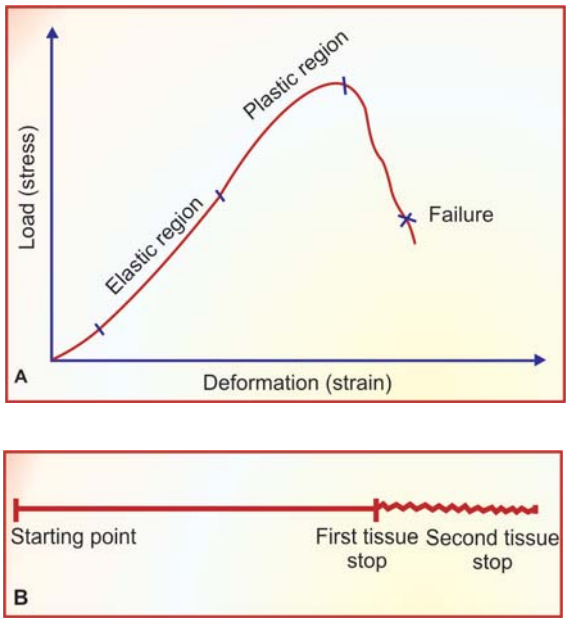
- Post-traumatic stiffness of the joint.
- Postoperative stiffness of the joint.
- Postimmobilization stiffness of the joint.
- Adhesion formation around the joint.
- Atrophy of the capsule.
- Atrophy of the synovial membrane.
- Painful joint.
- Disuse atrophy of the joint structures.

CONTRAINDICATIONS

- Synovial effusion.
- Hemarthrosis.
- Recent fractures around the joint.
- Dislocation.
- Recent injuries around the joints.
- Acute RA.
- Flial joint.
- Malignant tumors.
- Inflammatory joint disease like TB arthritis, psoriatic arthritis.
- Immediately after surgery around the joint.
- Total joint replacements.
- Scoliotic spine.
- Spondylolisthesis.

STRESS-STRAIN CURVE

The role of the extensibility of the soft tissue, the stress-strain curve gives the perfect knowledge about the load deformation of the soft tissue. Whenever the external force is applied to a soft tissue, it goes for more stress and strain. The first phase is "elastic phase", the stretched tissue will go for normal position after removing the external force. The second phase is "plastic phase", the stretched tissue may be remain in the elongated state when



Figs 10.13A and B: A. Stress-strain curve, and B. Tissue restriction on passive joint play test

the external force is removed. Third phase is "failure point", the stretched tissue may be teared or separated. Normally, joint mobilization techniques are done up to the limit of the plastic range and sometimes about to reaching the breaking point but without causing any tissue damage. If the breaking point is felt, the treatment should be terminated (Figs 10.13A and B).

While mobilizing the stiff joint the therapist may feel the restriction by the surrounding structures. Limitations may be due to capsule, ligaments, muscle, skin, fascia, cartilages or adhesions. The limitations or restrictions of movement, which is felt by the therapist, is called as first tissue stop. Normally, the passive movement can cross the first tissue stop. If the therapist adds more force after reaching first tissue stop, he may feel again the restriction of movement by some structures is called as second tissue stop. If we apply force more than the first tissue stop the tissue will be attaining

the plastic range. But if the therapist crosses the second tissue stop, the tissue may be separated or teared. So, the joint mobilization technique should be performed within the second tissue stop.

One more factor also influences on the joint extensibility, it can be gained by the rapid mobilization technique, which may increase the extensibility of the tissue than the slow techniques. So that the stretch administered up to the plastic phase or attaining about to the second tissue stop may give good result than the medium mobilization technique.

TREATMENT PLANE

It lies over the concave surface of the articular surface. The treatment plane moves with the movement of the concave surface. It will be constant or stable while the convex surface moves. The treatment plane is perpendicular to the axis of the rotation. The joint traction also will be given perpendicular to the treatment plane (Fig. 10.14).

While assessing a joint movement or joint play, the parallel or perpendicular to the treatment plane should be performed. The

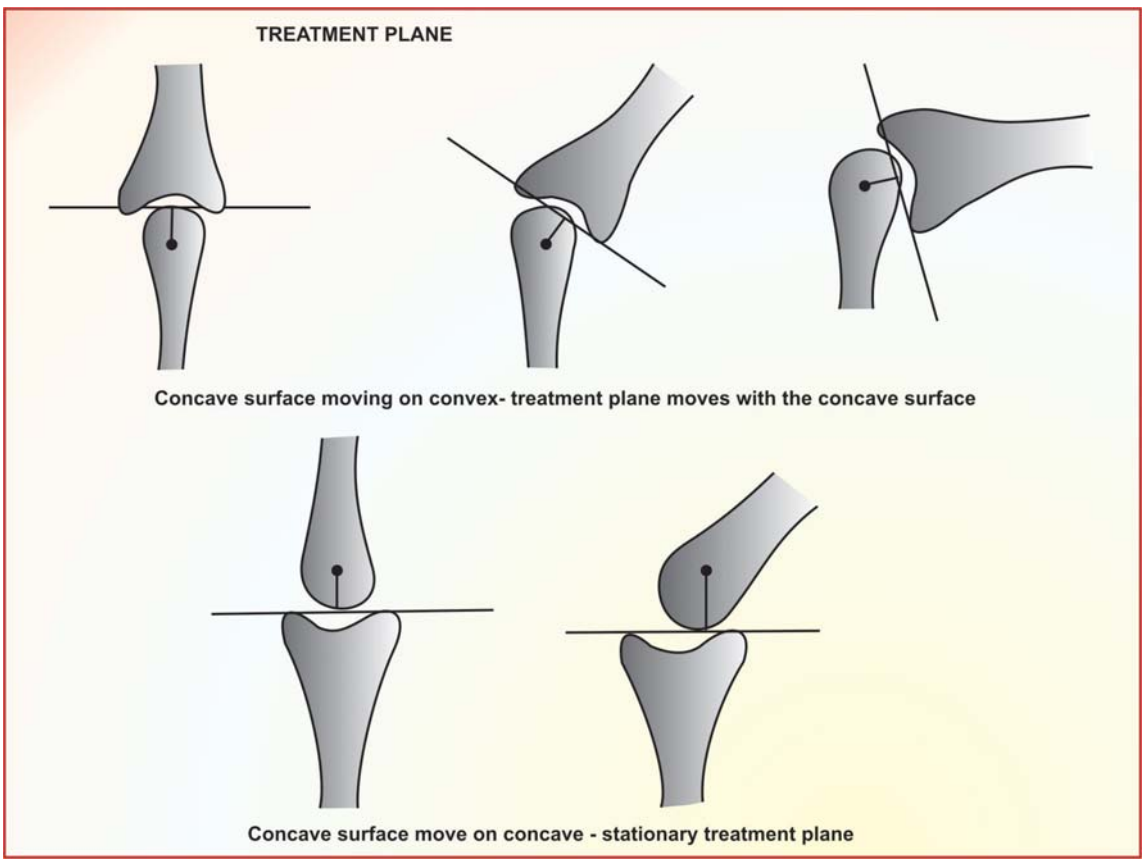


Fig. 10.14: Treatment plane

gliding or rolling tests are done parallel to the treatment plane. Traction and distraction can be performed perpendicular to the treatment plane. This joint play movement decides the grade of the joint movement.

PRINCIPLES

Relaxation

Patient has to be positioned in relaxed manner before starting the treatment procedure. During the relaxed state there will not be any muscle work and the total body part will be fully relaxed and also the patient can cooperate for the treatment. If the patient feels inconvenient by the position, he cannot cooperate for the treatment. So, the position of the patient is strictly noticed before giving the treatment and also the position should not be altered during a treatment process. The therapist's position also plays an important role to treat the patient. The therapist has to adopt the walk standing position while treating the patient.

Fixation

The joint, which is proximal to the mobilizing joint, should be fixed and avoid trick/vicarious movement. So, that the accessory movement may not occur in that joint which may reduce the ROM of the mobilizing joint and also the movement can be localized to one particular joint.

Support or Stabilization

The distal part of the joint being moved should be supported or comfortably stabilized for the relaxation and avoid the inconveniency. The therapist should grasp firmly which may stimulate the nerve endings and improves the condition as well as the psychological support of the patient.

Treatment Direction

The treatment direction may be parallel or perpendicular to the treatment plane. Distraction may be applied perpendicular to the treatment plane. The oscillatory technique may be performed parallel to the treatment plane.

Treatment Force and Range

The treatment force will be depended on the grade of the movement of the joint; it may be gentle or forcible. Range of the movement may differ depends on the stiffness of the joint. Normally, the actual resting position may be adopted for the treatment, because the resting and starting position may not be possible in the stiff or hypomobile joint. The treatment force is given within the second tissue stop or within the plastic range or sometime about to reach the breaking point of the tissue.

TREATMENT TECHNIQUES

Treatment is graded according to the amount of the motion and the joint play movement of the joint. There are two systems of grading of the mobilization.

1. Traction technique
2. Oscillatory technique.

Traction Technique (Fig. 10.15)

Grade I: Slow, small amplitude perpendicular movement (distraction) to the concave joint surface performed within the first tissue stop.

Grade II: Slow, large amplitude perpendicular movement (distraction) to the concave joint surface done up to the first tissue stop.

Grade III: Slow, large amplitude perpendicular movement (distraction) to the concave joint surface performed up to the level of crossing the first tissue stop, but without reaching the second tissue stop.

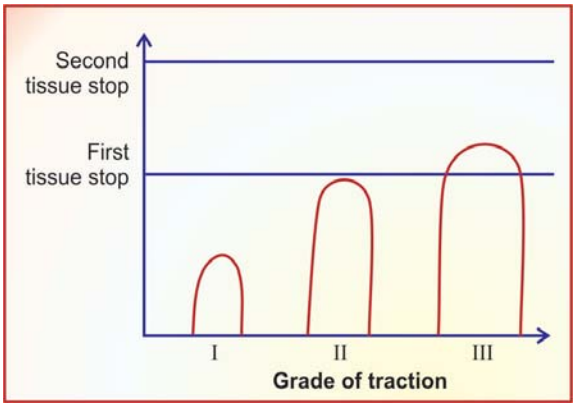


Fig. 10.15: Traction joint mobilization with gradings

Uses

Grade I: Used for reducing the pain.

Grade II: Used for pain reduction and increases the periarticular extensibility.

Grade III: Used for periarticular extensibility, to correct the positional fault and reduces the spinal disc herniation.

Oscillatory Technique (Fig. 10.16)

Grade I: Slow, small amplitude oscillatory movement parallel to the concave joint surface performed within the beginning range.

Grade II: Slow, large amplitude oscillatory movement parallel to the concave joint surface performed within the first tissue stop.

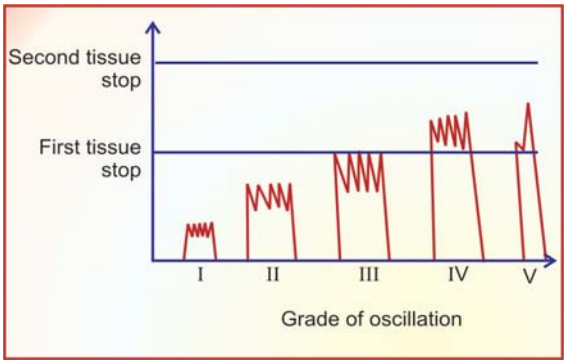


Fig. 10.16: Oscillation joint mobilization with gradings

Grade III: Slow, large amplitude oscillatory movement parallel to the concave joint surface performed up to reaching the first tissue stop.

Grade IV: Slow, small amplitude oscillatory movement parallel to the concave joint surface performed slightly through the first tissue stop.

Grade V: Slow, small amplitude, large velocity, thrust movement parallel to the concave joint surface performed to snap the adhesion and up to about to reach the second tissue stop.

Uses

Grades I and II: Reduces the pain.

Grades III and IV: Reduces the pain, increases the periarticular extensibility, correct the postural faults, breaking the adhesion.

Grade V: Reduces the spinal disc herniation and breaking the adhesion.

Traction is given for 10 seconds followed by rest period of several seconds. Oscillation is given for 2 or 3 per second for about 1 minute. Normally, the mobilization can be performed combined with the other modalities like wax bath, hot water fomentation, massage, IFT, ultrasound, etc.

MOBILIZATION PROCEDURES FOR INDIVIDUAL JOINTS

Sternoclavicular Joint (Fig. 10.17)

Type

Synovial joint

Variety

Saddle variety

Articular Surface

- Medial end of clavicle (concavoconvex)
- Clavicular notch of the manubrium sternum)

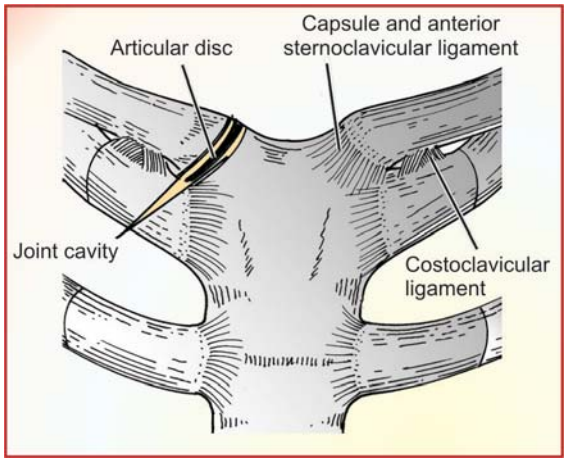


Fig. 10.17: Sternoclavicular joint

Ligaments

- Anterior-sternoclavicular joint
- Posterior-sternoclavicular joint
- Interclavicular ligament
- Costoclavicular ligament.

Movements

- Elevation and depression
- Protraction and retraction
- Rotation.

Elevation
- Trapezius (middle fibers)
- Levator scapulae
- Rhomboidus major, minor.

Depression
- Latissimus dorsi, pectoralis major,
- Serratus anterior, pectoralis minor
- Subclavius.

Protraction
- Serratus anterior, pectoralic major and minor.

Retraction
- Trapezius, rhomboidus major, minor

Lateral rotation
- Trapezius (middle fibers).

Medial rotation
- Levator scapular, rhomboidus major and minor
- Latissimus dorsi

Arthrokinematics

Arthrokinematics relations with the osteokinematics movements are:
- Elevation—caudal gliding
- Depression—cranial gliding
- Protraction—ventral gliding
- Retraction—dorsal gliding.

Positions

Starting position
- Clavicle lies in horizontal position.

Resting positing
- Clavicle lies in horizontal position.

Close packed position
- Full elevated position.

Capsular pattern
- In full elevation it is restricted.

Cranial Gliding (Fig. 10.18)

Goal
- To increase the joint play movement of the sternoclavicular joint.
- To reduce the pain around the sternoclavicular joint.

Fig. 10.18: Sternoclavicular joint cranial gliding

- To increase the depression movement of the shoulder.

Position of the patient: Supine lying.

Fixation : Sternum is fixed with the thoracic cage already.

Support: Distal joint to the mobilizing joints are supported already by the couch.

Position of the therapist and grasping
- Therapist is standing besides the patient and facing the patient's sternoclavicular joint.
- Therapist's both the thumbs are placed below the medial end of the clavicle.

Procedure
- Therapist's both the thumbs are gliding the clavicle in the cranial direction.

Caudal Gliding (Fig. 10.19)

Goal
- To increase the joint play movement of the sternoclavicular joint.
- To reduce the pain around the sternoclavicular joint.
- To increase the elevation movement of the shoulder.

Position of the patient: Supine lying.

Fixation: Sternum is fixed with the thoracic cage already.

Support: Distal joint to the mobilizing joints are supported already by the couch.

Position of the therapist and grasping
- Therapist is standing besides the patient and facing the patient's sternoclavicular joint.
- Therapist's both the thumbs are placed superior part of the medial end of the clavicle.

Procedure
- Therapist's both the thumbs are gliding the clavicle in the caudal direction.

Ventral Gliding (Fig. 10.20)

Goal
- To increase the joint play movement of the sternoclavicular joint.
- To reduce the pain around the sternoclavicular joint.
- To increase the protraction movement of the shoulder.

Position of the patient: Supine lying.

Fixation: Therapist's right hand is fixing the sternum.

Support: The couch already supports distal joints.

Position of the therapist and grasping
- Therapist is standing besides the patient and facing the patient's sternoclavicular joint.

Fig. 10.19: Sternoclavicular joint caudal gliding

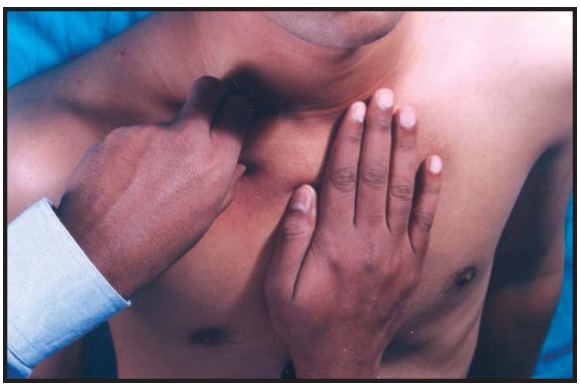


Fig. 10.20: Sternoclavicular joint ventral gliding

- Therapist's left hand is grasping the medial two-thirds of clavicle with the thumb below and the fingers up.

Procedure
Therapist's left hand pulls the clavicle up and gliding anteriorly.

Dorsal Gliding (Fig. 10.21)

Goal
- To increase the joint play movement of the sternoclavicular joint.
- To reduce the pain around the sternoclavicular joint.
- To increase the retraction movement of the shoulder.

Position of the patient: Supine lying.

Fixation: The thoracic cage already fixes sternum.

Support: The couch already supports distal joints.

Fig. 10.21: Sternoclavicular joint dorsal gliding

Position of the therapist and grasping
- Therapist is standing besides the patient and facing the patient's sternoclavicular joint.
- Therapist's both the thumbs are placed over the anterior part of the medial end of the clavicle.

Procedure
Therapist's thumbs are applying the pressure over the anterior part of the medial end of the clavicle and posteriorly gliding the clavicle.

Acromioclavicular Joint (Fig. 10.22)

Type
Synovial joint.

Variety
Plane.

Articular Surfaces
- Lateral end of clavicle (flat)
- Medial margin of the acromian process of scapula (flat).

Ligaments
- Acromioclavicular ligament
- Coracoclavicular ligament.

Movements

Osteokinematics
- As said in sternoclavicular joint.

Arthrokinematics
Arthrokinematics relation with the osteokinematics.
- Elevation—dorsal gliding
- Depression—ventral gliding

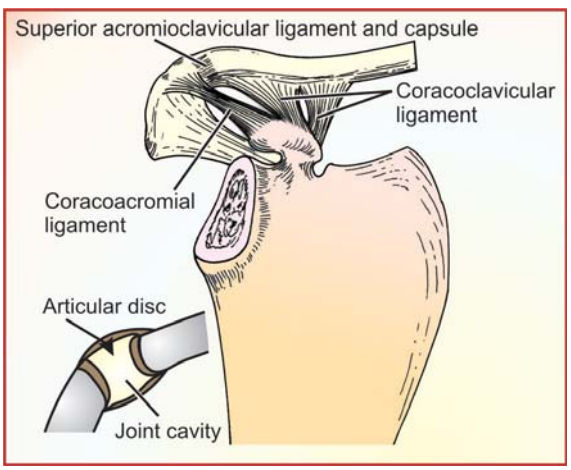


Fig. 10.22: Acromioclavicular joint

Position

Starting position

- Clavicle lies in horizontal position.

Resting position

- Clavicle lies in horizontal position.

Close packed position

- 90° abduction of the shoulder.

Capsular pattern

- Full elevation is limited.

Dorsal Gliding (Fig. 10.23)

Goal

- To increase the joint play movement of the acromioclavicular joint.
- To reduce the pain around the acromioclavicular joint.
- To increase the elevation movement of the shoulder.

Fig. 10.23: Acromioclavicular joint dorsal gliding

Position of the patient: Long sitting.

Fixation: Therapist's left hand grasping the shoulder and the acromian process with thumb anteriorly and the fingers posteriorly.

Support: No need of the support for the distal parts.

Position of the therapist and grasping

- Therapist is standing in front of the patient and facing the patient's acromioclavicular joint.
- Therapist's right hand thumb is placed over the lateral end of the anterolateral aspect of the clavicle.

Procedure: Therapist's right hand thumb is gliding the lateral end of the clavicle posteriorly.

Ventral Gliding (Fig. 10.24)

Goal

- To increase the joint play movement of the acromioclavicular joint.

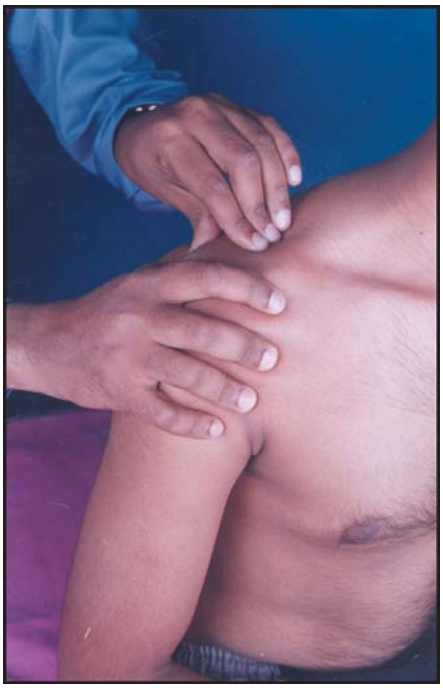


Fig. 10.24: Acromioclavicular joint ventral gliding

- To reduce the pain around the acromioclavicular joint.
- To increase the depression movement of the shoulder.

Position of the patient: Long sitting.

Fixation: Therapist's right hand grasping the shoulder and the acromian process.

Support: No need of the support for the distal parts.

Position of the therapist and grasping

- Therapist is standing back to the patient and facing the patient's acromioclavicular joint.
- Therapist's left hand thumb is placed over the later end of the posterior aspect of the clavicle with the fingers in the anterior grasping.

Procedure: Therapist's left hand thumb glides the lateral end of the clavicle anteriorly.

Scapulothoracic Joint

Type

- Fibrous joint

Articular Surface

- Anterior surface of the scapula.
- Posterior portion of the ribs.

Ligaments

- None

Movements

Osteokinematics

- As said in sternoclavicular joint.

Arthrokinematics

- Elevation—cranial gliding, lateral gliding
- Depression—caudal gliding, medial gliding
- Protraction—lateral gliding
- Retraction—medial gliding
- Medial rotation—caudal gliding, medial gliding
- Lateral rotation—cranial gliding, lateral gliding.

Position

Starting position

- Clavicle is in horizontal position.

Resting position

- Clavicle is in horizontal position and scapula is positioned from 2 to 7 ribs.

Close packed position

- Nothing

Capsular pattern

- Nothing

Distraction (Fig. 10.25)

Goal

- To increase the joint play movement of the scapulothoracic joint.
- To reduce the pain around the scapulothoracic joint.

Position of the patient: Side lying by facing the therapist.

Fixation: Therapist's left hand fixing the acromioclavicular joint.

Support: Patient's upper limb is resting on the therapist's left forearm.

Fig. 10.25: Scapulothoracic joint distraction

Position of the therapist and grasping

- Therapist is standing in front of the patient and facing the scapulothoracic joint.
- Therapist's right hand is fixing the acromioclavicular joint.

- Therapist's left hand grasping the inferior angle of the scapula.

Procedure: Therapist's left hand pulls the scapula from the rib.

Cranial Gliding (Fig. 10.26)

Goal

- To increase the joint play movement of the scapulothoracic joint.
- To reduce the pain around the scapulothoracic joint.
- To increase the scapular elevation and lateral rotation.

Fig. 10.26: Scapulothoracic joint cranial gliding

Position of the patient: Side lying.

Fixation: Therapist's left hand fixing the acromioclavicular joint.

Support: Patient's upper limb is resting on the therapist's left forearm.

Position of the therapist and grasping

- Therapist is standing in front of the patient and facing the scapulothoracic joint.
- Therapist's right hand is fixing the acromioclavicular joint.
- Therapist's left hand grasping the inferior angle of the scapula.

Procedure: Therapist's left is performing the cranial gliding with the distraction.

Caudal Gliding (Fig. 10.27)

Goal

- To increase the joint play movement of the scapulothoracic joint.
- To reduce the pain around the scapulothoracic joint.
- To increase the scapular depression and medial rotation.

Fig. 10.27: Scapulothoracic joint caudal gliding

Position of the patient: Side lying.

Fixation: Therapist's left hand fixing the acromioclavicular joint.

Support: Patient's upper limb is resting on the therapist's left forearm.

Position of the therapist and grasping

- Therapist is standing in front of the patient and facing the scapulothoracic joint.
- Therapist's right hand is fixing the acromioclavicular joint.
- Therapist's left hand grasping the inferior angle of the scapula.

Procedure: Therapist's left hand performs the caudal gliding of the scapulothoracic joint.

- Therapist also applies the caudal gliding force.

Medial Gliding (Fig. 10.28)

Goal

- To increase the joint play movement of the scapulothoracic joint.
- To reduce the pain around the scapulothoracic joint.
- To increase the scapular retraction, medial rotation and depression.

Fig. 10.28: Scapulothoracic joint medial gliding

Position of the patient: Side lying.

Fixation: No need of the fixation for this technique.

Support: Patient's upper limb is resting on the therapist's left forearm.

Position of the therapist and grasping
Therapist's both the hands are placed over the lateral border of the scapula one over the acromion process and another over the inferior angle of the scapula.

Procedure: Therapist's both hands glide the scapula in medial direction.

Lateral Gliding (Fig. 10.29)

Goal

- To increase the joint play movement of the scapulothoracic joint.
- To reduce the pain around the scapulothoracic joint.
- To increase the scapular protraction, elevation and lateral rotation.

Fig. 10.29: Scapulothoracic joint lateral gliding

Position of the patient: Side lying.

Fixation: No need of the fixation for this technique.

Support: Patient's upper limb is resting on the therapist's left forearm.

Position of the therapist and grasping

- Therapist is standing in front of the patient and facing the scapulothoracic joint.
- Therapist's both hands and fingers are placed over the medial border of the scapula in spreader manner and the thumbs are placed over the lateral border.

Procedure: Therapist's both the hands are gliding the scapula in lateral direction.

Shoulder Joint (Fig. 10.30)

Type

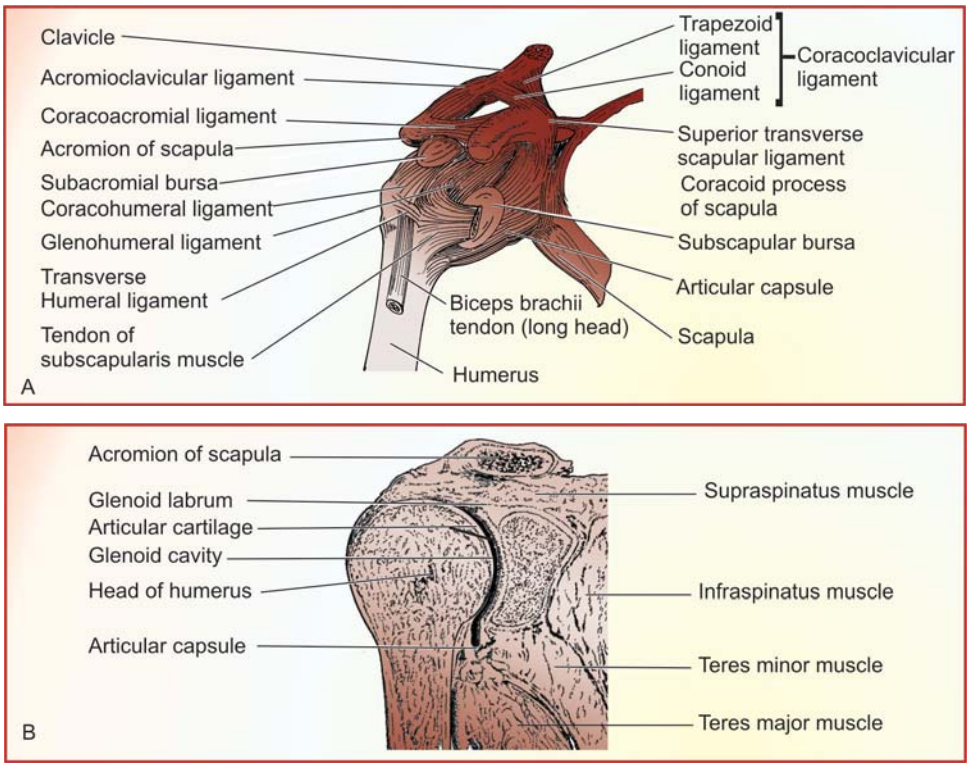
Synovial joint.

Variety

Ball and socket (spheroid)

Articular Surfaces

- Glenoid cavity of scapula (concave)
- Head of humerus (convex).



Figs 10.30A and B: Shoulder joint. A. Diagram of shoulder joint anterior view, B. Sagittal section of shoulder joint

Ligaments

- Superior glenohumeral ligament
- Middle glenohumeral ligament
- Inferior glenohumeral ligament
- Coracohumeral ligament
- Transverse humeral ligament
- Coracoacromial ligament.

Arthrokinematic

Arthrokinematic relations with the osteokinematics movements are:

- Abduction—inferior gliding, superior rolling
- Flexion—posterior gliding, anterior rolling
- Extension—anterior gliding, posterior rolling
- Adduction—superior gliding, interior rolling.

While convex surface moves on concave surface, rolling occurs towards the angular movements and the gliding will be opposite to the angular motion.

Range of Motion (ROM)

• Flexion	0º-180º (150º to 180º)
• Extension	0º-45º (40º to 60º)
• Abduction	0º-180º (150º to 180º)
• Adduction	0º
• Hyperadduction	0º-35º (25º to 35º)
• Internal rotation	0º-90º (70º to 90º)
• External rotation	0º-90º (80º to 90º)

Positions

I. *Starting position*
Upper limb hanging parallel to the trunk with elbow extension.

Movements (Table 10.5)

Osteokinematics

Table 10.5: Muscles responsible for shoulder movement

Sl. No	*Movement*	*Muscle responsible for*
01.	Flexion	1. Clavicular head of pectorals major 2. Anterior fibers of deltoid 3. Biceps 4. Coracobrachialis
02.	Extension	1. Posterior fibers of deltoid 2. Triceps 3. Teres major 4. Latissimus dorsi
03.	Abduction	1. Supraspinatus (Initiations of abduction 0°-15°) 2. Middle fibers of deltoid (15°-30° to 60°-90°) 3. Trapezius and serratus Anterior final degree of abduction (120-180)
04.	Adduction	1. Latissimus dorsi 2. Teres major 3. Coracobrachialis 4. Pectroralis major 5. Subscapularis
05.	Medial rotation	1. Anterior fibers of deltoid 2. Teres major 3. Pectoralis major 4. Subscapularis 5. Latissimus dorsi
06.	Lateral rotation	1. Posterior fibers of deltoid 2. Teres minor 3. Infraspinatus
07.	Circum-duction	Combination of all the muscle

II. *Resting position*
Slightly abduction of the shoulder (35-55).

III. *Close packed position*
Extreme abduction and lateral rotation.

IV. *Capsular pattern*
Lateral rotation→abduction→medial rotation.

Distraction (Fig. 10.31)

Goal

- To increase the joint play movements in the glenohumeral joint.
- To break the adhesion formation.
- To increase the joint space to improve joint play.

Position of the patient: Supine lying with shoulder adducted.

Fixation: Scapula thoracic movements restricted by the assistant or by the belt.

Support: Patient's forearm and hand supported by the therapist's forearm.

Fig. 10.31: Shoulder joint distraction

Therapist's position

- Walk standing position and standing beside the patient by facing the glenohumeral joint.
- Grasping the midpart of the humerus by the both hands.
- Therapist's right hand placed up and the left hand down.

Procedure

- Articular surfaces are pulled apart by the therapist's right hand.

Caudal Gliding (Fig. 10.32)

Aims

- To increase joint play movements.
- To improve the abduction ROM.

Position of the patient: Supine lying and the shoulder in adducted position.

Fixation: Scapular movements restricted by the assistant or by the belt.

Some of the movements restricted by the couch already.

Fig. 10.32: Shoulder joint caudal gliding

Fig. 10.33: Shoulder joint caudal gliding progression

Support: Distal part to the mobilizing joint is supported by the therapist's forearm or positioning the patient's forearm and hand between the therapist's upper arm and trunk.

Therapist's position

- Standing side to the patient by the facing the glenohumeral joint.
- Grasping the upper part to the humerus by both the hands.

Procedure

- Therapist's right hand performing traction and the caudal gliding.

Caudal Gliding (Progression) (Fig. 10.33)

Aims

- To improve joint play movements.
- To increase abduction ROM from the available range.

Position of the patient: Supine lying and the mobilizing glenohumeral joint kept in available abduction range.

Fixation: Scapular movements restricted by the assistant or by the belt.

Support: The patient's forearm and the hand is placed between the therapist's upper arm and trunk.

Therapist's position

- Therapist standing behind the abducted or mobilizing glenohumeral joint.
- Therapist's left hand with the web space over the patient's upper part of the humerus.
- Therapist's right hand placed distal part of the humerus.

Mobilizing force

- Traction applied by the right hand of the therapist.
- Caudal gliding done by the web space of the left hand of the therapist.

Note: Progression is achieved by the mobilizing (gliding) the joint in the available range.

Dorsal Gliding (Fig. 10.34)

Aims

- To improve joint play movements.
- To increase the flexion and internal rotation ROM of the glenohumeral joint.

Position of the patient: Supine lying with the mobilized glenohumeral joint is slightly abducted and placed in the end of the couch.

Fixation: Scapular movements are restricted by the assistant or by the belt.

Support: The patients forearm and hand is resting on the therapist's forearm.

Fig. 10.34: Shoulder joint dorsal gliding

Therapist's position and holding

- Therapist standing beside the patient by facing the glenohumeral joint.
- Therapist's right palm of the hand is positioned on the upper part of the humerus.
- Therapist's left hand grasping the distal part of the humerus.

Procedure

- Traction applied by the therapist's left hand.
- Therapist's right hand glides the humerus in the dorsal direction.

Dorsal Gliding (Progression) (Fig. 10.35)

Aims

- To improve joint play movements.
- To increase the flexion and internal rotation from the available range.

Position of the patient: Supine lying with the glenohumeral joint is available flexed position.

Fixation: Scapular movements are restricted by the muscles and by placing the folded towel over the scapular region.

Support: Patient's hand is positioned on the chest wall of his own.

Therapist's position

- Therapist standing beside the patient by facing the glenohumeral joint.
- Therapist's right hand positioned over the olecranon process of the ulna.
- Therapist's left hand positioned in the middle of the humerus.

Procedure

- Traction given by the therapist's left hand towards the lateral side.
- Therapist's right hand glides the humerus in the posterior aspect.

Ventral Gliding (Fig. 10.36)

Aims

- To improve joint play movements of the glenohumeral joint.
- To increase the extension and external of the shoulder joint.

Fig. 10.35: Shoulder joint dorsal gliding progression

Fig. 10.36: Shoulder joint ventral gliding

Position of the patient: Prone lying with the glenohumeral joint is slightly abducted position and placed in the end of the couch.

*Fixation:*Belt can be used to restrict the scapular movement.

Support: Forearm and the hand of the patient remain kept handing.

- The folded towels are supporting coracoid process and the anterolateral chest wall.

Position of the therapist

- Standing beside the patient by facing the glenohumeral joint.
- Therapist's right hand positioned in the proximal part of the humerus.
- Therapist's left hand holding the lower part of the arm.

Mobilizing force

- Traction applied by the therapist's left hand.
- Therapist's right hand glides the humerus in the ventral direction.

Elbow Joint (Fig. 10.37)

Type

Synovial joint

Variety

Hinge variety

Articular Surface

1. Lower end of the humerus (Convex)
2. Head of the radius (Concave)
3. Upper end of the ulnar (Concave).

Ligaments

- Ulnar collateral ligament
- Radial collateral ligament.

Movements

Osteokinematics

- Flexion—brachialis, biceps, brachioradialis.
- Extension—triceps, anconeus.

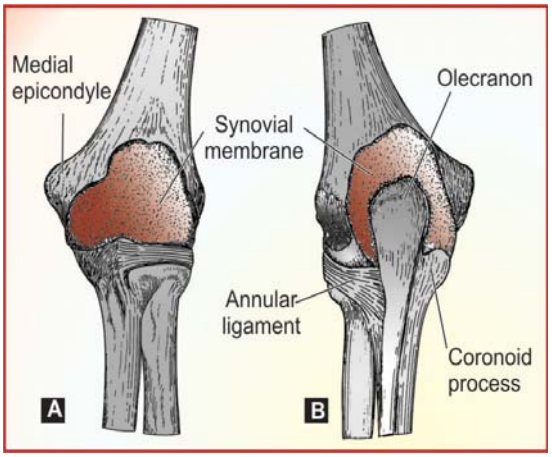


Fig. 10.37: A. Anterior view, and B. Posterior view of elbow joint

Arthrokinematics

Arthrokinematics relations with the osteokinematics are:

- *Flexion:* Medial gliding, lateral gliding of humerus ulnar joint and the ventral gliding of the radiohumeral joint.
- *Extension:* Medial gliding, lateral gliding of the ulnohumeral joint and the dorsal gliding of the radiohumeral joint.
- *Abduction:* Medial gliding.
- *Adduction:* Lateral gliding.

Range of Motion

- Flexion 0°-120° To 150°
- Extension 0°

Position

Ulnohumeral joint

- *Starting position:* Forearm supinated and the elbow extended.
- *Resting position*: Elbow 70° flexion and 10° supination.
- *Close packed position:* Elbow extension and supination.
- *Capsular pattern:* Flexion—Extension. 10° of extension limitation seen only when the 90° flexion limitation.

Radiohumeral joint

- *Starting position:* Forearm supinated and the elbow extended.
- *Resting position:* Full extension and supination.
- Close *packed position:* 90° flexion and 5° supination.
- *Capsular pattern*: Flexion and extension. 10° of extension limitation seen when the 90° flexion limitation.

Ulnohumeral Joint (Fig. 10.38)

Joint distraction

Goal

- To increase the ioint play movement of the elbow joint.
- To reduce the pain around the elbow joint.

Fig. 10.38: Ulnohumeral distraction

Position of the patient: Supine lying or long sitting and the elbow is positioned in actual resting position.

Fixation: Arm of the patient is fixed by the assistance or it may be fixed by the therapist's left hand.

Support: No need of support for the distal parts.

Position of the therapist and grasping

- Therapist is standing near to the hip region of the patient.
- Therapist's right hand fingers grasping the proximal end of the anterior aspect of the patient.
- Therapist's left hand reinforces the activity.

Procedure: Therapist's right hand applies long axis distraction force over the patient's elbow in 45° flexion.

Medial Gliding (Fig. 10.39)

Goal

- To increase the joint play movement of the ulnohumeral joint.
- To reduce the pain around the ulnohumeral joint.
- To increase the elbow extension and flexion of ulnohumeral joint.

Position of the patient: Supine lying or long sitting.

Fixation: Therapist's left hand grasping the distal humerus and restricting the movement over the shoulder joint.

Support: Patient's forearm and hand is placed in between the trunk and arm of the therapist.

Position of the therapist and grasping

- Therapist is standing besides the patient and facing the elbow joint.
- Therapist's left hand grasping the distal humerus and restricting the proximal joint motion.

Fig. 10.39: Ulnohumeral medial gliding

- Therapist's right hand and fingers are placed posteriorly and grasping the olecranon process of ulna and the thumb is placed proximal part of anterior aspect of the ulna.

Procedure: Therapist's right thumb applies distraction force and the fingers grip the olecranon and glides the ulna medially.

Lateral Gliding (Fig. 10.40)

Goal

- To increase the joint play movement of the ulnohumeral joint.
- To reduce the pain around the ulnohumeral joint.
- To increase the elbow extension and flexion.
- To increase the elbow adduction.

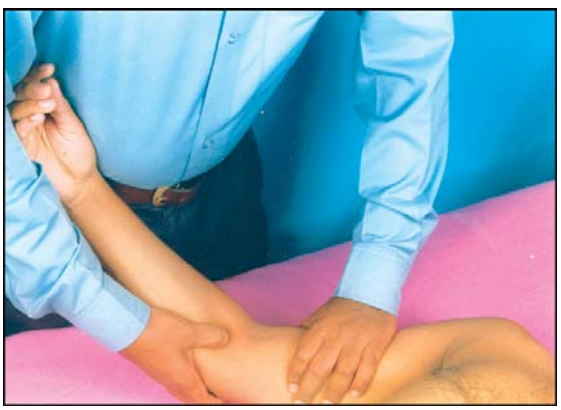


Fig. 10.40: Ulnohumeral lateral gliding

Position of the patient: Supine lying or long sitting.

Fixation: Therapist's left hand grasping the distal humerus and restricting the movement over the shoulder joint.

Support: Patient's forearm and hand is placed in between the trunk and arm of the therapist.

Position of the therapist and grasping

- Therapist is standing beside the patient and facing the elbow joint.
- Therapist's left hand grasping the distal humerus and restricting the proximal joint motion.
- Therapist's right hand fingers placed posteriorly and grasping the olecranon process of ulna and the thumb is placed proximal part of anterior aspect of the ulna.

Procedure: Therapist's right thumb applies the distraction force and the thumb web and fingers performing the lateral gliding of the ulna.

Humeroradial Joint (Fig. 10.41)

Distraction

Goal

- To increase the joint play movement of the humeroradial joint.
- To reduce the pain around the humeroradial joint.
- To increase the elbow extension and flexion.

Position of the patient: Supine lying and long sitting.

Fixation: Therapist's left hand grasping the distal humerus and restricting the movement over the shoulder joint.

Support: No need of support for this mobilization.

Position of the therapist and grasping

- Therapist is standing besides the patient and Facing the elbow joint.

Fig. 10.41: Radiohumeral distraction

- Therapist's left hand grasping the distal humerus and restricting the proximal joint motion.
- Therapist's right hand grasping the lower end of radius.

Procedure: Therapist's right hand pulls the radius downwards and applying the distraction force.

Dorsal gliding (Figs 10.42A and B)

Goal

- To increase the joint play movement of the radiohumeral joint.
- To reduce the pain around the radiohumeral joint.
- To increase the elbow extension.

Position of the patient: Supine lying and long sitting.

Fig. 10.42A: Radiohumeral dorsal gliding

Fixation: Therapist's left hand grasping the distal humerus and restricting the movement over the shoulder joint.

Support: Distal parts are already supported by the couch.

Position of the therapist and grasping

- Therapist is standing besides the patient and facing the elbow joint.
- Therapist's right hand grasping the distal humerus and restricting the proximal joint motion.
- Therapist's left hand grasping the proximal radius with the thumb anteriorly and fingers posteriorly.

Procedure: Therapist's left hand glides the radius posteriorly.

Ventral gliding

Goal

- To increase the joint play movement of the radiohumeral joint.
- To reduce the pain around the radiohumeral joint.
- To increase the elbow flexion.

Position of the patient: Supine lying or long standing.

Fixation: Therapist's right hand grasping the distal humerus and restricting the movement over the shoulder joint.

Fig. 10.42B: Radiohumeral ventral gliding

Support: Distal parts are already supported by the couch.

Position of the therapist and grasping

- Therapist is standing beside the patient and facing the elbow joint.
- Therapist's right hand grasping the distal humerus and restricting the proximal joint motion.
- Therapist's left hand grasping the proximal radius with the thumb anteriorly and fingers posteriorly.

Procedure: Therapist's left hand glides the radius anteriorly.

Compression (Fig. 10.43)

Goal

- To reduce the positional fault of the radius.

Position of the patient: Supine lying with elbow in 70-90° flexion.

Fixation: Therapist's left hand grasping the distal humerus and restricting the movement over the shoulder joint.

Support: Therapist's right hand grasping the patient's hand and supporting the distal parts.

Position of the therapist and grasping

- Therapist is standing besides the patient and facing the elbow joint.
- Therapist's left hand grasping the distal humerus and restricting the proximal joint motion.

Fig. 10.43: Radiohumeral compression

- Therapist's right hand grasping the patient's hand.

Procedure: Therapist's right hand applying the downward force and compresses the radio-humeral joint through wrist joint.

Radioulnar Joint

Proximal Radioulnar Joint

Dorsal gliding (Fig. 10.44)

Goal

- To increase the joint play movement of the proximal radioulnar joint.
- To reduce the pain around the proximal radioulnar joint.
- To increase the pronation of the proximal radioulnar joint.

Position of the patient: Supine lying or long sitting.

Fig. 10.44: Proximal radioulnar joint dorsal gliding

Fig. 10.45: Proximal radioulnar joint ventral gliding

Fixation: Proximal ulna is fixed with the right hand of the therapist.

Support: Distal part is stabilized by the couch itself.

Position of the therapist and grasping

- Therapist is standing beside the patient and facing the proximal radioulnar joint.
- Therapist's right hand fixing the proximal ulna of the patient.
- Therapist's left hand grasping the proximal radius of the patient.

Procedure: Therapist's left hand glides the radius in the dorsal and ventral direction.

Ventral gliding (Fig. 10.45)

Goal

- To increase the joint play movement of the proximal radioulnar joint.
- To reduce the pain around the proximal radioulnar joint.
- To increase the supination of the proximal radioulnar joint.

(Dorsal gliding increases pronation and ventral gliding increases the supination.)

Position of the patient: Supine lying or long sitting.

Fixation: Proximal ulna is fixed with the ulna hand of the therapist.

Support: Distal part is stabilized by the couch itself.

Position of the therapist and grasping

- Therapist is standing beside the patient and facing the proximal radioulnar joint.
- Therapist's left hand fixing the proximal ulna of the patient.
- Therapist's right hand grasping the proximal radius of the patient.

Procedure: Therapist's right hand glides the radius in the dorsal and ventral direction.

Distal Radioulnar Joint

Dorsal and ventral gliding (Fig. 10.46)

Goal

- To increase the joint play movement of the distal radioulnar joint.
- To reduce the pain around the distal radioulnar joint.
- To increase the supination and pronation of the distal radioulnar joint.

Position of the patient: Supine lying or long sitting.

Fixation: Distal ulna is fixed with the right hand of the therapist.

Support: No need of the support.

Fig. 10.46: Distal radioulnar joint dorsal and ventral gliding

Position of the therapist and grasping

- Therapist is standing beside the patient and facing the proximal radioulnar joint.
- Therapist's right hand fixing the proximal ulna of the patient.
- Therapist's left hand grasping the proximal radius of the patient.

Procedure: Therapist's left hand glides the radius in the dorsal and ventral direction.

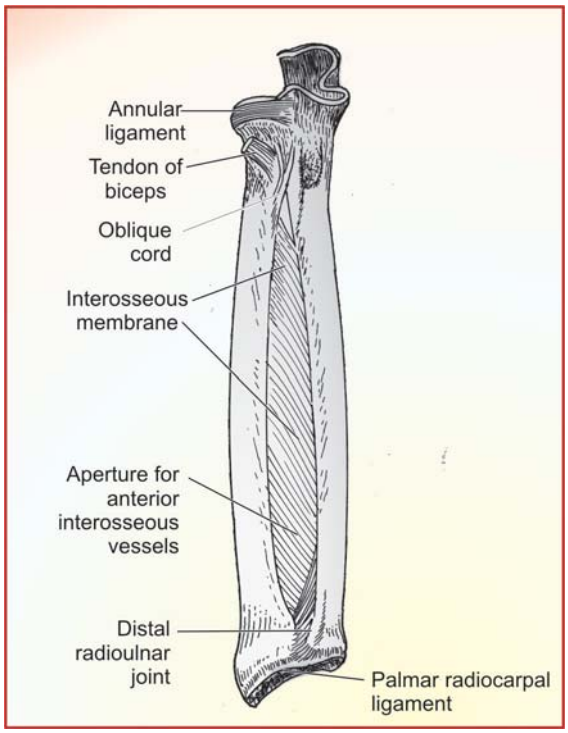


Fig. 10.47: Proximal and distal radioulnar joint

Radioulnar Joint

Type

- Upper radioulnar joint—synovial
- Middle radioulnar joint—Fibrous
- Lower radioulnar joint—synovial

Variety

- Upper radioulnar joint—pivot
- Middle radioulnar joint—syndesmosis
- Lower radioulnar joint—pivot

Articular Surface

- Upper radioulnar joint (Fig. 10.47)
  Head of the radius (convex)
  Radial notch of ulna(concave)
- Middle radioulnar joint
  Interosseous border of the ulna and radius
- Lower radioulnar joint
  Head of ulna (convex)
  Ulnar notch of radius (concave).

Movements

Osteokinematics

- Supination—Biceps, supination, brachioradialis
- Pronation—Pronator teres, brachioradialis, flexor carpiradialis, palmaris longus, pronator quadratus.

Arthrokinematics

Arthrokinematics relations with the osteokinematics movements are:

Upper radioulnar joint

Supination—Ventral gliding
Pronation—Dorsal gliding

Lower radioulnar joint

Supination—Dorsal gliding
Pronation—Ventral gliding.

Range of motion

Supination—90°
Pronation—80°

Positions

Starting position

- Arm is parallel to the trunk with the elbow at right angle.

Resting position

- Proximal radioulnar joint supination 35° flexion 70°.
- Distal radioulnar joint supination 10°.

Close packed position

- Proximal radioulnar joint full extension, 5° supination.

Capsular pattern

- Proximal radioulnar joint resisted equally in both directions.

Supination—Pronation

Wrist Joint (Fig. 10.48)

Type

Synovial joint

Variety

Ellipsoid

Articular surfaces

- Lower end of radius—Proximally(concave)
- Scapoid, lunate and traquetral—Distally (convex).

Ligaments

- Ulnar collateral ligaments
- Radio-collateral ligaments
- Palmar ulnocarpal ligaments
- Dorsal radiocarpal ligaments
- Palmar radiocarpal ligaments.

Movements

Osteokinematics.

Flexion

- Flexor carpi radialis
- Flexor carpi ulnaris
- Palmaris longus
- Flexor digitorum profundus
- Flexor pollicis longus.

Extension

- Extensor carpi radialis longus
- Extensor carpi ulnaris
- Extensor digitorum
- Extensor indicis
- Extensor digitorum mini
- Extensor pollicis longus.

Ulnar Deviation

- Flexion carpi ulnaris
- Extension carpi ulnaris.

Radial Deviation

- Flexor carpi radialis
- Extension carpi radialis longus
- Flexor pollicis longus.

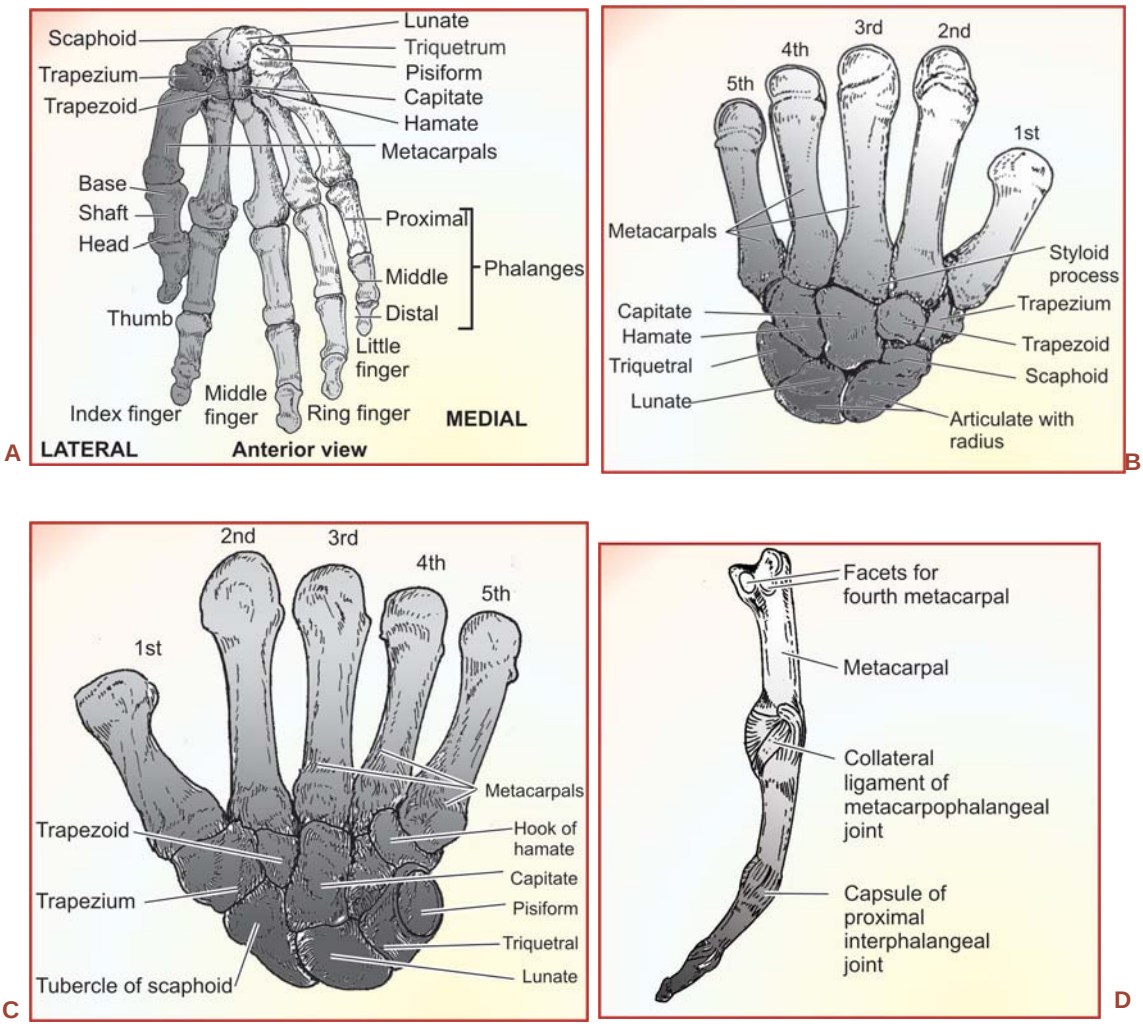
Arthrokinematics

Arthrokinematics relations with the osteokinematics movements are:

- Flexion—dorsal gliding
- Extension—ventral gliding
- Ulnar deviation—radial gliding
- Radial deviation—ulnar gliding.

Range of Motion

Flexion 70°-90°
Extension 60°-70°
Ulnar deviation 45°
Radial deviation15°-20°



Figs 10.48A to D: A. Right hand and wrist, B. Intercarpal and carpometacarpal joint posterior view, C. Intercarpal and carpometacarpal joint anterior view, and D. Interphalangeal joint

Position

Starting position

- Radius lower and the 3 metacarpal in straight line.

Resting position

- Slight ulnar deviation.

Close packed position

- Maximum extension.

Capsular pattern

Restricted equally in all directions.

Distraction (Fig. 10.49)

Goal

- To increase the joint play movement of the radiocarpal, ulnocarpal and intercarpal joint.
- To reduce the pain around the distal radiocarpal, ulnocarpal intercarpal joint.

Fig. 10.49: Wrist distraction

Fig. 10.50: Wrist ventral gliding

- To increase the ROM of the radiocarpal, ulnocarpal and intercarpal joints.

Position of the patient: Long sitting and the wrist is placed in the end of the couch.

Fixation: Distal ulna and radius of the patient is fixed with the therapist's left hand.

Support: Therapist's right hand grasps the hand region of the patient.

Position of the therapist and grasping

- Therapist is standing beside the patient and facing the wrist of the patient.
- Therapist's left hand grasping the distal ulna and radius of the patient.
- Therapist's right hand grasps the metacarpal region of the patient.

Procedure: Therapist's right hand applies the distraction.

Ventral Gliding (Fig. 10.50)

Goal

- To increase the joint play movement of the radiocarpal, ulnocarpal and intercarpal joints.
- To reduce the pain around the distal radiocarpal, ulnocarpal and intercarpal joints.
- To increase the wrist extension.

Position of the patient: Long sitting and the wrist is placed in the end of the couch and forearm in pronated position.

Fixation: Distal ulna and radius of the patient is fixed with the therapist's left hand.

Support: Therapist's right hand grasps the hand region of the patient.

Position of the therapist and grasping

- Therapist is standing beside the patient and facing the wrist of the patient.
- Therapist's left hand grasping the distal ulna and radius of the patient.
- Therapist's right hand grasps the metacarpal region of the patient.

Procedure: Therapist's right hand performing the ventral gliding of the radiocarpal, ulnocarpal and intercarpal joints.

Dorsal gliding (Fig. 10.51)

Goal

- To increase the joint play movement of the radiocarpal, ulnocarpal and intercarpal joints.
- To reduce the pain around the distal radiocarpal, ulnocarpal and intercarpal joints.
- To increase the wrist flexion.

Position of the patient: Long sitting and the wrist is placed in the end of the couch and the forearm in supinated position.

Fig. 10.51: Wrist dorsal gliding

Fixation: Distal ulna and radius of the patient is fixed with the therapist's left hand.

Support: Therapist's right hand grasps the hand region of the patient.

Position of the therapist and grasping

- Therapist is standing beside the patient and facing the wrist of the patient.
- Therapist's left hand grasping the distal ulna and radius of the patient.
- Therapist's right hand grasps the metacarpal region of the patient.

Procedure: Therapist's right hand performing the dorsal gliding of the radiocarpal, ulnocarpal and intercarpal joints.

Ulnar gliding (Fig. 10.52)

Goal

- To increase the joint play of the wrist joint.
- To reduce the pain over the wrist.
- To increase the radial deviation of the wrist.

Position of the patient: Long sitting and the wrist is placed in the end of the couch. Patient's forearm in mid prone position.

Fixation: Distal ulna and radius of the patient is fixed with the therapist's left hand.

Support: Therapist's right hand grasps the hand region of the patient.

Fig. 10.52: Wrist ulnar gliding

Position of the therapist and grasping

- Therapist is standing beside the patient and facing the wrist of the patient
- Therapist's left hand grasping the distal ulna and radius of the patient
- Therapist's right hand grasps the metacarpal region of the patient.

Procedure: Therapist's right hand glides the wrist in ulnar direction.

Radial gliding (Fig. 10.53)

Goal

- To increase the joint play of the wrist joint.
- To reduce the pain over the wrist.
- To increase the ulnar deviation of the wrist

Fig. 10.53: Wrist radial gliding

Position of the patient: Long sitting and the wrist is placed in the end of the couch. Patient's forearm in midprone position.

Fixation: Distal ulna and radius of the patient is fixed with the therapist's left hand.

Support: Therapist's right hand grasps the hand region of the patient.

Position of the therapist and grasping
- Therapist is standing beside the patient and facing the wrist of the patient.
- Therapist's left hand grasping the distal ulna and radius of the patient.
- Therapist's right hand grasps the metacarpal region of the patient.

Procedure: Therapist's right hand glides the wrist in the radial direction.

Thumb (1st carpometacarpal joint)

Type

Synovial joint

Variety
- Saddle

Articular Surfaces
- Trapezium (concavoconvex)
- Proximal part of metacarpal (concavoconvex)

Ligaments
- Capsular ligament
- Dorsal ligament
- Palmar ligament
- Lateral ligament.

Movements

Osteokinematics

Flexion:
- Flexion pollicis longus and brevis
- Opponens pollicis.

Extension:
- Extensor pollicis longus and brevis
- Abdutor pollicis longus and brevis.

Abdution
- Abductor pollicis longus and brevis.

Addution
- Addutor pollicis longus and brevis.

Opponens
- Opponens pollicis brevis.

Arthrokinematic

Arthrokinematics relations with the osteokinematics movement are:
- Flexion—ulnar gliding
- Extension—radial gliding
- Abduction—dorsal gliding
- Adduction—ventral gliding.

Positions

Starting position
- Midway between flexion extension and abduction and adduction.

Resting position
- Midway between flexion extension and abduction and adduction.

Close packed position
- Movement is restricted in abduction and extension.
- Abduction > extension.

Carpometalcarpal Joint (2nd-5th)

Distraction (Fig. 10.54)

Goal
- To increase the joint play in the 2nd to 5th carpometacarpal joints.
- To increase the ROM of the 2nd to 5th carpometacarpal joints.
- To reduce the pain around the 2nd to 5th carpometacarpal joints.

Patient's position: Sitting and hand is placed on the table.

Fig. 10.54: Thumb joint—joint distraction

Fig. 10.55: Carpometacarpal joint dorsal and ventral gliding

Fig. 10.56: Carpometacarpal joint (2nd-5th) dorsal and ventral gliding

Fixation: Carpal bones are fixed by therapist's left hand with the thumb on the dorsal surface and the finger on ventral surface.

Support / Stabilization: Distal part is supported by the table itself.

Therapist's position:

- Therapist is standing near the patient and facing the carpometacarpal joint.
- Therapist's right hand is grasping the base of the carpometacarpal with the thumb on the dorsal surface and the flexion on the ventral surface.
- Therapist's left hand is grasping the distal row of the carpal bone with the thumb on the dorsal surface and the finger on the ventral surface.

Procedure: Therapist's right hand is pulling the metacarpal distally from the relevant carpal bones, (i.e. 2nd metacarpal on trapezoid, 3rd on capitate, 4th on hamate, 5th on hamate).

Dorsal and ventral gliding (Figs 10.55 and 10.56)

Goal:

- To increase the joint play around the 2nd to 5th carpometacapal joints.
- To increase the flexion and extension of the 2nd to 5th (dorsal gliding increases flexion and ventral gliding increases extension of carpometacarpal joint).
- To reduce the pain around the 2nd to 5th carpometacarpal joint.

Patient's position: As said in distraction.

Fixation: As said in distraction.

Support / Stabilization: As said in distraction.

Therapist's position: As said in distraction.

Procedure: Therapist's right hand is gliding the metacarpals on the relevant carpal bone in the volar and dorsal diversion (i.e. 2nd metacarpal on trapezoid, 3rd metacarpal on capital, hamate 5th metacarpal on hamate).

Intermetacarpal Joint

Dorsal and ventral gliding (Fig. 10.57)

Goal

- To increase the joint play around the intermetacarpal joint.

- To reduce the pain around the inter-metacarpal joint.

Fig. 10.57: Intermetacarpal joint dorsal and ventral gliding

Patient's position: As said in the distraction of the carpometacarpal joint.

Fixation: Therapist's right hand is fixing the adjacent mid shaft of the metacarpal with the thumb on the dorsal surface and the index finger on the ventral surface.

Support / Stabilization: No need of support.

Therapist's position:

- Therapist is standing near the patient and facing the intermetacarpal joint.
- Therapist's right hand is fixing the adjacent mid-shaft of the metacarpal with the thumb on the dorsal surface and the index finger on the ventral surface.
- Therapist's left hand is grasping the mid-shaft of the first metacarpal with the thumb on the dorsal surface and index finger on the ventral surface.

Procedure: Therapist's left hand is gliding the first metacarpal on the adjacent metacarpal in the dorsal and ventral direction (2nd metacarpal on the 3rd metacarpal, 4th metacarpal on the 3rd metacarpal, 5th metacarpal on the 4th metacarpal).

Metacarpophalangeal Joint

Type

Synovial joint

Variety

Condyloid variety

Articular Surface

- Head of the metacarpal (convex)
- Proximal end of proximal phalanx (concanve).

Ligaments

- Palmar ligament
- Collateral ligament—medial, lateral.

Movements

Osteokinematics

- Flexion—Flexor pollicis longus and brevis
- Extension—Extension pollicis longus and brevis
- Abduction—Abductor pollicis longus and brevis
- Flexion
  - 1st MCP—Flexion pollicis longus and brevis
  - 2nd-5th MCP—Lumbricals, flexion digitorum superficialis.
- *Extension*
  - 1st MCP—Extensor pollicis longus and brevis
  - 2nd-5th MCP—Extensor digitorum, extensor digiminimi.
- *Abduction*
  - 1st MCP—Abduction pollicis brevis and longus
  - 2nd–4th MCP—Dorsal interosseous
  - 5th MCP—Abductor digitiminimi.
- *Adduction*
  - 1st MCP—1st palmar interosseous
  - 2nd MCP—2nd interosseous

- 4th MCP—3rd interosseous
- 5th MCP—4th interosseous.

Arthrokinematics:
Arthrokinematic relations with the osteokinematics.
- Flexion—Ventral gliding
- Extension—Dorsal gliding
- Abduction—1st –3rd MCP radial gliding
- Adduction—4th-5th MCP medial gliding.

Adduction
- 1st-3rd medial gliding
- 4th-5th radial gliding.

Range of Motion
- Flexion—90°
- Extension—15°-20°
- Abduction—25°-35°
- Adduction—0°

Positions
Starting position
- Metacarpals and phalanx are in straight line.

Resting position
- Slight flexion in all joints

Close packed position
- 1st MCP—maximum extension
- 2nd –5th MCP—maximum flexion

Capsular pattern
- Restricted in all directions.

Distraction (Fig. 10.58)
Goal
- To increase the joint play around the metacarpophalangeal joint.
- To reduce the pain around the metacarpophalangeal joint.
- To increase the ROM of the metacarpophalangeal joint.

Patient's position: As said in the distraction of the metacarpophalangeal joint.

Fig. 10.58: Metacarpophalangeal joint distraction

Fixation: Therapist's left hand is fixing the head of the metacarpal with the thumb on the dorsal surface and the index finger on the ventral surface.

Support / Stabilization: Not necessary.

Therapist's position:
- Therapist is standing near to the patient and facing the metacarpophalangeal joint.
- Therapist's right hand is grasping the proximal end of the proximal phalanx with the thumb on the dorsal surface and the index finger on the ventral surface.
- Therapist's left hand is fixing the head of the metacarpal with the thumb on the dorsal surface and the index finger on the ventral surface.

Procedure: Therapist's right hand moves the proximal phalanx distally.

Dorsal Gliding and Ventral Gliding (Fig. 10.59)
Goal:
- To increase the joint play around the metacarpophalangeal joint.
- To increase the flexion and extension of the metacarpophalangeal joint.
  (Dorsal gliding increases the extraction, ventral gliding increases the flexion).

- To reduce the pain around the metacarpophalangeal joint.

Fig. 10.59: Metacarpophalangeal joint dorsal, ventral, medial and lateral gliding

Patient's position: As said in the distraction.

Fixation: As said in the distraction.

Support / Stabilization: As said in the distraction.

Therapist's position: As said in the distraction.

Procedure: Therapist's right hand is gliding the proximal phalanx on the metacarpal in the dorsal and ventral surfaces.

Medial and Lateral Gliding

Goal:

- To increase the joint play around the metacarpophalangeal joint.
- To increase the ROM around the metacarpophalangeal joint (Medial gliding increases the adduction of digit 1 and 2 ulnar abduction of digit 3, abduction of digit 4 and 5. Lateral gliding increases the abduction of digit 1 and 2 radial abduction of digit 3, and abduction of digits 4 and 5.).
- Reduce the pain around the metacarpophalangeal joint.

Patient's position: As said in distraction.

Fixation: As said in distraction.

Support / Stabilization: As said in distraction.

Therapist's position: As said in distraction.

Procedure: Therapist's right hand glides the proximal phalanx in the medial and lateral direction.

Interphalangeal Joint

Type

Synovial

Variety

Hinge

Articular Surfaces

- Distal end of the proximal phalanx (convex)
- Proximal end of the distal phalanx (concave).

Ligaments

- Medial collateral ligament
- Lateral collateral ligament
- Palmar collateral ligament.

Movements

Osteokinematic

Flexion

- 1st IP—Flexion pollicis longus
- 2nd-5th IP—Flexion digitorum profundus
- 2nd IP—Flexion carpi radialis longus
- 5th IP—Flexion carpi ulnaris.

Extension

- 1st IP—Extension pollicis longus
- 2nd–5th IP—Extension digitorum
- 2nd IP—Extension carpi radialis longus, extension indicis
- 3rd IP—Extension carpi radialis brevis
- 5th IP—Extension carpi ulnaris.

Range of Motion

- Flexion—90°
- Extension—0°

Positions

Starting position
- Both the phalanx is in straight line.

Resting position
- Slight flexion in all joints.

Close packed position
- Maximum extension.

Capsular pattern
- Restricted in all directions.
- Flexion, extension.

Distraction (Fig. 10.60)

Goal:
- To increase the joint play in the interphalangeal joint.
- To reduce the pain in the interphalangeal joint.
- To increase the ROM in the interphalangeal joint.

Fig. 10.60: Interphalangeal joint distraction

Patient's position: Sitting.

Fixation: Therapist's left hand is fixing the distal end of the proximal phalanx with the thumb on the dorsal surface and the index finger on the ventral surface.

Support / Stabilization: Not necessary.

Therapist's position:
- Therapist is facing the interphalangeal joint.
- Therapist's right hand is grasping the proximal end of the distal phalanx with the thumb on the dorsal surface and the index finger on the ventral surface.
- Therapist's left hand is grasping the distal end of phalanx with the thumb on the dorsal surface and the index finger on the ventral surface.

Procedure: Therapist's right hand moves the distal phalanx distally.

Dorsal and Ventral Gliding (Fig. 10.61)

Goal:
- To increase the joint play around the interphalangeal joint .
- To increase the flexion and extension of the interphalangeal joint (Dorsal gliding increases the extension, ventral gliding increases the flexion).
- To reduce the pain.

Fig. 10.61: Interphalangeal joint dorsal and ventral gliding

Patient's position: As said in distraction.

Fixation: As said in distraction.

Support / Stabilization: As said in distraction.

Therapist's position: As said in distraction.

Procedure: Therapist's right hand glides the distal phalanx on the proximal phalanx in the ventral and dorsal direction.

Hip Joint

Type

Synovial joint.

Variety

Ball and socket joint.

Articular Surfaces

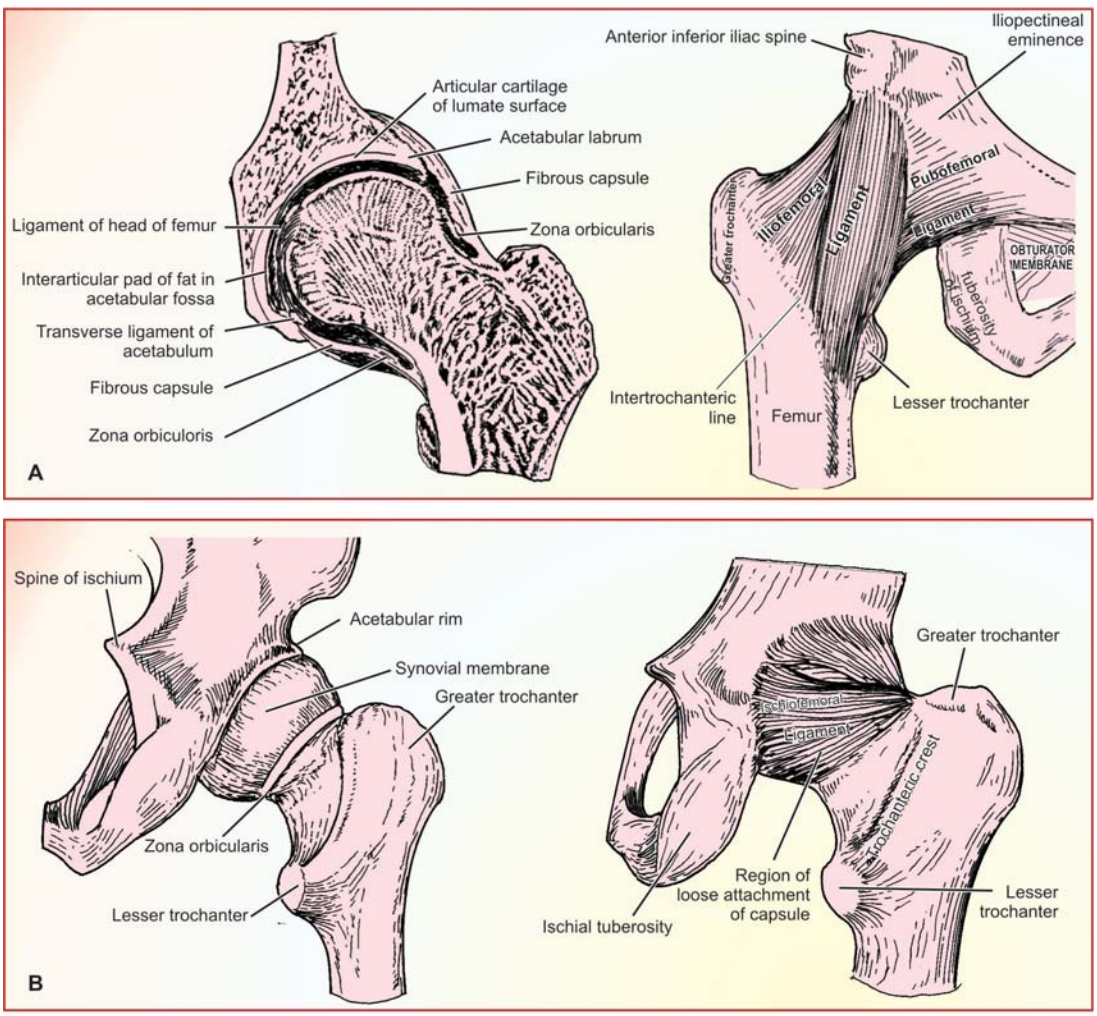
- Acetabulum of the hip bone (concave)
- Head of the femur (convex).

Ligaments (Fig. 10.62)

- Iliofemoral ligament
- Pubofemoral ligament
- Ischiofemoral ligament
- Transverse ligament
- Round ligament.

Movements

Osteokinematic



Figs 10.62A and B: Hip joints

Flexion
- Ilium, psoas major, sartorium, rectus femoris, lateral part of pectineus.

Extension
- Gluteus maximum, hamstrings.

Abduction
- Gluteus medius, gluteus minimus
- Sartorius, tensor fascia latae.

Adduction
- Adductor longus, adductor brevis, adductor magnus
- Gracilis, pectineus.

Lateral rotation
- Piriformis, obturator internus and externus, quadratus femoris.
- Gluteus maximum, sartorius.

Medial rotation
- Iliac psoas, gluteus medius and minimus.

Arthrokinematics

Arthrokinematics relations with the osteokinematics movements are:
- Flexion—Dorsal gliding
- Extension—Ventral gliding
- Abduction—Caudal gliding
- Adduction—Lateral gliding
- Lateral rotation—Ventral gliding
- Medial rotation—Dorsal gliding.

Range of Motion

Flexion	20°-135°
Extension	45°
Abduction	45°-60°
Adduction	0°
Medial rotation	0°-45°
Lateral rotation	0°-35°

Position

Starting position
- Line drawn from ASIS to patella and the two ASIS lies at right angle to each other.

Resting position
- 30° hip flexion, 30° abduction, externally rotation.

Close packed position
- Maximum extension, medial rotation, abduction.

Capsular pattern
- Restriction of the movements in this order
- Medial rotation > extension >abduction > lateral rotation

Distraction (Fig. 10.63)

Goal
- To increase the ROM around the hip joint .
- To increase the joint play around the hip.
- To reduce the pain around the hip.

Fig. 10.63: Hip joint distraction

Patient's position: Supine lying.

Fixation: Patient's pelvic is fixed by the assistance or by the belt.

Support / Stabilization: Patient leg is kept on the therapist's shoulder.

Therapist's position and holding

- Therapist is standing foot end of the patient and facing the patient's hip.
- Therapist's both the hands are grasping the upper thigh of the patient.
- Patient's hips and knees are flexed and the patient's leg is kept on the therapist's shoulder.

Procedure: Therapist's both the hands are applying the distraction force on the hip joint.

Caudal Gliding (Fig. 10.64)

Goal

- To increase the hip abduction movement.
- To increase the joint play around the hip.
- To reduce pain around hip.

Fig. 10.64: Hip joint caudal gliding

Patient's position: Supine lying.

Fixation: Patient's pelvic is fixed and the movement is restricted by the assistance or by the belt.

Support / stabilization: There is no need of stabilization because the therapist's holding is around the ankle of the patient.

Therapist's position

- Therapist is standing foot end of the patient and facing the hip joint of the patient.
- Therapist's both the hands are grasping the ankle joint of the patient.

Procedure: Therapist's both the hands are pulling the leg down and the caudal gliding with mild distraction.

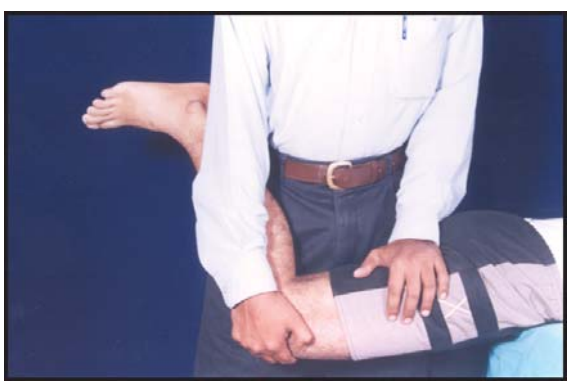
Ventral Gliding (Fig. 10.65)

Goal

- To increase the extension and external rotation of the hip.
- To increase the joint play around the hip.
- To reduce the pain around the hip.

Patient's position: Half-prone lying and the lower joint to keep hanging in the bed end.

Fixation: Patient's pelvic is fixed by the assistant or may not be necessary because the



Figs 10.65A and B: Hip joint ventral gliding

pelvic movement will be restricted by the couch itself.

Support / Stabilization: Lower leg of the patient is supported by the therapist's right hand.

Therapist's position

- Therapist is standing at the foot end of the patient and facing the posterior aspect of the hip of the patient.
- Therapist's left hand is placed over the posterior aspect of the upper thigh of the patient.
- Therapist's right hand is grasping the knee joint of the patient and supports the lower leg of the patient.

Procedure: Therapist's left hand applies anterior force and performing the anterior sliding around the hip joint of the patient with mild distraction.

Dorsal Gliding (Fig. 10.66)

Goal

- To increase the hip flexion and medial rotation.
- To increase the hip joint play movement.
- To reduce the hip pain.

Patient's position: Supine lying patient's hip is placed over the bed end.

Fixation: Patient's pelvis is already fixed to the couch.

Fig. 10.66: Hip joint dorsal gliding

Support / Stabilization: Patient's thigh and lower leg is supported and stabilized by therapist's left hand.

Therapist's position and holding

- Therapist is standing in the foot end of the patient and facing the hip joint of the patient.
- Therapist's right hand is placed on the anterior aspect of the upper thigh of the patient.
- Therapist's left hand grasping around the knee and the supporting the lower leg of the patient.

Procedure: Therapist's right hand applies posterior force and hand performing the dorsal gliding of the hip of the patient with mild distraction and the lower thigh of the patient is stabilized by the therapist's left hand.

Lateral Gliding (Fig. 10.67)

Goal:

- To increase the internal rotation and adduction.
- To reduce the pain around the hip joint.
- To increase the joint play movement around the hip.

Fig. 10.67: Hip joint lateral gliding

Position of the patient: Supine position.

Fixation: Pelvic is already fixed by the positioning itself.

Support / Stabilization: As said in distraction.

Therapist's position:

- Therapist is standing near the patient's lower extremity.
- Therapist's left and right hands are grasping the upper thigh of the patient.

Procedure: Therapist's both the hands are gliding the femur in lateral direction.

Knee Joint

Type

Synovial

Variety

Condylar

Articular Surfaces

- Lower end of femur (convex)
- Upper end of tibia (concave).

Ligaments (Fig. 10.68)

- Meniscus—medial, lateral
- Medial collateral ligament
- Lateral collateral ligament
- Arcuate ligament
- Ligamentum patellae
- Cruciate ligament(anterior, posterior).

Movements

Osteokinematics

- Flexion—Hamstrings
- Extension—Quadriceps
- Medial rotators—Semi-membranosus
- Lateral rotators—Biceps femoris

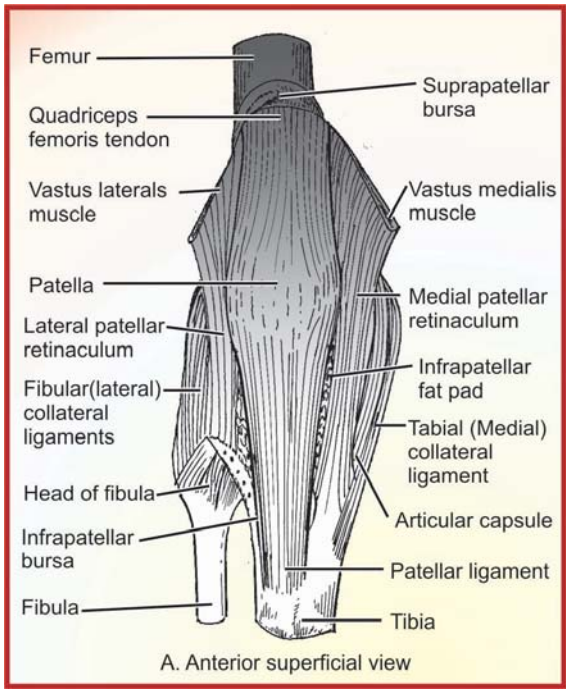


Fig. 10.68A

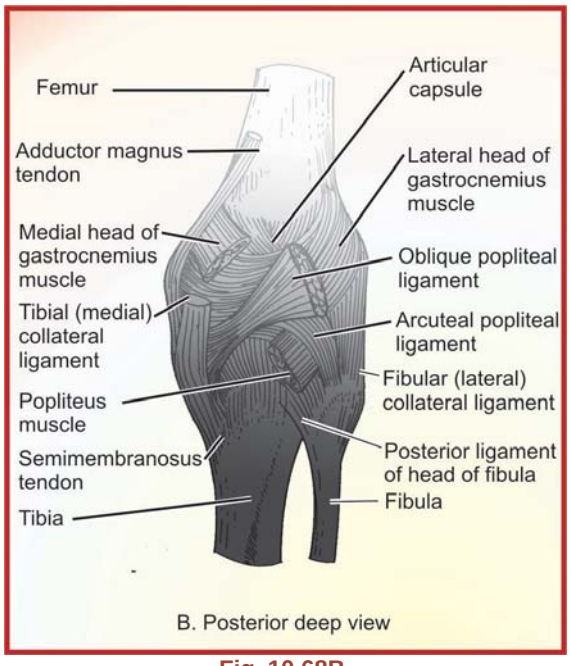
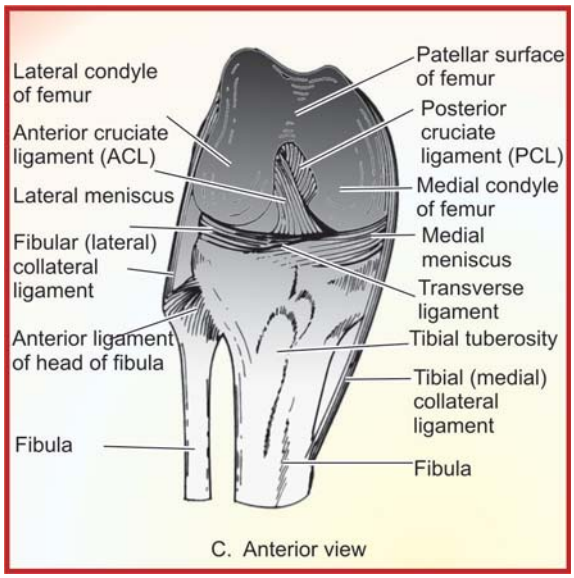


Fig. 10.68B



Figs 10.68A to C: Knee joint

Arthrokinematic

Arthrokinematic relations with the osteokinematic movements are:

- Flexion—Dorsal gliding
- Extension—Ventral gliding
- Medial rotators—Dorsal gliding
- Lateral rotators—Ventral gliding.

Range of Motion

Knee flexion	135° – 150°
Knee extension	0°
Medial rotation	15°
Lateral rotation	45°

Positions

Starting position

- Neutral range

Resting position

- 25° of flexion

Close packed position

- Maximum exension and external rotation.

Capsular pattern

- Restriction of the movement
- Flexion>Extension

Tibiofibular Joint (Fig. 10.69)

Type

- Superior tibiofibular joint—synovial
- Middle tibiofibular joint—fibrous joint
- Inferior tibiofibular joint—fibrous.

Variety

- Superior tibiofibular joint—plane
- Middle tibiofibular joint—syndesmosis
- Inferior tibiofibular joint—syndesmosis

Articular End

Superior tibiofibular joint

- Lateral condyle of the articular facet of the tibia (concave)
- Articular facet of the head of fibula (convex).

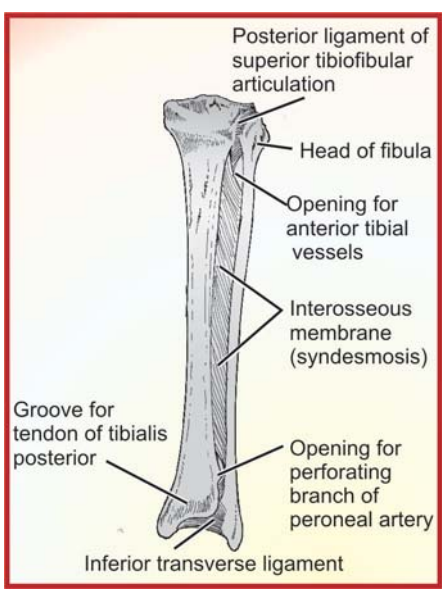


Fig. 10.69: Proximal and distal tibiofibular joint

Inferior tibiofibular joint
- Lateral surface of the lower end of the tibia (concave)
- Medial surface of the lower end of the fibula (convex)

Middle tibiofibular joint
- Shafts of tibia and fibula

Ligaments
- Superior tibiofibular joint
  - Anterior ligament
  - Posterior ligament
- Anterior tibiofibular ligament
- Posterior tibiofibular ligament
  - Inferior transverse ligament
  - Interosseous ligament.

Movements
- Osteokinematic
- Superior tibiofibular joint
- Gliding up and down help in knee flexion and extension.
- Inferior tibiofibular joint.
- Gliding up and down helps in dorsiflexion and plantar flexion.

Positions
Starting position
- Neutral position of the ankle

Resting position
- Superior tibiofibular
  - 25° knee flexion, 10° plantar flexion
- Inferior tibiofibular
  - 10° plantar flexion, 5° inversion.

Close packed position
- Superior tibiofibular—none
- Inferior tibiofibular—none

Capsular pattern
- Superior tibiofibular—none
- Inferior tibiofibular—none.

Tibiofemoral Articulation

Distraction (Fig. 10.70)

Goal
- To increase the joint play around knee joint.
- To increase the ROM around knee joint.
- To reduce the pain around the knee joint.

Fig. 10.70: Tibiofemoral distraction

Patient's position: Sitting in the bed end or stool end.

Fixation: Already proximal joint is fixed sometime the lower thigh is fixed with the help of the assistance.

Support / Stabilization: Therapist's both the forearms are supporting the leg of the patient.

Therapist's position
- Therapist is sitting opposite to the patient on the stool and facing the patient's knee joint.

- Therapist's both hands are grasping the upper end of the tibia of the patient.
- Therapist's both legs are supporting the lower leg of the patient.

Procedure: Therapist performing the distraction over the knee by pulling the tibia downwards.

Dorsal Gliding (Fig. 10.71)

Goal
- To increase the joint play of the knee joint
- To increase the ROM of the knee joint.
- To increase the flexion of the knee joint.

Fig. 10.71: Tibiofemoral dorsal gliding

Patient's position: Long sitting and the leg is hanging in the end of the couch knee is in extended position.

Fixation: Already the proximal joint is fixed.

Support / Stabilization: Distal part of the leg is grasped by the therapist right hand.

Therapist's position
- Therapist is standing opposite to the patient and forcing the patient knee joint.
- Therapist's left hand grasping the proximal tibia of the patient.
- Therapist's right hand is grasping the distal tibia of the patient.

Procedure:
- Therapist's right hand applies mid-distraction of the knee joint of the patient.
- Therapist's left hand glides the tibia dorsally.

Dorsal Gliding (Progression) (Fig. 10.72)

Goal
- To increase the maximum ROM of the knee joint.

Fig. 10.72: Tibiofemoral dorsal gliding progression

- To increase the maximum flexion of the knee joint.
- To reduce the pain of the knee joint.

Patient's position: Patient is in long sitting position. Knee is kept in maximum available flexed position.

Fixation: Proximal joints are already fixed.

Support / Stabilization: Lower leg is supported and holding with therapist's both the knee joint.

Therapist's position

- Therapist is sitting opposite to the patient.
- Therapist's right hand is grasping the anterior part of the proximal part of the tibia of the patient.
- Therapist's left hand is grasping the posterior part of the proximal part of the tibia of the patient.
- Therapist's knee and leg are giving support to the lower leg of the patient.

Procedure:

- Therapist's leg and the left hand apply minimal traction around the knee of the therapist.
- Therapist's right hand performs the dorsal gliding around the knee joint of the patient.

Ventral Gliding (Fig. 10.73)

Goal

- To increase the ROM of the knee joint.
- To increase the joint play around the knee joint.
- To increase the extension of the knee joint.

Patient's position: Prone lying and the knee is in available extension position.

Fixation: Proximal joints are fixed already by the positioning itself and the assistant fixes the distal thigh.

Support / Stabilization: Distal joints already stabilized by the positioning itself.

Fig. 10.73: Tibiofemoral ventral gliding

Therapist's position

- Therapist is standing beside the patient and facing the knee joint.
- Therapist's left hand placed over the posterior aspect of the upper part of the tibia.
- Therapist's right hand is grasping the lower end of the tibia and fibula.

Procedure:

- Therapist's left hand performing the ventral gliding with the minimal traction.
- Therapist's right hand applies the minimal distraction force.

Ventral Gliding—Second Technique (Fig. 10.74)

Goal

- To increase the joint play around the knee joint.
- To increase the ROM of the knee joint.
- To increase the extension range around the knee joint.

Patient's position: Long sitting and the legs are kept hanging in the end of the couch.

Fixation: Already fixed by the position.

Fig. 10.74: Tibiofemoral ventral gliding and technique

Support / Stabilization: Therapist sitting front to the patient on the stool and holding the patient's leg with his both the knee.

Therapist's position

- Therapist is sitting front to the patient and holding the patients lower leg with his both the knee.
- Therapist's both the hands are grasping the upper part of the tibia.

Procedure: Therapist's both the hands are performing the ventral gliding with the minimal traction therapist's legs also maintain the traction.

Patellofemoral Joint

Cranial Gliding (Fig. 10.75)

Goal

- To increase the joint play in the patellofemoral joint.
- To increase the knee extension ROM.

Fig. 10.75: Patellofemoral cranial gliding

Patient's position: Supine lying.

Fixation: Not needed.

Support / Stabilization: Not needed.

Therapist's position:

- Therapist is standing to the lower extremity of the patient.
- Therapist's left hand thumb web space is placed over apex of the knee.
- Therapist's right hand placed over the base of the patella.

Procedure: Therapist's left hand performing the cranial gliding of the patella.

Caudal Gliding (Fig. 10.76)

Goal

- To increase the joint play around the patellofemoral joint.
- To increase the knee flexion ROM.

Fig. 10.76: Patellofemoral caudal gliding

Patient's position: Supine lying.

Fixation: As said in cranial gliding.

Support / Stabilization: As said in cranial gliding.

Therapist's position

- Therapist is standing near to the patients lower extremity and facing the knee joint of the patient.
- Therapist's right hand is placed over the base of the patella patient.
- Therapist left hand placed over the patella.

Procedure: Therapist's right hand performing the caudal gliding of the patella.

Medial Gliding (Fig. 10.77)

Goal

- To increase the joint play in patellofemoral joint.
- To increase the knee flexion ROM.

Fig. 10.77: Patellofemoral medial gliding

Fig. 10.78: Patellofemoral lateral gliding

Patient's position: Supine lying.

Fixation: As said in cranial gliding.

Support / Stabilization: As said in cranial gliding.

Therapist's position

- Therapist is standing near to the patient's lower extremity.
- Therapist's both hands index and middle finger are placed over the lateral margin of the patella of the patient.

Procedure: Therapist's both hands, index and middle fingers are performing the medial gliding over the patella femoral joint.

Lateral Gliding (Fig. 10.78)

Same like the medial gliding is that therapists' thumbs are placed over the medial margin of the patella of the patient instead of lateral margin as said in medial gliding and gliding the patella laterally.

Tibiofibular Joint

Upper Tibiofibular

Dorsal Gliding (Fig. 10.79)

Goal

- To increase the joint play around the upper tibiofibular joint.
- To reduce the pain over the upper tibiofibular joint.

Patient's position: Supine lying or sitting in the bed end.

Fixation: Therapists' right hand is fixing the upper end of tibia.

Support / Stabilization: No need of support because the position itself gives the support for the distal part.

Therapist's position

- Therapist is standing near the lower extremity of the patient and facing the upper tibiofibular joint.

Fig. 10.79: Upper tibiofibular joint dorsal gliding

- Therapist's right hand fixing the upper end of tibia of the patient.
- Therapist's left hand grasping the head of the fibula.

Procedure: Therapist's left hand performing the dorsal gliding of the fibula head over the tibia.

Ventral Gliding (Fig. 10.80)

Goal

- To increase the joint around the upper tibiofibular joint.
- To reduce the pain around the upper tibiofibular joint.

Fig. 10.80: Upper tibiofibular joint ventral gliding

Patient's position: Prone lying or side lying.

Fixation: Therapist's left hand fixing the upper end of the tibia by grasping it in posterior aspect.

Support / Stabilization: To need of support for the distal part because it is already supported by the position itself.

Therapist's position and holding

- Therapist is standing near the lower extremity of the patient.
- Therapist's left hand is grasping the fibular head.
- Therapist's right hand grasping the upper end of the posterior aspect of the tibia and fixing it.

Procedure: Therapist's right hand is gliding the fibula in ventral direction on the tibia.

Lower Tibiofibular Joint

Distraction (Fig. 10.81

Goal

- To increase the joint play around the lower tibiofibular joint.
- To increase the dorsiflexion of the ankle.
- To reduce the pain around the lower tibiofibular joint.

Fig. 10.81: Lower tibiofibular joint distraction

Patient's position: Supine lying.

Fixation: No need of proximal joint fixation already it is done by the positioning itself.

Support / Stabilization: No need of distal joint support already.

Therapist's position:

- Therapist is standing near to the lower extremity of the patient and facing lower tibiofibular joint.
- Therapist's right hand is grasping the medial malleolus of the patient.
- Therapist's left hand is grasping the lateral malleolus of the patient.

Procedure: Therapist's both the hands move the tibia and fibula away from each other.

Dorsal Gliding (Fig. 10.82)

Goal:

- To increase the joint play in the distal tibiofibular joint.
- To increase the plantar flexion of the ankle.
- To reduce the pain around the lower tibiofibular joint.

Fig. 10.82: Lower tibiofibular joint dorsal gliding

Patient's position: Supine lying.

Fixation: Therapist's right hand fixing the medial malleolus of the patient.

Support / Stabilization: As said in distraction of lower tibiofibular joint.

Therapist's position:

- Therapist is standing over the foot end of the patient and facing the lower tibiofibular joint.
- Therapist's right hand fixing the medial malleolus and preventing the movement.
- Therapist's left hand grasping the lateral malleolus of the patient.

Procedure: Therapist's left hand gliding the lateral malleolus in dorsal direction.

Ventral Gliding (Fig. 10.83)

Goal:

- To increase the joint play around lower tibiofibular joint.
- To increase the dorsiflexion movement of the ankle.
- To reduce the pain over the lower tibiofibular joint.

Fig. 10.83: Lower tibiofibular joint ventral gliding

Patient's position: Supine lying.

Fixation: Therapist's right hand fixing the medial malleolus of the patient and restricting the movement.

Support / Stabilization: As said in distraction of the lower tibiofibular joint.

Therapist's position:

- Therapist is standing near the foot of the patient and facing the lower tibiofibular joint.
- Therapist's right hand is fixing the medial malleolus of the patient and restricting the movement.
- Therapist's left hand gasping the lateral malleolus of the patient.

Procedure: Therapist's left hand glides the lateral malleolus in ventral direction.

Caudal Gliding (Fig. 10.84)

Goal

- To increase the pain in the lower tibiofibular joint.
- To decrease the pain over the lower tibiofibular joint.
- To increase the plantar flexion of the ankle.

Fig. 10.84: Lower tibiofibular joint caudal gliding

Patient's position: Supine lying.

Fixation: Therapist's right hand fixing the medial malleolus and restrict the movement (As said in dorsal gliding).

Support / Stabilization: As said in distraction of lower tibiofibular joint.

Therapist's position

- Therapist is standing in the foot end of the patient and facing the lower tibiofibular joint.
- Therapist's right hand is fixing the medial malleolus of the patient.
- Therapist's left hand is grasping the lateral malleolus of the patient.

Procedure: Therapist's right hand glides the medial malleolus in the caudal direction.

Cranial Direction (Fig. 10.85)

Goal

- To increase the joint play around the lower tibiofibular joint.
- To reduce the pain over the lower tibiofibular joint
- To increase the dorsiflexion of the ankle.

Patient's position: Supine lying.

Fixation: As said in dorsal and ventral gliding.

Fig. 10.85: Lower tibiofibular joint cranial gliding

Support / Stabilization: As said in ventral gliding.

Therapist's position: As said in dorsal and ventral gliding.

Procedure: Therapist's right hand is gliding the medial malleolus in cranial direction.

Ankle Joint (Fig. 10.86)

Type

Synovial joint

Variety

Hinge variety

Articular Ends

Proximally

- Distal articular surface of tibia (concave)
- Lateral surface of medial malleolus (flat)
- Medial surface of lateral malleolus (flat).

Distally

- Trochlear surface of talus (convex)
- Coma shaped facet of talus (flat)
- Shaped facet of talus (flat).

Ligaments

- Medial ligament
- Lateral ligament

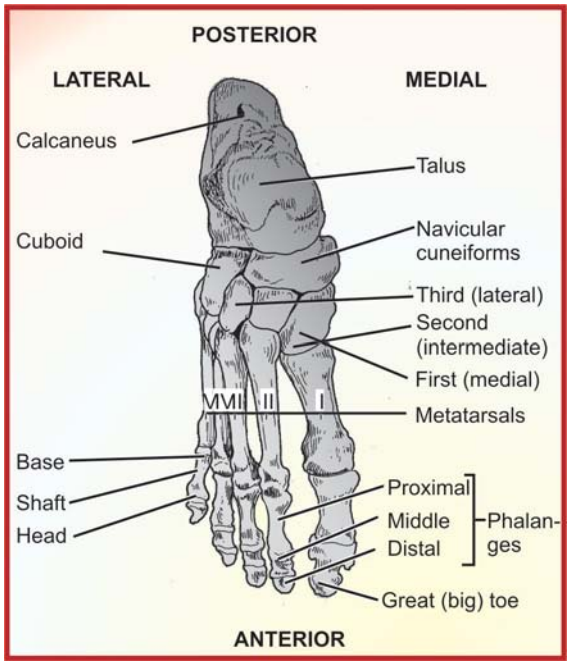


Fig. 10.86: Foot—Anterior view

- Anterior ligament
- Posterior ligament.

Movements

Osteokinematics

- Dorsiflexion
  - Tibialis anterior, extensor hallucis longus, extensor digitorum longus.
  - Plantar flexion.
  - Soleus, gastrocnemius flexor hallucis longus, flexor digitorum longus.

Arthrokinematics

- Dorsiflexion—Dorsal gliding
- Plantar flexion—Ventral gliding.

Range of Motion

- Plantar flexion 40°-50°
- Dorsiflexion 20°

Positions

Starting position

- Neutral position of the ankle.

Resting position

- 10 plantar flexion and midway between the inversion and eversion.

Close packed position

- Maximum dorsiflexion.

Capsular pattern

- Movements are restricted.
- Plantar flexion>dorsiflexion.

Distraction (Fig. 10.87)

Goal

- To increase the joint play over the ankle.
- To increase the ROM of the ankle joint.
- To decrease the pain around the ankle.

Patient's position: Supine lying.

Fixation: Proximal joints are already fixed by the position itself.

Support / Stabilization: Proximal joints are already supported by the position itself.

Therapist's position

- Therapist is standing at the foot of patient and facing the ankle joint.

Fig.10.87: Ankle distraction

- Therapist's right hand grasping the proximal talus anteriorly.
- Therapist's left hand is grasping the calcaneus of the patient and the both distal leg.

Procedure: Therapist's both the hands are applying the downward pulling by which separating the joints.

Dorsal Gliding (Fig. 10.88)

Goal:
- To increase the joint play in the ankle.
- To increase the dorsal flexion.
- To reduce the pain around the ankle.

Fig.10.88: Ankle dorsal gliding

Patient's position: Supine lying.

Fixation: Therapist's left hand is fixing the distal part of lower leg of the patient.

Support / Stabilization: No support is necessary for distal part.

Therapist's position:
- Therapist is standing at the foot of the patient.
- Therapist's right hand is grasping the ventral talus and the foot with the web space.
- Therapist's left hand is fixing the dorsal surface of the distal lower leg.

Procedure: Therapist's right hand glides the talus in the dorsal direction with the traction as per the grading.

Ventral Gliding (Fig. 10.89)

Goal:
- To increase the joint play in the ankle.
- To increase the plantar flexion in the ankle.
- To reduce the pain over the ankle.

Fig.10.89: Ankle ventral gliding

Patient's position: Prone lying.

Fixation: Therapist's left hand is fixing the ventral surface of the distal leg.

Support / Stabilization: As said in the dorsal gliding.

Therapist's position:
- Therapist is standing at the foot of the patient.
- Therapist's right hand is grasping the calcaneus of the patient.
- Therapist's left hand is grasping the ventral surface of the distal leg.

Procedure: Therapist's right hand is gliding the talus in ventral direction with traction as per the gliding.

Talocalcaneal Joint

Type

Synovial

Variety

Plane variety

Articular Surfaces

- Convex area of upper surface of the middle third of the calcaneus.
- Concave area of the lower surface of the body of talus.

Ligaments

- Medial lateral talocalcaneal ligament
- Interosseous talocalcaneal ligament
- Cervical ligament.

Movements

Osteokinematics

- Inversion
  - Tibialis anterior and tibialis posterior
- Eversion
  - Peroneus longus and brevis, peroneus tertius.

Arthrokinematics

- Inversion—medial gliding
- Eversion—lateral gliding.

Range of Motion

Inversion—40°
Eversion—20°

Positions

Starting position

- Foot is right angle to the leg.

Resting position

- Midway between the inversion eversion into 10 of plantar flexion.

Close packed position

- Maximum inversion

Capsular pattern

- Inversion > eversion

Talonavicular Joint

Type

Synovial

Variety

Ball and socket variety

Articular Surfaces

- Head of the talus (convex)
- Proximal end of the navicular (concave)

Ligaments

- Spring ligament
- Bifurcate ligament

Calcaneocuboid

Type

Synovial

Variety

Saddle

Articular Surfaces

- Anterior surface of calcaneum (concavo-convex)
- Posterior surface of cuboid (concavoconvex).

Ligaments

- Bifurcated ligament
- Short plantar ligament
- Long plantar ligament.

Movements

Osteokinematics

- Inversion—Tibialis anterior and posterior
- Eversion—Peroneus longus and brevis, peroneus tertius.

Arthrokinematics
- Talonavicular
  - Inversion—Dorsal gliding
  - Eversion—Ventral gliding
- Calcaneocuboid
  - Inversion—Ventral gliding
  - Eversion—Dorsal gliding.

Positions

Starting position
- Foot and legs are perpendicular to each other

Resting position
- Midway between supination and pronation with 10° plantar flexion.

Close packed position
- Full supination

Capsular pattern
- Movements are restricted
- Supination > pronation.

Distraction

Goal
- To increase the ROM around the subtalar joint.
- To increase the joint play around the subtalar joint.
- To reduce the pain around the subtalar joint.

Patient's position: Prone lying and the ankle is kept in the bed end.

Fixation: Talus is fixed with the therapist's left hand in the ventral aspect.

Support / Stabilization: No need of the distal joint support.

Therapist's position:
- Therapist is standing at the foot of the patient.
- Therapist's right hand is grasping the calcaneus of the patient.
- Therapist's left hand is grasping the ventral aspect of the talus and fixing it from the movement.

Procedure: Therapist's right hand moves the calcaneus distally.

Medial gliding (Fig. 10.90)

Goal:
- To increase the joint play around the talocalcaneus joint.
- To increase the eversion movement.
- To reduce the pain round the talocalcaneus joint.

Fig. 10.90: Talocalcaneal medial gliding

Patient's position: Prone lying.

Fixation: Therapist's right hand is fixing the talus of the patient and restricting the movement.

Support / Stabilization: Support is necessary for the distal joint.

Therapist's position:
- Therapist is standing at the foot end of the patient and facing the talocalcaneal joint.
- Therapist's right hand is fixing the talus and restricting the movement.
- Therapist's left hand is grasping the calcaneus at the dorsal surface of the patient.

Procedure: Therapist's left hand is gliding the calcaneus in the medial direction.

Lateral Gliding (Fig. 10.91)

Goal:
- To increase the joint play around the talocalcaneal joint.

- To increase the inversion movement
- To reduce the pain around the talocalcaneal joint.

Fig. 10.91: Talocalcaneal lateral gliding

Patient's position: Prone lying.

Fixation: Therapist's left hand is grasping the talus of the patient and restricting the movement.

Support / Stabilization: No need of the support for distal joints.

Therapist's position:
- Therapist is standing at the foot end and facing the talocalcaneal joint.
- Therapist's left hand is fixing the talus of the patient.
- Therapist's right hand is grasping the dorsal aspect of the calcaneus.

Procedure: Therapist's right hand is performing the lateral gliding the calcaneus.

Talonavicular Joint

Dorsal gliding (Fig. 10.92)

Goal:
- To increase the joint play around the talonavicular joint.
- To increase the inversion movement.
- To increase the dorsiflexion movement.
- To reduce the pain around the talonavicular joint.

Fig. 10.92: Talonavicular dorsal gliding

Patient's position: Prone lying with the knee is in flexed position and the sole of the foot facing up.

Fixation: Therapist right hand is fixing the talus of the patient.

Support / Stabilization: No need of the support for distal joints.

Therapist's position:
- Therapist is standing at the foot end of the patient and facing the talonavicular joint.
- Therapist's right hand is fixing the talus of the patient.
- Therapist's left hand index finger down thumb up is holding the navicular.

Procedure: Therapist's left hand is gliding the navicular in dorsal direction.

Plantar gliding (Fig. 10.93)

Goal:
- To increase the joint play around the talonavicular joint.
- To increase the midtarsal eversion movement.
- To increase the midtarsal plantar flexion.
- To reduce the pain around the talonavicular joint.

Patient's position: Supine lying.

Fixation: Therapist's left hand is fixing the talus of the patient.

Fig. 10.93: Talonavicular plantar gliding

Support / Stabilization: As said in dorsal gliding.

Therapist's position:
- Therapist is standing at the foot end of the patient.
- Therapist's left hand is fixing the talus in the plantar aspect of the patient.
- Therapist's right thumb is in dorsal aspect and the index finger is plantar surface.

Procedure: Therapist's right hand is gliding the navicular in plantar direction.

Calcaneocuboidal Joint (Fig. 10.94)

Dorsal gliding

Goal:
- To increase the joint play over the calcaneocuboidal joint.
- To increase the midtarsal eversion.
- To increase the midtarsal plantar flexion.
- To reduce the pain around the calcaneocuboidal joint.

Patient's position: As said in dorsal gliding of the talonavicular joint.

Fixation: Therapist's left hand is fixing the calcaneus in the dorsal aspect and the ankle too.

Support / Stabilization: As said in dorsal gliding of talonavicular joint.

Therapist's position:
- Therapist is standing at the foot of the patient.
- Therapist's right hand is grasping the cuboid with the thumb is plantar surface and the index finger on the dorsal surface.
- Therapist's left hand is fixing the calcaneus in the dorsal direction surface and ankle.

Procedure: Therapist's left hand is performing the dorsal gliding of the cuboid.

Plantar Gliding (Fig. 10.95)

Goal
- To increase the joint play around the calcaneocuboidal joint.
- To increase the midtarsal inversion.
- To increase the midtarsal dorsiflexion.
- To reduce the pain and the calcaneocuboidal joint.

Fig. 10.94: Calcaneocuboidal dorsal gliding

Fig. 10.95: Calcaneocuboidal plantar gliding

Patient's position: Supine lying.

Fixation: Therapist's right hand is fixing the calcaneus with finger in dorsal and plantar aspect.

Support / Stabilization: As said in dorsal gliding of talonavicular joint.

Therapist's position:
- Therapist is standing at the foot end of the patient.
- Therapist's right hand is fixing the calcaneus with the finger in dorsal and plantar surface.
- Therapist's left hand grasping the cuboid with the thumb in dorsal surface and the index finger in plantar surface.

Procedure: Therapist's left hand is gliding the cuboid in plantar direction.

Tarsometatarsal Joint

Plantar dorsal gliding

Goal:
- To increase the joint play around the tarsometatarsal joint.
- To increase the plantar dorsiflexion (plantar gliding increases the plantar flexion dorsiflexion increases the dorsiflexion).
- To reduce the pain around the tarsometatarsal joint.

Patient's position: Supine lying.

Fixation: Therapist's left hand is fixing the tarsal joint movement.

Support / Stabilization: No need of distal joint support.

Therapist's position:
- Therapist is standing at the foot of the patient.
- Therapist's left hand is fixing the tarsal joint movement.
- Therapist's right hand is grasping the metatarsal with the thumb on the dorsal surface and the index finger is in the plantar surface.

Procedure: Therapist's right hand is gliding the metatarsal in the plantar dorsal direction.

Intermetatarsal Joint

Dorsal and plantar gliding

Goal:
- To increase the joint play around the intermetatarsal joint.
- To reduce pain around the intermetatarsal joint.

Patient's position: Supine lying.

Fixation: Therapist's left hand is grasping the mid-shaft of the first metatarsal with the thumb in dorsal surface and the finger in the plantar surface of the patient.

Support / Stabilization: No need of support for the distal joint.

Therapist's position:
- Therapist is standing at the foot of the patient.
- Therapist's left hand is grasping the mid-shaft of the first metatarsal in the thumb on the dorsal surface and the finger in the plantar surface.
- Therapist's right hand is grasping the mid-shaft of the metatarsal with the thumb on the dorsal surface and the finger on the plantar surface.

Procedure: Therapist's right hand performing the dorsal and plantar gliding of the intertarsal joint.

Metatarsal Phalangeal Joint (Fig. 10.96)

Distraction

Goal:
- To increase the joint delay around the metatarsophalangeal joint.

Fig.10.96: Metatarsophalangeal joint distraction, medial, lateral, dorsal and ventral glidings

- To increase the ROM of the metatarsophalangeal joint.
- To reduce the pain around the metatarsophalangeal joint.

Patient's position: Supine lying.

Fixation: Therapist's left hand is grasping the mid-shaft of the metatarsals and restricting the movement.

Support / Stabilization: Distal joints are supported with the therapist's right hand.

Therapist's position:
- Therapist is standing near the foot of the patient.
- Therapist's left hand is grasping the mid-shaft of the metatarsals and restricting the movement.
- Therapist's right hand is grasping the mid-shaft of the proximal phalanx of the patient.

Procedure: Therapist's right hand is pulling the proximal phalanx distally.

Dorsal and plantar gliding

Goal:
- To increase the joint play and the metatarsophalangeal joint.
- To increase the flexion and extension of the metatarsophalangeal joint (Dorsal gliding increase the extension plantar gliding increases the flexion.).
- To reduce the pain and the metatarsophalangeal joint.

Patient's position: Supine lying

Fixation: As said in distraction.

Support / Stabilization: As said in distraction.

Therapist's position: As said in distraction.

Procedure: Therapist's right hand is gliding the phalanx in dorsal and plantar diversion.

Medial lateral gliding

Goal:
- To increase the joint play and the metatarsophalangeal joint.
- To increase the abduction and adduction to the metatarsophalangeal joint (Medial gliding increases the abduction of the digit 1 and 2, tibial abduction of digit 3 and abduction of digit 4 and 5, lateral gliding increases the adduction of the digit 1 and 2, fibular abduction of the digit 3 and abduction of digits 4 and 5).

Patient's position: As said in distraction.

Fixation: As said in distraction.

Support / Stabilization: As said in distraction.

Therapist's position: As said in distraction.

Procedure: Therapist's right hand is gliding the phalanx in the medial and lateral directions.

Interphalangeal Joint

The same procedure has to be followed as said in the interphalangeal joint gliding in the upper limb.

11
CHAPTER

Stretching

DEFINITION

It is the elongation of the pathologically shortened or tightened soft tissues with the help of some therapeutic techniques.

TYPES

- Passive stretching
- PNF
- Self-stretching.

Passive Stretching

- Manual
- Mechanical.

Manual Stretching

It is done by the therapist or by the physician. The stretching may be given for 15-30 seconds, sometimes it may be extended up to 60 seconds. The stretching duration and the force applied may change depending on the condition and the tolerance power of the patients. It is of two types:

i. Static stretching
ii. Ballistic stretching.

Static stretching: In this slow and prolonged stretch is applied to avoid the reflex contraction from the muscle spindle and Golgi tendon organ. In this stretch, the muscle is elongated gently and maintained for long period without pain. The Golgi tendon organ protects the muscle from the stretch by firing the type Ib fibers. This Ib fibers further relaxes the muscle by efferent impulse. So, the muscle fiber goes for more relaxation and flexibility. Effective duration of the stretch is found out by comparing the groups stretched for 15, 30 and 60 seconds, among that 30 and 60 seconds, stretched muscle fibers show more flexibility than the 15 seconds stretched muscle fibers.

There is no different seen the 30 and 60 seconds stretched muscle fibers. Taking the sensitive muscle as a model the test is performed.

Ballistic stretching: It is the bouncing or jerky type of stretching. It is a high velocity and short duration stretching. It can be done actively. Even though the ballistic stretching increases the flexibility, it may cause injury because the movements may exceed the limits of extensibility and it has poor control over the movements. The ballistic stretch activates the muscle spindle, which send impulses to the spinal cord, from there to the CNS. The efferent impulse, i.e. the contracting response enters

through the α fibers to the muscle fibers. So, the tension created inside the muscle cause the microtrauma. Thus, the ballistic stretch causes the microtrauma in the muscle and connective tissues, apart from increasing their flexibility earlier.

Zachazawski was arguing about the stretching program for the athletes because most of the athletes require ballistic type of activities. So, he derived one stretching program for the athletes that is called as "Progressive Velocity Flexibility Program". This stretching program is mainly based on the velocity [slow, fast] ROM [end range, full].

Here, the athletes undergo a series of stretching program. First the athletes are given static stretching. After sometime it is changed to slow and controlled stretching with mild oscillation in the end range called as slow short end range (SSER). Then the athlete is progressed to perform the full-length muscle stretch, i.e. slow full range (SFR). Once he is mastered in it, he is progressed to fast stretching in shortened range called as fast short end range (FSER). Finally, he is made to perform the fast full range stretch.

Mechanical Stretching

Long duration mechanical stretching: The low intensity and long duration stretch gives more flexibility in the muscle and connective tissue than the less duration stretch. The stretch, which is given from 20 minutes to several hours, gives good effect than the stretch applied for less than 20 minutes. The serial cast, pulleys, dynamic splints, tilting table, traction are some of the mechanical devices made for prolonged mechanical stretching. The stretch is given by external force in low intensity for longer duration with the help of mechanical instrument.

Cyclic mechanical stretching: The stretching program can be given in cyclic manner with the help of mechanical devices. The intensity of stretch, duration of stretch and number of stretch cycle per minute can be set in the mechanical device itself. Thus, manual and mechanical stretching have different effect. The mechanical stretching (long duration, cyclic) gives more flexibility in a short period than the manual method of applying stretching.

PNF

According to *Knott* and *Ross*, facilitation the proprioceptor with help of neuromuscular activities can be used to stretch a particular muscle some main PNF techniques are used for the stretching, they are:

1. Hold and relax
2. Contract relax
3. Slow reversal.

Hold and Relax

Here the therapist keeps the limb in the end range of ROM. For example, in hamstring stretching, the muscle is kept at the end range by flexing the hip and extends the knee with the patient in supine lying. Then the patient is asked to perform the isometric contraction against the force applied by the therapist. This contraction activates the GTO and it sends impulses to spinal cord, from there to the brain. The brain responds by relaxation impulse through Ib fibers. After some relaxation, the therapist flexes the hip some more and achieves a new position. After reaching the new position, the above said process may be repeated again.

Contract and Relax

Here the therapist takes the limb to the end range. For example, in hamstring stretching, the knee is extended and hip is flexed with the patient in supine lying. After attaining the end range, the patient is asked to contract the opposite muscle to the muscle being stretched, i.e. the hip flexor is asked to contract which results in maximum stretching of the hamstrings. Normally, in any synergic group,

contraction of agonist results in reflexive relaxation of the antagonist, i.e. hip flexors contraction causes the hamstring relaxation. After the consecutive contraction of the hip flexor, the therapist moves the limb still more forward, i.e. hip flexion and new position is attained. The same procedure is followed without lowering the legs.

Slow Reversal

Here too the therapist takes the limb to the end range for example, in hamstring stretching, the knee is extended with hip flexed and end range is attained. In the end range, the patient is asked to do the isometric contraction of the hamstring muscle, by opposing the force given by the therapist. This isometric contraction activates the GTO and results in relaxation impulse as we have seen earlier. Then the patient is asked to do the isotonic contraction of the opposite muscle to the muscle being stretched, i.e. hip flexors, so that more amount of stretching is achieved.

After the isotonic contraction, the new position is attained, i.e. the stretch is increased because, due to the isotonic contraction, the hamstring muscle gets more flexibility. So, it can go for maximum stretch, then the patient is asked to relax for some time. Again the same procedure is followed without lowering the leg.

Self-stretching

The patient himself does this stretching program. This type of exercise showing early improvement in performing stretching with the guideline of the therapist improves the neuromuscular facilitation and relaxes the muscle. All the procedures are same as in passive stretching.

STRETCH REFLEX

The proper muscle function is decided by the afferent and efferent impulses from the nervous system. The efferent system contains two varieties of neurons, they are:

i. α motor neuron
ii. γ motor neuron.

Alpha motor neurons are the neurons, which supply large muscle fibers and excite too many skeletal muscles, which are collectively called as motor units. Alpha motor neurons supplies to the extrafusal muscle fibers of the muscle spindle. The afferent system, which contains the (1) muscle spindle, (2) Golgi tendon organ like receptors to send the impulses to the afferent neurons (Fig. 11.1).

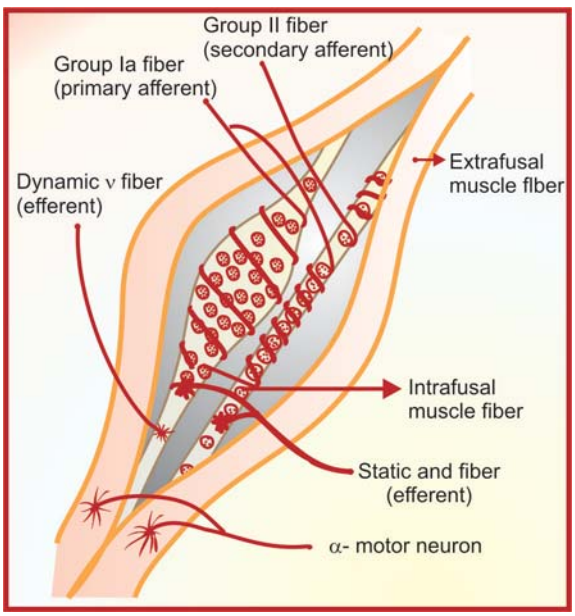


Fig. 11.1: Stretch reflex

Muscle Spindle

A muscle spindle has two types of muscle fibers; they are intrafusal and extrafusal muscle fibers. Intrafusal muscle fibers again divided into two varieties; 1) nuclear bag fibers, 2) nuclear chain fiber.

Nuclear bag fibers contains the nucleus in the center portion of the receptor and it gives the bag like structure and the end portion of

the fiber is innervated by the gamma efferent neurons.

Nuclear chain fibers look like the chain and the nucleus concentrate more in the center and scatterly present in the receptor part of the fiber. The end portion of the fiber also supplied by gamma efferent neurons. The nuclear bag fibers are innervated by group Ia afferent fibers in the middle portion and the nuclear chain fibers are innervated by the group Ia, II fibers.

Functions of Gamma Motor Neurons

Gamma motor neurons are of two types; they are γ-s and γ-d fibers. γ-d fibers excite the nuclear bag fibers and enhance the dynamic responses in the muscle spindle and the γ-s fibers excite the nuclear chain fibers and enhance the static response in the muscle spindle.

Static Response

When the muscle spindle is stretched, the receptors which is present in that spindle is activated and it sends impulses to the nervous system through the group Ia and group II fibers. Whenever the muscle spindle is stretched slowly, the proportion of the impulse transmit impulses many more minutes is called as static response of the spindle. It occurs due to the stretching of the nuclear chain fibers because it supplied by both the group Ia (primary afferent) and group II (secondary afferent) nerve fibers.

Dynamic Response

If the muscle spindle structures stretched suddenly the nerve ending is stimulated powerfully and it is called dynamic response of the spindle. It occurs when the nuclear bag fibers stretched because it is innervated by type Ia afferent fibers.

Stretch Reflex

Type Ia fibers arise from the muscle spindle and enter into the posterior horn cells of the spinal cord. Some of the branches of the nerve enter into anterior horn cells of the spinal cord and make synapse and send the nerve to the same muscle is called as monosynaptic pathway. Type II fibers also end in monosynaptic pathway and the more delayed signal to the anterior motor neurons. Whenever the sudden stretching of the muscle spindle, the dynamic stretch impulses carried out through the type Ia (primary afferent) nerve fibers to the spinal cord, from there strong contraction reflex comes to the muscle. After the dynamic reflex is over the muscle is kept in new stretched position, so the slow and continuous stretch reflex goes via the group Ia and group II afferent fibers to the spinal cord, and the continuous contraction response originates from the spinal cord.

Negative Stretch Reflex

Whenever the muscle is shortened, the opposite effect occurs. If the muscle shortens, will elicit both the static and dynamic reflexes.

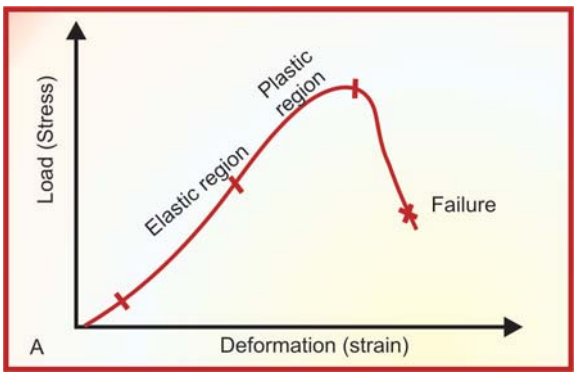
Golgi Tendon Organ

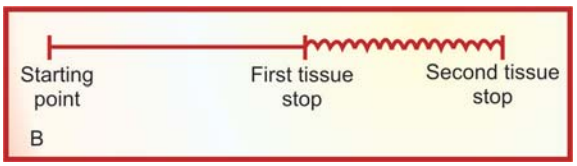
Golgi tendon organs are present in the junction between the muscle and the tendon. From Golgi tendon organ impulses are transmitted to the type Ib nerve fibers. Muscle spindle reflex changes the length of the muscle and the GTO reflex changes the tension in the muscle. From the GTO the impulses are carried out by the type I a fibers to the posterior horn cells and to the anterior gray matter. It has both static and dynamic function in it. Normally, the responses from the spinal cord or from the CNS are mostly relaxation of the muscle.

STRESS-STRAIN CURVE

The role of the extensibility of the soft tissue, the stress-strain curve gives the perfect knowledge about the load deformation of the soft tissue. Whenever the external force is

applied to a soft tissue, it goes for more stress and strain. The first phase is "elastic phase", the stretched tissue will go for normal position after removing the external force. The second is "plastic phase", the stretched tissue may be remain in the elongated state when the external force is removed. Third phase is "failure point", the stretched tissue may be teared or separated. Normally, stretch techniques are done up to the limit of the plastic range and sometimes about to reaching the breaking point but without causing any tissue damage. If the breaking point is felt, the treatment should be terminated (Figs 11.2A and B).





Figs 11.2: A. Stress-strain curve, B. Tissue restriction with the stretch

While stretching the tightened joint or muscle the therapist may feel the restriction by the surrounding structures. Limitations may be due to capsule, ligaments, muscle, skin, fascia, cartilages tightness or adhesions. The limitations or restrictions to stretch is felt by the therapist is called as first tissue stop. Normally, the passive movement can cross the first tissue stop. If the therapists add more force after the fist tissue stop, he may feel again the restriction to stretch by some structures is called as second tissue stop. If we apply force more than the first tissue stop the tissue will be attaining the plastic range. But if the therapist crosses the second tissue stop, the tissue may be separated or teared. So, the stretching technique should be performed within the second tissue stop.

Indications

- Post-traumatic stiffness
- Post-immobilization stiffness
- Restrictive mobility
- Congenital or acquired bony deformity
- Joint pathology resulting in soft tissue stiffness
- Soft tissue pathology leading to relative soft tissue stiffness
- Healed burn scars
- Fear of pain spasm
- Adhesion formation over soft tissue
- Contracture of the joint and soft tissue
- Any type of muscular spasm
- Spasticity (UMS cause).

Contraindications

- Synovial effusion
- Recent fracture
- Sharp pain while doing stretch
- Inflammation in the tight tissue
- Infection over tight tissue
- Immediately after dislocation
- Edema
- Osteoporosis
- Hemophilic joint
- Hemarthrosis
- Malignant tumors
- Flial joint
- After joint arthroplasty
- Neuropathic joint
- Unhealed scars
- Unhealed burns
- Chronic rheumatoid arthritis.

EFFECTIVE STRETCHING

Some of the physical modalities are helpful to increase the effect of stretching. The assistive modality that increases the quality of stretch can be given before the stretching regime. Some of them are:

1. Heat
2. Massage
3. Oscillation
4. Joint mobilization
5. Active exercise.

Heat

Heat increases the relaxation and lengthens the muscle fastly. Normally, heat increases relaxation, circulation, and nutrition, to tissue and decreases spasm and tightness. Stretching performed after applying heat modality requires less force to stretch. The physiotherapy modalities like hot water, fomentation, IRR, wax bath, ultrasound, SWD, produces heat in the tissue. So, they can be applied before performing the stretching. The heat will activate the GTO and results in relaxation response from the higher center, which reduces the tension in the muscle.

Massage

Effective maneuver of massage produces:

i. It increases blood circulation.
ii. It increases blood nutrition.
iii. It enhances local relaxation.
iv. It decreases spasm.

Massage can be done after application of heat therapy, which improves the effect of massage thereby helpful in stretching.

Active Exercise

Active exercise produces heat inside the body. Warm tissue can be stretched easily. Active exercise like walking, jogging, cycling increases local blood circulation thereby increases the intramuscular temperature. Stretching which is performed after an active exercise will be more effective.

Joint Mobilization

Before doing the joint stretching, joint mobilization is done; it reduces the stiffness of the joint by breaking the adhesion formed and makes the joint free. Joint traction breaks the adhesion and stretches the tightened structures. The pendular and oscillation movement relaxes and reduces the tightness of the soft tissue. Sometime 1 lb to 2 lb weight also can be used in the extremity to perform the pendular movement of the joint.

Note: The stretching can be given about to reaching the second tissue stop without causing the microtrauma. If the microtrauma occurs during stretching the iceing can be done to constricting the blood vessels thereby reducing the local blood circulation thus prevents further damage. Iceing also reduces the post-stretching muscular soreness.

Normally, three varieties of stretching can be performed in body. They are:

a. Muscular stretching
b. Joint stretching
c. Skin stretching.

MUSCULAR STRETCHING

To stretch one particular muscle, the opposite action of that muscle should be performed.

Tendo-Achilles Stretching

Action—Flexion of knee, plantar flexion of ankle.

Passive Stretching (Figs 11.3 and 11.4)

Position of Patient: Supine lying.

Position of therapist: Standing beside the patient.

Fig. 11.3: Tendo-Achilles stretching starting stage

Fig. 11.4: Tendo-Achilles stretching end stage

Procedure:

- The therapist holds the lower thigh region with his left hand and flexing the knee.
- The therapist's right hand holds the heel in neutral position.
- Slowly extending the knee with the left hand and dorsiflexes the heel with the right hand.

Self-stretching

- Standing on slopping surface and falling forwards (Fig. 11.5).
- Standing on the steps with the ball of the toes (Fig. 11.6).

Note: For soleus stretching knee extension should be avoided. Gastrocnemius flexes the

Fig.11.5: Soleus self-stretching

Fig. 11.6: Gastrocnemius stretching

knee and plantar flexes the ankle but soleus is purely for plantar flexion.

Dorsiflexors of Ankle

Passive Stretching

Position of patient: Supine lying.

Position of therapist: Standing beside the patient.

Procedure:

- Therapist's left hand holds the lower leg region and right hand holds the foot, plantar flexing (pulling downwards).

Self-stretching

Sitting on the stool by leg hanging, right foot is placed on the left foot and stretching the dorsiflexors.

Quadriceps Stretching

Action: Hip flexion and knee extension (Rectus femoris—hip flexion and knee extension, vastus medialis, vastus lateralis, vastus intermedius —knee extension).

Passive Stretching (Fig. 11.7)

Method-I

Position of the patient: Prone lying.

Fig.11.7: Quadriceps stretching in supine lying

Position of the therapist: Standing beside the patient and looking the stretched part.

Procedure: Patient's knee is flexed and the therapist's left hand holds the anterior portion of the knee, right hand holds the ankle of the patient while forearm and elbow stabilizing the patient's pelvic.

Lifting the thigh up with the left hand of the therapist extends patient's hip.

Method – II (Fig. 11.8)

Position of the patient: Supine lying with the lower part kept hanging at the end of the couch (from the hip region).

Position of the therapist: Standing beside the leg region of the patient, which is hanging.

Fig.11.8: Quadriceps stretching by lying in bed end

Procedure:

- Left leg of the patient is kept flexed and hold by the patient himself.
- Therapist's right hand holding the lower leg and pushing towards inside, i.e. flexing the knee.
- Left hand applies force on the lower part of the thigh and pushes downwards, i.e. hip flexion.

Method-III

Position of the patient: Side lying.

Position of the therapist: Standing back to the patient and seeing the limb.

Procedure:

- Left hand of the therapist stabilizes the pelvic and restrict the movement.
- Right hand of the therapist holds the right knee flexed position and forearm supporting the leg.

After maximum flexion of the knee, hip extension is made by pulling the leg backwards.

Self-stretching (Fig. 11.9)

Patient standing with one-foot support and the other foot, ankle grasped by the respective side hand by knee flexion then the hip is extended.

Fig.11.9: Quadriceps Self-stretching

Hamstring Stretching

Action: Flexion of the knee, extension of the hip.

Passive Stretching (Fig. 11.10A)

Position of the patient: Supine lying.

Position of the therapist: Therapist is kneeling near the leg region of the patient and the patient leg is kept over his shoulder.

Procedure: With the knee extension therapist flexes the hip of the patient.

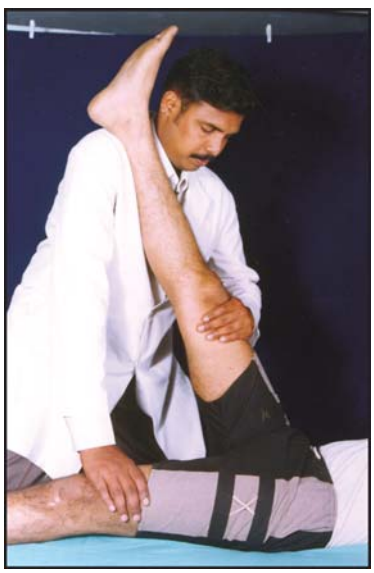


Fig. 11.10A: Hamstring passive stretching

Self-stretching

- Patient standing on one leg and other over an elevated position and stretching the hamstrings by bending the hip and trunk (Fig. 11.10B).

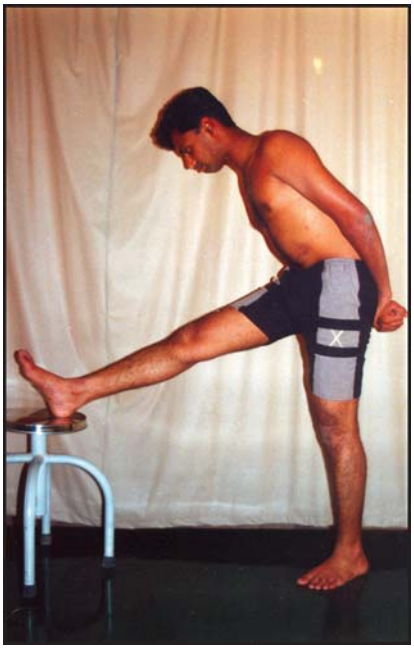


Fig. 11.10B: Hamstring self-stretching

Fig. 11.11: Iliopsoas passive stretching in supine position

- Long sitting on the floor—grasping the toes by the corresponding hand and bending the trunk forwards.

Iliacus and Psoas Major Stretching

Passive Stretching

Method – I (Fig. 11.11)

Action: Hip flexion.

Position of the patient: Supine lying with the lower part of the body hanging at the end of the couch.

Position of the therapist: Therapist is standing near to the leg region of the patient.

Procedure:

- Normal side leg is kept flexed and holding by the patient himself.
- Therapist is grasping the other leg and performing the hip extension by pushing the leg down.

Method – II (Fig. 11.12)
Position of patient: Side lying.

Position of therapist: Standing back to the patient.

Procedure:

- Therapist's left hand stabilizes the pelvis and right hand grapes the lower thigh and knee,

Fig. 11.12: Iliopsoas passive stretching in side lying position

with forearm supporting the leg region of the patient.
- The leg is pulled back with the help of right hand.

Self-stretching

- Fall out standing posture stretches the illiopsoas (Fig. 11.13).
- Stretched side hip and knee are extended and kept backwards, the opposite side hip and knee are medium flexed and kept forwards and stretches the iliopsoas.

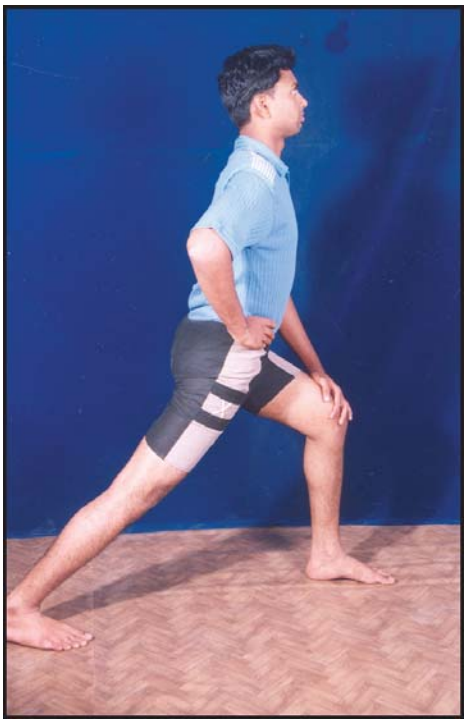


Fig. 11.13: Iliopsoas Self-stretching

Gluteus Maximus

Action: Hip extension.

Passive Stretching (Fig. 11.14)

Position of patient: Patient is lying supine.

Position of therapist: Therapist is standing beside the patient and facing the limb.

Fig. 11.14: Gluteus maximus passive stretching

Procedure:

- Therapist's right hand grasping the ankle while his left hand holds the knee posteriorly.
- The leg is lifted with hip and knee flexed, towards the cranial side of the patient.

Self-stretching

- Kneel sitting is one way of stretching the gluteus maximum.
- Patient flexing the hip and knee himself, in supine with his hand maintains a good stretch.

Hip Adductor

Passive Stretching (Fig. 11.15)

Position of patient: Crook lying.

Fig.11.15: Hip adductor passive stretching

Position of therapist: Standing or sitting beside the patient facing the limb.

Procedure: Both the heels are kept together and then drawn apart.

Self-stretching

- Ride sitting stretches the hip adductor
- Long sitting (Fig. 11.16):
  - Knee bending to placing the sole of the foot together.
  - Pressure applied on the knee to touch the floor.
- Carrying the child in the hip (Indian style of carrying the child).

Fig.11.16: Hip adductor self-stretching

Iliotibial Tract

Passive Stretching (Fig. 11.17)

Action: Flexion, abduction, external rotation of hip, flexion of knee.

Position of patient: Side lying.

Position of therapist: Standing back to the patient and facing the limb.

Procedure:

- Therapist's left hand stabilizes the pelvic and right hand grasps the patient knee with the leg placed over the forearm.
- Hip is extended, adducted and medially rotated, finally knee extended to stretch the illioitibial tract.

Fig. 11.17: Iliotibial tract passive stretching

Self-stretching

- Patient is standing and feet away from the wall and leaning forward with one leg placed front and the other internally rotated, 1 foot back to the front leg (Fig. 11.18).
- In side lying the patient top leg foot is hooked over the bed end, the hip is internally rotated, adducted and knee is extended with support of the bed end.

Fig. 11.18: Iliotibial tract self-stretching

Pectoralis Major

Passive Stretching (Fig. 11.19)

Action: Flexion, adduction, and medial rotation of the shoulder.

Fig. 11.19: Pectoralis major passive stretching

Position of patient: Supine lying with the upper limb kept at the end of the couch.

Position of therapist: Therapist is standing beside the patient and facing the respective upper limb.

Procedure: Therapist's left hand grasps the wrist and hand of the patient while the right hand stabilizes the shoulder then the left hand performs the reverse action of pectoralis major, i.e. lateral rotation abduction, extension of shoulder.

Self-stretching

- Both the hands grasped behind the head and the patient is asked to relax and drop down to touch the support surface (Fig. 11.20).
- The relative hand is placed over the wall by standing 3-4 feet away from the wall and back facing the wall with the shoulder externally rotated, abducted and extended.

Fig. 11.20: Pectoralis major self-stretching

Biceps Stretching

Action: Flexion of shoulder and elbow, supination of forearm.

Passive Stretching (Fig. 11.21)

Position of patient: Side lying.

Position of therapist: Therapist is standing back to the patient and facing the limb to be stretched.

Fig. 11.21: Biceps passive stretching

Procedure:

- Therapist's left hand grasps the wrist and hand of the patient while right hand stabilizes the shoulder.

- Left hand performs the shoulder extension, elbow extension and forearm pronation.

Self-stretching

- In high sitting, the patient place the hand back to body on the surface and stretches the biceps.
- In standing—holding the rod back side and stretching (Fig. 11.22).

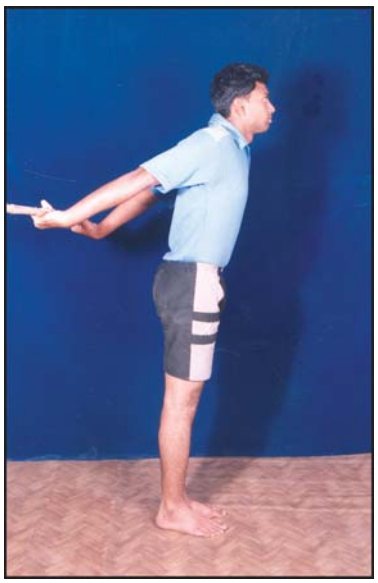


Fig. 11.22: Biceps self-stretching

Triceps

Action: Shoulder extension and elbow extension.

Passive Stretching (Fig. 11.23)

Position of patient: Supine lying or sitting.

Position of therapist: Therapist is standing beside the patient.

Procedure:

- Left hand of the therapist holding the patient hand and flexing the elbow after the hand reaches the shoulder. Therapist's left hand stabilizes the shoulder also.
- Therapist's right hand grasping the elbow lifts up to gain shoulder flexion.

Fig 11.23: Triceps passive stretching

Self-stretching (Fig. 11.24)

In sitting or standing with the opposite side hand elbow and shoulder extension is performed to stretch the triceps.

Flexor Compartment Muscles of Forearm

Action: Wrist flexion, elbow flexion, finger flexion (MCP, PIP, DIP).

Passive Stretching (Fig. 11.25)

Position of the patient: Sitting or supine lying, side lying.

Position of the therapist: Standing beside the patient.

Procedure:

- Therapist's left hand grasping the lower arm and preventing the shoulder movement.

Fig 11.24: Triceps self-stretching

Fig 11.25: Flexor compartment of the forearm passive stretching

- Therapist's right hand grasps the hand and the fingers.
- Therapist extending the fingers and wrist after the elbow extension. Here the whole flexor compartment muscles undergo stretching.

Self-stretching (Fig. 11.26)

Place the hand on the couch with wrist, fingers and elbow extended and stretching the flexor compartment of the forearm.

Fig 11.26: Flexor compartment of the forearm self-stretching

Sternomastoid Stretching

Action: Same side flexion and opposite side rotation of the neck and also forward flexion of the neck.

Position of the patient: Sitting or supine lying with the neck placed at the end of the couch.

Position of the therapist: Therapist is standing behind the patient's head.

Procedure: The therapist holds the patient head with both the hand (one below the occipit other below the chin) and performs the opposite action of the sternomastoid, i.e. opposite side flexion and same side rotation and extension of the neck.

JOINT STRETCHING

Joint stretching means the stretching of the soft tissue around the joint including the muscles. The individual muscles can be stretched as mentioned earlier but we need to stretch the ligaments, bursae, capsule, cartilage and other soft tissues of the joint

which may get tight and make the joint stiff. To prevent the stiffness and to improve the ROM of the joint, this joint stretching will be helpful. To stretch one particular muscle, the opposite action of the muscle has to be done. To stretch one joint we have to analyze which action or movement has been restricted and same action or movement has to be performed to stretch the structures, which is stiff.

Shoulder Joint

For Restricted Flexion Movement (Fig. 11.27)

Position of the patient: Supine lying.

Position of the therapist: Therapist is standing beside the patient and facing the limb.

Procedure:

- Therapist's left hand grasps the lower arm region and the patient's forearm resting over the therapist's forearm.
- Therapist's right hand apply opposite force on the scapular region to prevent scapular movement.
- Stretch force is given towards the flexion of the shoulder with the therapist's left hand.

Stretched parts: Capsule, articular cartilages, glenoidal labrum, extensor muscles and synovial membrane of the shoulder joint.

Fig.11.27: Stretching the restricted flexion movement of the shoulder

Restricted Extension Movement (Fig. 11.28)

Position of the patient: Prone lying.

Position of the therapist: Therapist is standing beside the patient and facing the limb.

Fig.11.28: Stretching the restricted extension movement of the shoulder

Procedure:

- Therapist's left hand grasps the lower arm region and the patient's forearm resting over the therapist's forearm.
- Therapist's right hand applies opposite force on the scapular region to prevent scapular movement.
- Stretch force is given towards the extension of the shoulder with the therapist's left hand.

Stretched parts: Capsule, articular cartilages, glenoidal labrum, flexor muscles, glenohumeral ligament and synovial membrane of the shoulder joint.

Restricted Abduction Movement (Fig. 11.29)

Position of the patient: Supine lying.

Position of the therapist: Standing beside the patient and facing the limb.

Procedure:

- Therapist's left hand grasps the lower arm region and the patient's forearm resting over the therapist's forearm.

Fig.11.29: Stretching the restricted abduction movement of the shoulder

- Therapist's right hand applies opposite force on the scapular region to prevent scapular movement.
- Stretch force is given towards the abduction of the shoulder with the therapist's left hand.

Stretched parts: Capsule, articular cartilages, glenoidal labrum, adductor muscles and synovial membrane of the shoulder joint.

For Restricted Medial Rotation (Fig. 11.30)

Position of the patient: Supine lying.

Fig.11.30: Stretching the restricted medial rotation movement of the shoulder

Position of the therapist: Therapist is standing beside the patient and facing the limb.

Procedure:

- Therapist's left hand grasping the lower arm of the patient while his right hand grasping the wrist and applying the stretch force towards the medial rotation.

Stretched parts: Capsule, articular cartilages, glenoidal labrum, lateral rotator muscles and synovial membrane of the shoulder joint.

For Restricted Lateral Rotation (Fig. 11.31)

Position of the patient: Supine lying.

Position of the therapist: Therapist is standing beside the patient and facing the limb.

Procedure:

- Therapist's left hand grasping the lower arm of the patient while his right hand grasping the wrist of the patient and applying the stretch force towards the lateral rotation.

Fig.11.31: Stretching the restricted lateral rotation movement of the shoulder

Stretched parts: Capsule, articular cartilages, glenoidal labrum, medial rotator muscles and synovial membrane of the shoulder joint.

Elbow Joint

For Restricted Flexion Movement (Fig. 11.32)

Position of the patient: Supine lying.

Position of the therapist: Therapist is standing beside the patient and facing the limb.

Fig.11.32: Stretching the restricted flexion movement of the elbow

Procedure:

- Therapist's left hand grasping the lower arm of the patient and stabilizing the proximal joint.
- Therapist's right hand grasping the wrist of the patient.
- Stretch force is applied with the right hand of the therapist towards the flexion of the elbow.

Stretched parts: Capsule, articular cartilages, elbow extensor muscles, radial and ulnar collateral ligament.

For Restricted Extension Movement (Fig. 11.33)

Position of the patient: Supine lying.

Position of the therapist: Therapist is standing beside the patient and facing the limb.

Procedure:

- Therapist's left hand grasping the lower arm of the patient and stabilizing the proximal joint.
- Therapist's right hand grasping the wrist of the patient.
- Stretch force is applied with the right hand of the therapist towards the extension of the elbow.

Fig.11.33: Stretching the restricted extension movement of the elbow

Stretched parts: Capsule, articular cartilages, elbow flexor muscles, radial and ulnar collateral ligament.

Forearm

For Restricted Supination and Pronation Movement (Fig. 11.34)

Position of the patient: Supine lying.

Position of the therapist: Therapist is standing beside the patient and facing the limb.

Procedure:

- Therapist's left hand stabilizing the anterior aspect of proximal humerus of the patient.
- Therapist's right hand grasping the lower forearm,wrist and hand of the patient and elbow is in 90° flexed position.
- Therapist's right hand supinates and pronates the forearm and stretches the structures.

Stretched parts

- While performing supination: Annular ligament, ulnar collateral ligament, capsule, articular cartilages and pronator muscles.

Fig.11.34: Stretching the restricted supination and pronation movement of the forearm

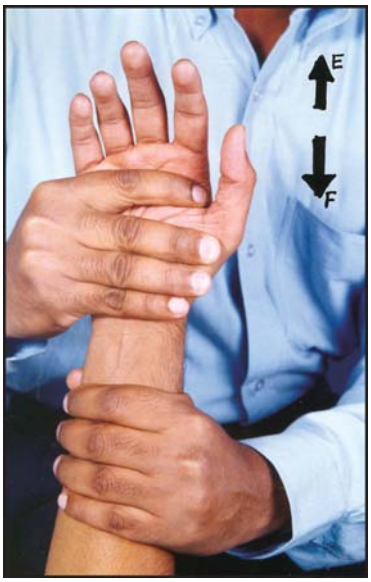


Fig.11.35: Stretching the restricted flexion and extension movement of the wrist

- While performing pronation: Annular ligament, radial collateral ligament, capsule, articular cartilages and supinator muscles.

Wrist Joint

Restricted Flexion Movement (Fig. 11.35)

Position of the patient: Patient is sitting on the stool or supine lying.

Position of the therapist: Therapist is standing beside the patient and facing his wrist.

Procedure:
- Therapist's left hand grasping the lower forearm of the patient while his right hand grasp the palm and fingers.
- The therapist flexes the wrist of the patient with his right hand.

Stretched parts: Articular disc, capsule, extensor muscles of the wrist, ulnar and radial ligament, extensor retinaculum.

Restricted Extension Movement (Fig. 11.35)

Position of the patient: Patient is sitting on the stool or supine lying.

Position of the therapist: Therapist is standing beside the patient and facing his wrist.

Procedure:
- Therapist's left hand grasping the lower forearm of the patient while his right hand grasp the palm and fingers.
- The therapist extends the wrist of the patient with his right hand.

Stretched parts: Articular disc, capsule, flexor muscles of the wrist, ulnar and radial ligament, flexor retinaculum.

Restricted Ulnar Deviation Movement (Fig. 11.36)

Position of the patient: Patient is sitting on the stool or supine lying.

Position of the therapist: Therapist is standing beside the patient and facing his wrist.

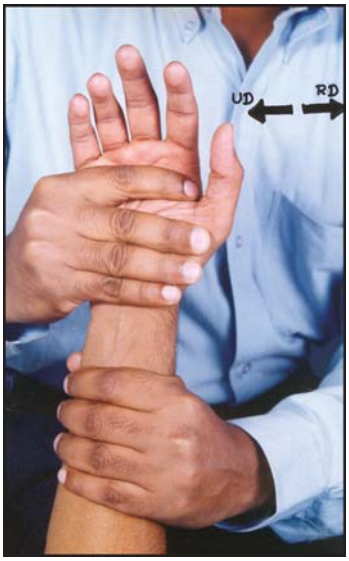


Fig.11.36: Stretching the restricted ulnar and radial deviation movement of the wrist

Procedure:

- Therapist's left hand grasping the lower forearm of the patient while his right hand grasp the palm and fingers.
- The therapist performs the ulnar deviation of the wrist of the patient with his right hand.

Stretched parts: Articular disc, capsule, radial deviation muscles of the wrist, radial ligament, radial part of extensor and flexor retinaculum.

Restricted Radial Deviation Movement (Fig. 11.36)

Position of the patient: Patient is sitting on the stool or supine lying.

Position of the therapist: Therapist is standing beside the patient and facing his wrist.

Procedure:

- Therapist's left hand grasping the lower forearm of the patient while his right hand grasp the palm and fingers.
- The therapist performs the radial deviation of the wrist of the patient with his right hand.

Stretched parts: Articular disc, capsule, ulnar deviation muscles of the wrist, ulnar ligament, ulnar part of extensor and flexor retinaculum.

Hip Joint

Restricted Flexion Movement (Fig. 11.37)

Position of the patient: Supine lying.

Position of the therapist: Therapist is standing beside the patient and facing the hip joint.

Fig. 11.37: Stretching the restricted flexion movement of the hip

Procedure:

- Right hand of the therapist is grasping the lower leg region of the patient while left hand grasping the patient's knee.
- Therapist's both the hand flexes hip and knee of the patient.

Stretched parts: Capsule, ischiofemoral ligament, extensors of hip, articular cartilages.

Restricted Extension Movement (Fig. 11.38)

Position of the patient: Side lying.

Position of the therapist: Therapist is standing beside the patient and facing the hip joint.

Procedure:

- Therapist's left hand stabilizing the patient pelvis, while his right hand grasping the upper thigh and the leg is resting on the forearm of the therapist.

Fig.11.38: Stretching the restricted extension movement of the hip

- Patient's thigh is lifted by the therapist's right hand and performing the extension movement of the hip.

Stretched parts: Capsule, iliofemoral ligament, pubofemoral ligament and flexors of hip.

Restricted Abduction Movement (Fig. 11.39)

Position of the patient: Supine lying.

Position of the therapist: Therapist is standing beside the patient and facing the hip joint.

Fig.11.39: Stretching the restricted abduction movement of the hip

Procedure:

- Therapist's left hand stabilizes the opposite leg while his right hand grasping the lower thigh and the leg is placed on the therapist's forearm.
- Leg is pulled apart by the therapist's right hand.

Stretched parts: Capsule, transverse ligaments, articular cartilage, adductor muscles.

Restricted Adduction Movement

Position of the patient: Supine lying.

Position of the therapist: Therapist is standing beside the patient and facing the hip joint.

Procedure:

- Therapist's left hand stabilizing the opposite leg of the patient, while his right hand grasping the lower thigh.
- Therapist's right hand pushes the leg inside.

Stretched parts: Capsule, abductors of the hip, articular cartilages.

Restricted Medial and Lateral Rotation Movement (Fig. 11.40)

Position of the patient: Supine lying

Position of the therapist: Therapist is standing beside the patient and facing the hip joint.

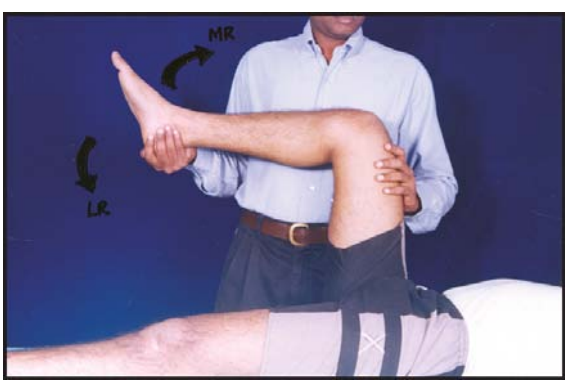


Fig.11.40: Stretching the restricted medial and lateral rotation movements of the hip

Procedure:

- Therapist's left hand stabilizing the thigh of the patient, while his right hand grasping the lower leg.
- Hip and knee are kept in flexed position of 90°.
- Therapist performing stretching both in medial and lateral rotation directions.

Stretched parts:

- During medial rotation—Capsule, ischiofemoral ligament, articular cartilage, lateral rotators.
- During lateral rotation—Capsule, pubofemoral ligament, iliofemoral ligament, transverse ligament, round ligament, articular cartilages, medial rotators.

Knee Joint

Restricted Flexion Movement (Fig. 11.41)

Position of the patient: Prone lying.

Position of the therapist: Therapist is standing beside the patient and facing the knee joint.

Fig.11.41: Stretching the restricted flexion movement of the knee

Procedure:

- Therapist's left hand stabilizing the pelvis of the patient while his right hand grasping the lower leg region.
- Therapist's right hand flexes the knee and stretches the tightened structures.

Stretched parts: Ligaments, medial and lateral meniscus, capsule, bursae and extensor muscles.

Restricted Extension Movement (Fig. 11.42)

Position of the patient: Prone lying.

Position of the therapist: Therapist is standing beside the patient and facing the knee joint.

Fig.11.42: Stretching the restricted extension movement of the knee

Procedure:

- Therapist's left hand stabilizing the pelvis of the patient while his right hand grasping the lower leg region.
- Therapist's right hand extends the knee and stretches the tightened structures.

Stretched parts: Ligaments, medial and lateral meniscus, capsule, bursae and flexor muscles.

Ankle Joint

Restricted Plantar Flexion Movement (Fig. 11.43)

Position of the patient: Supine lying.

Position of the therapist: Therapist is standing beside the patient and facing the ankle joint.

Procedure:

- Therapist's left hand grasping the lower leg region and his right hand palm holding the heel of the patient.

Fig.11.43: Stretching the restricted plantar and dorsiflexion movement of the ankle

Fig.11.44: Stretching the restricted inversion and eversion movement of the subtalar

- Therapist's right hand plantar flexes the ankle and stretches the tightened structures.

Stretched parts: Ligaments, capsule and dorsiflexors.

Restricted Dorsiflexion Movement

Position of the patient: Supine lying.

Position of the therapist: Therapist is standing beside the patient and facing the ankle joint.

Procedure:
- Therapist's left hand grasping the lower leg region and his right hand palm holding the heel of the patient.
- Therapist's right hand dorsiflexes the ankle and stretches the tightened structures.

Stretched parts: Ligaments, capsule and plantar flexors.

Subtalar Joints

Restricted Inversion Eversion Movement (Fig. 11.44)

Position of the patient: Supine lying.

Position of the therapist: Therapist is standing beside the patient and facing the ankle joint.

Procedure:
- Therapist's left hand grasping the ankle joint of the patient while his right hand grasping the foot region.
- Therapist's right hand is applying stretch force towards the inversion and eversion movement and stretches the tightened structures.

Stretched structures
- During inversion—Ligaments, capsules, articular cartilages and evertors.
- During eversion—Ligaments, capsules, articular cartilages and invertors.

SKIN STRETCHING

It is also like the joint stretching, the stretching has to be performed in the side of the movement lacking. This type of stretching mainly performed for the burns contracture, prolonged immobilization contracture and traumatic contracture. For example, if the skin is tight in the necks that restrict the extension movement has to undergo for the extension stretching. The same procedure as said in the joint stretching has to be followed.

12
CHAPTER

Functional Re-education Training

INTRODUCTION

Re-education means educating something, which is already known by an individual. This chapter explains us the educational training for an activity or function, which is known by the patient earlier. Here the patient knows the activities or movements that has, to be performed but due to his ailment or diseased pathology he could not perform it properly. So, the functional re-education program helps the patient to make him independent. "Making the man independent" is the main motto for the functional re-education program.

In the functional re-education training, sequence of progressions of the position like the development of the milestone of the child from the lying to the walking. As soon as childbirth it can adopt the supine position, later the stability improves, it achieves the side lying. From the side lying it progressed to the prone. After achieving the prone it tries to lift its head and the trunk with help of the elbow and the forearm, thus it attains the elbow prone lying. Soon after getting the prone on elbow position it still tries and gains the prone-on-hand position. In the prone-on-hand position the child pulls its lower limb upwards and adopting the quadruped position with this the child crawls and starts its first mobility. From quadruped the child holds the furniture, wall or some objects and achieving the kneeling position, with that it starts kneel walking with the support. After development of the stability it attains the standing position with help of the support from the kneeling.

Depends on the condition and the level of his independence the program can be designed. Depends on the condition, the sequence can be planned and the multiple posture may be overlapped during that program. The sequence activities, techniques also can be varying from one patient to another. Normally, the functional re-education program can be helpful mostly for the entire orthopedics, neurological, cardiac conditions.

It helps to:

- Improve the coordination and balance.
- Increase the strength endurance of the muscle.
- Increase the pelvic stability.
- Increase the dynamic and static stability.
- Enhance the proprioception function.
- Improve the postural instability.
- Improve the ambulatory skill.

The functional re-education training consists of perambulatory mat exercise and ambulatory training.

- Rolling
- Supine to side lying
- Side lying to prone lying
- Prone to side lying
- Side lying to supine
- Elbow prone lying
- Hand prone lying
- Elbow side lying—quadruped position
- Side sitting
- Sitting
- Kneeling
- Kneel sitting
- Half-kneeling
- Standing
- Walking.

In each and every posture many of the exercises can be practiced for the progression and to improve the stability as well as mobility. This progressive exercise program in each position makes the patient master in that particular posture and also gives more confident for the next progressive posture.

SUPINE

Progressive Activities in Supine

Most of the exercises can be performed in the supine lying posture.

- Neck stability and strengthening exercises.
- Upper and lower limb coordination as well as strengthening programs.
- Trunk exercises.
- Postural drainage techniques.

And also supine position is the very much convenient posture to adopt for long period. All the strengthening exercises starts with assisted exercise progressed to assisted resisted ends with resisted exercises.

Assisted → Active → Assisted resisted → Resisted

BRIDGING (Fig. 12.1)

In the supine lying both the knees are flexed and the feet are placed on the couch. Patient is asked to raise his trunk from the floor or couch. The hip knee trunk aligns in straight line. Normally, in hemiplegic's condition early weight bearing is made to practice to improve the independency.

1. This is the important exercise has to be practiced to improve the trunk stability. It improves the pelvic and trunk stability as well as facilitates hip abductors and adductors.

Fig. 12.1: Bridging with assistance of the therapist

2. Earlier it started with the assisted type, i.e. movement practiced with the assistance support may be given for knee from falling apart.
3. Patient is made to practice independently without any support or assistance to improve the ability to hold the trunk for some time after rising from the floor.
4. Modification can be made to improve the stability and endurance. Performing the bridging exercise with one lower extremity support and another lower extremity with hip flexed and knee extended.
5. Once he masters in it, made to practice it with the manual resistance by the therapist later with mechanical.

This exercise program can be altered for the hemiplegia and paraplegic cases.

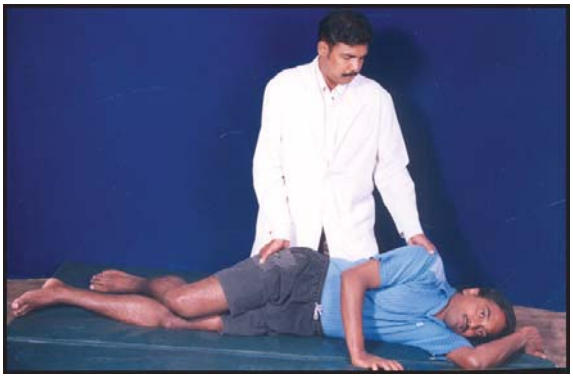


Fig. 12.2: Rolling from supine to side lying with assistance of the therapist

SUPINE TO SIDE LYING (Fig. 12.2)

Rolling can be practiced with the assistance. While rolling towards left side below said sequences are performed.

- Right hand pulls the upper body, i.e. upper trunk and pelvic towards left side by holding the bed end or bedside bars in the left side.
- Right knee is flexed and with the foot, the pelvic and lower trunk pushed towards left side.
- Left leg can be hooked over the bed end and rotated the lower trunk.
- Left hand also may assist to turn the upper trunk by grasping the bed end.

Uses

- Useful in bed making activities.
- Useful in preventing the bedsore.
- Easy to progress to next posture.

Uses of Side Lying

- Some of exercises like upper and lower extremities strengthening exercises can be performed.
- Coordination exercises can be performed.
- Postural drainage techniques can be performed.
- Assistive movements can be performed in the early stage.
- Independent activities can be practiced.
- If the stability and strength is more the patient can practice the resisted exercises.
- Depends on the muscle power the stage of exercise program is selected.

SIDE LYING TO PRONE

- Left shoulder adducted and elbow extended and placed under the body.
- Right hand grasping the head end bedside bars or bed end and rotates the upper trunk.
- Left upper extremity extended throughout.
- Right knees flexed and with the foot pushes the mat to rotated the lower trunk.

Progressive Activities

- Neck stability exercises can be performed mainly extension and side flexion movement.
- Spinal extensor exercises can be practiced.
- Some of the upper lower extremity exercises can be practiced.
- Starts with the assisted exercise and ends in the resisted exercises to improve the strength of the muscles.

Uses

- Useful for bed activities.
- Useful for postural drainage techniques.
- Prevent bedsore.
- Useful to perform above said exercises.

PRONE TO SIDE LYING

- Right hand placed sideways and the pressure applied over the mat by which the upper trunk and the head can be raised up.
- Right knee flexed and the pressure applied on the mat to rotate the lower trunk.
- Left hand holds the bedside bars or right side bed end and pushes the body towards left side.

Here the total body rotates 90° now the left hand goes down and right hand comes up.

SIDE LYING TO SUPINE

- Right hand holds the bed end or the side bars and pulls the upper trunk towards back side.
- Left lower limb hooks the bed end and pulls the lower trunk towards the front side.
- Left hand applies pressure over the bed or the bedside bars and pushes body back side.

Above mentioned all the rolling techniques done with assistance in the early stage and it is progressed into independent rolling.

Assisted → dependent → Resisted

ELBOW PRONE LYING (Fig. 12.3)

The elbow and the forearm supports patient's upper trunk and the weight is transmitted through the elbow. This position is achieved from the prone lying.

Fig. 12.3: Achieving the prone on elbow positioning with assistance of the therapist

Position

Shoulder — Flexion, elevation
Elbow — Flexion
Forearm — Pronation
Wrist hand — Extension
Palm is flat supported by the surface.

Progressive Activities

- This position can be adopted with help of the assistance from the prone lying.
- Progression can be made to maintain the posture independently.
- Manual approximation force can be applied towards one side to another may improve the dynamic stability of the upper extremity.
- Elbow walking can be practiced.
- Shifting the weight towards one side of the elbow and another side elbow can be removed from the mat and swings towards the weight-bearing limb posteriorly. This may improve the proprioception activity more over the shoulder joint.
- The resistance can also be applied manually to improve the strength.

Uses

- Bed making.
- Dressing activities.
- Patient can hold the magazine and read in this position.
- These activities are move helpful for the paraplegic patients to improve their upper limb stability.

HAND PRONE LYING (Fig. 12.4)

This position is same like the elbow prone lying. In this position the BOS bit decreases and COG raised comparatively with the elbow prone lying. Here instead of weight bearing on the elbow, the weight is transmitted through the hand and wrist. This is intermediate position between the elbow prone lying and the quadruped position.

Hyperextension of spine as well as hip joint occurs more, which is useful for postural alignment during ambulation. In beginning this

Fig. 12.4: Achieving the hand prone lying position from prone on elbow position with assistance of the therapist

position can be achieved by the assistance of the therapist. Like prone on elbow position many of the progressive activities can be performed.

Position

Shoulder — Elevation flexion and abduction
Elbow — Extension
Wrist — Hyperextension
Fingers — Extension
Forearm — Pronation.

Progressive Activities

- Position may be achieved by the assistants and the support given to maintain the posture during the early stage.
- Preparing the patient to maintain the posture independently without any assistants.
- Approximation can be applied in sideways, anteroposterior direction by which we can achieve the proximal muscle stability as well as coordination.
- Weight shifting from one side to another can be practiced to increase the muscle power as well as proprioception activities over the shoulder joint.
- Hand walking can be practiced to improve the dynamic stability over the upper limb.
- Push-up exercise may helpful to improve the static as well as dynamic stability of the upper limb.
- Pegboards can be used to improve the hand coordination.

Uses

- This position is helpful for the paraplegic patient to improve the upper limb muscle power and strength.
- It is used for dressing activities.
- Bed mobility can be improved.

QUADRUPED POSITION (Fig. 12.5)

It is otherwise called as four-feeted position or animal position. In this position the BOS decreases while comparative with the hand prone lying and the COG increases. It is the first position in which the weight bearing through the hip joint takes place in the re-education training. It can be achieved from: (1) hand prone lying, (2) side sitting.

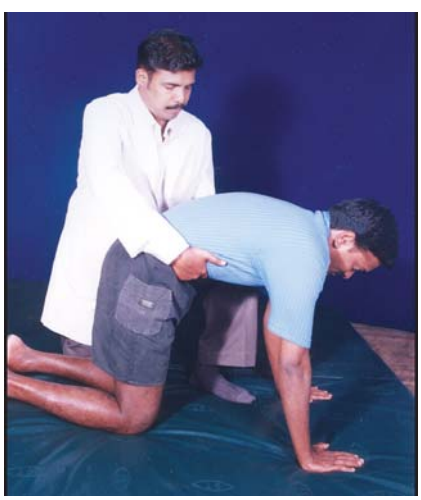


Fig. 12.5: Achieving the quadruped from hand prone lying position with assistance of the therapist

From Hand Prone Lying

From the hand prone lying hip and knee is flexed and the pelvis is taken up to the knee level and the body is raised with the help of therapist's support.

From Side Sitting

From the side sitting the trunk is rotated and raised up. Both the upper limb is placed front and allowing weight bearing on the knees and the hands.

Position

Trunk — Forward flexion (placed horizontal to the floor)
Hip — Flexed 90°
Knee — Flexed 90°
Elbow — Extension
Wrist — Extension
Shoulder — Flexion and extension
Forearm — Pronation
Palm — Flat and placed on the floor.

Progressive Activities

- This position is achieved from the prone on hand or side sitting position with the help of the assistants.
- Active maintenance of the posture is practiced regularly to maintain independence.
- Manual force is applied sideways and antero-posterior direction to achieve the co-ordination as well as stability of the upper and lower limb.
- Weight shifting sideways and antero-posterior direction can be practiced to improve the dynamic stability of the limb.
- Weight bearing on the contralateral upper and lower extremities practiced, which is helpful during the upper limb swinging walking.
- Crawling movement can be practiced to improve the dynamic stability of the limbs. It improves the neuromuscular and proprioceptive activities over the joints.
- Weight bearing on three limbs. Two can be practiced which may be increasing the static stability of the limbs.
- Forward and backward crawling movement can be practiced.
- 'Cat and Camel' exercise for the trunk has to be practiced, i.e. raising and lowering of the trunk in the quadruped position.
- 'Elephant movement', i.e. forward, backward and sideways oscillatory movement of the body can be done in the quadruped position, which increases the static and dynamic stability of the limbs.
- During the above, mentioned activities manual resistance can be applied to improve the muscle strength.

Uses

- Floor level activities like playing with the kids, seeding, weeding and gardening activities.
- It is useful for the patients who cannot walk to ambulate in and out of the house.

ELBOW SIDE LYING

This can be achieved from the side lying. The BOS is supportless and the COG is high while comparing with the elbow prone lying. It is the very much unstable and inconvenient for an individual to maintain for the longer period. This posture can be supported with the opposite side hand placing over the mat in front.

Position

Same like the side lying but the elbow is flexed and placed on the mat and the upper trunk weight is transmitted through the weight-bearing elbow.

Elbow — Flexion
Shoulder — Extension, elevation and internal rotation.

Progressive Activities

- This position is achieved from the elbow prone lying with the help of the assistant.
- Independently maintaining the position also can be practiced.
- Creeping with the help of the elbow on the mat is taught to improve the dynamic and static stability as well as proprioception activities.
- Manual approximation force is applied to increase the static stability over the upper limb.
- Resisted activities can be performed to improve the muscle power.

Uses

- Mat mobility activities.
- Relaxed position for reading books and watching television.
- This is the enroute for the sitting position.

SIDE SITTING (Fig. 12.6)

This position can be achieved from the elbow side lying as well as from kneel sitting. Here the BOS still reduces and the COG increases while comparing with elbow side lying and it is more stable than kneel sitting posture. Both the upper extremity will be supporting this posture.

Fig. 12.6: Achieving the side sitting position from elbow side lying position with assistance of the therapist

From Elbow Side Lying

We can achieve from the elbow side lying. HIP and knee is flexed, elbow extended, palm is flat and placed on the floor and the trunk raised.

From Kneel Sitting

From kneel sitting hip and knees are extended and one side of the hip is placed on the floor with the same side upper limb support.

Position

- Hip and knees are flexed and kept in the side.
- Weight is transmitted through one upper limb and the pelvis of the one side.
- Shoulder is abducted and elevated.
- Elbow is extended.
- Lower hip is flexed, abducted and laterally rotated.
- Upper hip is medially rotated and flexed.

Progressive Activities

- Earlier this position is adopted from the elbow side lying and kneel sitting with the help of assistance of the therapist. Therapist will be sitting side to the patient and first flexing both the hip and knees, with extending the elbow.
- The patient is made to practice to maintain the posture without any support.
- Side sitting will be practiced for the both sides.
- Manual approximation force is given in anterior and posterior as well as lateral direction also to improve the static stability of the trunk as well as the weight-bearing limb.

- Weight shifting over the upper limb will be practiced to activate the proprioceptors over the shoulder and elbow joint.
- Balancing exercise will be practiced by removing the upper limb support.
- Moving on the mat by dragging the buttocks and by the support of the upper limb.
- Opposing resisted force may be given over the trunk to improve the trunk stability.

Uses

Floor level household activities like cutting vegetables, eating, garland making, etc.

LONG SITTING

This is very stable position to maintain for longer period. This can be achieved from side sitting. The trunk muscles should have good power and strength to maintain the trunk in erect posture and is supported by both upper limbs by placing either side; sometime the upper limb may be placed posteriorly to avoid back falling.

Position

Spine — Erect
Shoulder — Abduction and elevation
Elbow — Extension
Wrist — Extension
Hip — Flexion and lateral rotation
Knee — Flexion 90º.

Progressive Activities

- Posture is achieved with the help of the therapist. Therapist grasping the trunk and making it straight.
- Patient is made to maintain this posture with the help of the upper limb support without any external support.
- Balancing force can be applied in side as well as anteroposterior direction.
- Weight shifting from one upper extremity to another will be practice to improve the proprioceptor activity over the shoulder region.
- Some of the trunk, upper extremity, lower extremity free, strengthening exercise can be performed.
- Mat crutch exercise can be practiced with the help of the crutches.
- *Hitching hiking:* Both the hip is lifted with the help of the upper limb support is called as hitching. Forward backward and sideways movements can be practiced in this position. Sandbags, wooden blocks or small size crutches can be used for performing hitching. Lifting the one side of the pelvic up is called as hiking. Hiking is the most important movement should be practiced because during the swing phase hip hiking is must to clear the foot from the floor.
- Patient is made to practice sit without the support of the upper extremity.
- Walking on the buttocks can be practiced to improve the dynamic stability.
- Sitting push-ups can be performed which gives more stability and strength to the upper extremity.
- Sitting with leg crossed can be performed.

KNEELING (Figs 12.7 and 12.8)

Standing on both the knees are called as kneeling. This can be achieved from the quadruped position and side sitting. In this position BOS is decreased and the COG is raised. This is very much inconvenient posture to maintain for long-time. Stability in this posture also very less.

From Quadruped Position

Therapist, standing back of the patient grasping the upper trunk and lifting the trunk and upper extremity up. The posture is maintained by the help of the back support by the therapist.

From Side Sitting

Same like quadruped position the therapist grasping the upper trunk by standing back to

Fig. 12.7: Achieving the kneel sitting from side sitting position with assistance of the therapist

Fig. 12.8: Achieving the kneeling from kneel sitting position with assistance of the therapist

the patient and lifting him. In the middle sometime the kneel sitting also may be attained but it is on the way process to the kneeling posture.

Progressive Activities

- Patient is assisted to maintain the posture in the beginning stage.
- Independent maintaining the posture can be practiced.
- Manual approximation force is applied in the anteroposterior as well as lateral directions to improve the static and dynamic stability of the patient.
- Hip hiking can be practiced in this posture as said in the long sitting.
- Kneel walking may be encouraged to increase the dynamic stability of the patient.
- Mat crutch activities can be practiced swing the upper extremity by holding the crutches. Lifting the body by holding the furniture or wall.
- Progression can be made to walk in side-ways.

Uses

- For dressing activities.
- Useful for mobility.
- Useful to play with the kids.
- Improves the floor level activities.

HALF-KNEELING (Fig. 12.9)

It is achieved from the kneeling, to achieve from the kneeling weight is transmitted to one side knee and the opposite lower extremity is lifted and the hip is flexed and the foot is placed front on the mat. In this posture the BOS is more the COG is less while comparative to the kneeling posture and it is stable than the kneeling. It is the intermediate posture between the kneeling and the standing .

Position

Weight bearing over one side knee another side hip and knees are flexed and the foot is kept on the floor.

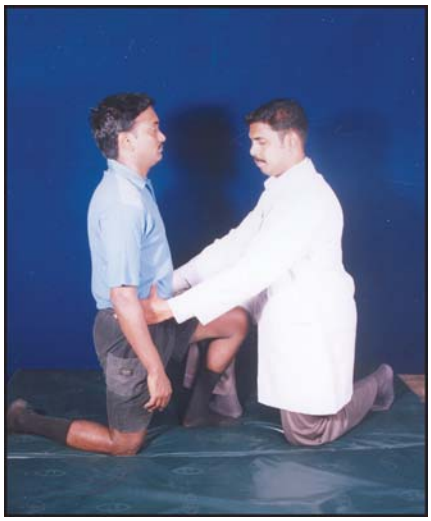


Fig. 12.9: Half-kneeling with the support of the therapist

Fig. 12.10: Achieving the standing position from sitting position with assistance of the therapist

Progressive Activities

- Assisted balancing approximation force weight shifting activities can be performed as said in previous postures.
- Push-ups can be practiced to come out of this posture and go for the standing posture with the help of the furniture or wall.

STANDING (Figs 12.10 and 12.11)

Here the BOS is less and the COG increases more. So, this is the unstable posture to maintain for prolonged time. This is the intermediate position between the half-kneeling and the walking. It can be achieved from the half-kneeling and the long sitting. This is the starting position for walking.

Half-Kneeling

Therapist is standing back to the patient and grasping the upper trunk with both the hands and lifting the patient up. The kneeling legs move forwards and the foot on the mat or the floor, otherwise patient can hold the furniture or the wall and lift his body up to reach standing with the help of the assistance.

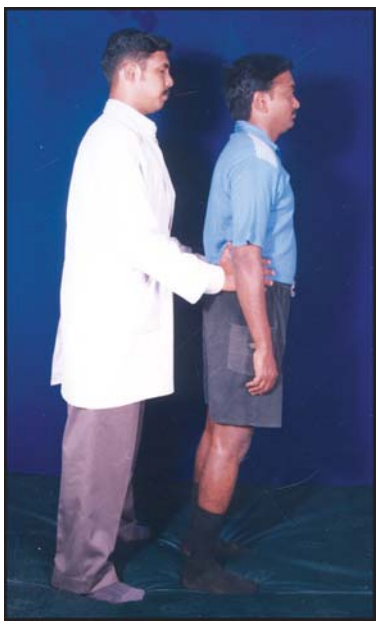


Fig. 12.11: Standing position with assistance of the therapist

Fig. 12.12: Practice walking with the support of the therapist

FROM SITTING

From the sitting the therapist has to sit in front of the patient on the stool and has to lock the patient's knee with his knees, while he is made to stand. The therapist has to hold the pelvis of the patient and lift him, the patient by holding the shoulder region of the therapist to avoid falling.

Whenever the patient allowed standing for first time, the therapist should be alert to complaint of nausea, light-headedness due to the sudden drop of the BP.

Progressive Activities (Fig. 12.12)

- Beginning the patient is made to stand in the corner of the wall with the therapist support in front, so that the patient cannot fall front, back, and sideways.
- Independent maintaining the standing posture can be performed to improve the static stability.
- Approximation force is applied in front, back, and lateral direction to improve the lateral stability.
- Weight shifting from one side to another will be carried out to increase the proprioceptor and the balancing activity. It may be started with the support of an object or the therapist.
- Crutch exercises may be performed in this posture to improve the crutch activities.
- Many of the upper and lower extremities exercises can be performed.
- Forward, backward, and sideways stepping can be practiced to improve the dynamic stability and to attain earlier walking.

PARALLEL BAR WALKING

As soon as the motor control is achieved in the standing posture the parallel bar activities can be introduced. Before going for the parallel bar activities the parallel bar should be adjusted depends on the patient's height. Normally, the height of the parallel bar should be up to the level of the greater trochanter.

General Instructions

Proper instructions in parallel bar activities should be given throughout the walking training. It includes walking pattern, progressive activities, turning techniques, stability, balance and coordination. Generally, the verbal command improves or facilitates the activities more. The support or assistance of the therapist will be given in the weaker side limb to increase more stability. In some conditions like unstable knee, the therapist should lock the knee of the patient and body weight is transmitted through the locked knee joint.

Progressive Activities (Fig. 12.13)

During the initial range of the parallel bar activities the therapist should give support to the patient from falling. Normally, the therapist has to stand towards the weaker side to give the stability. Guarding belt or the towel tied over the waist is used to guarding the patient from falling. During the initial standing the therapist should be careful about the complaints

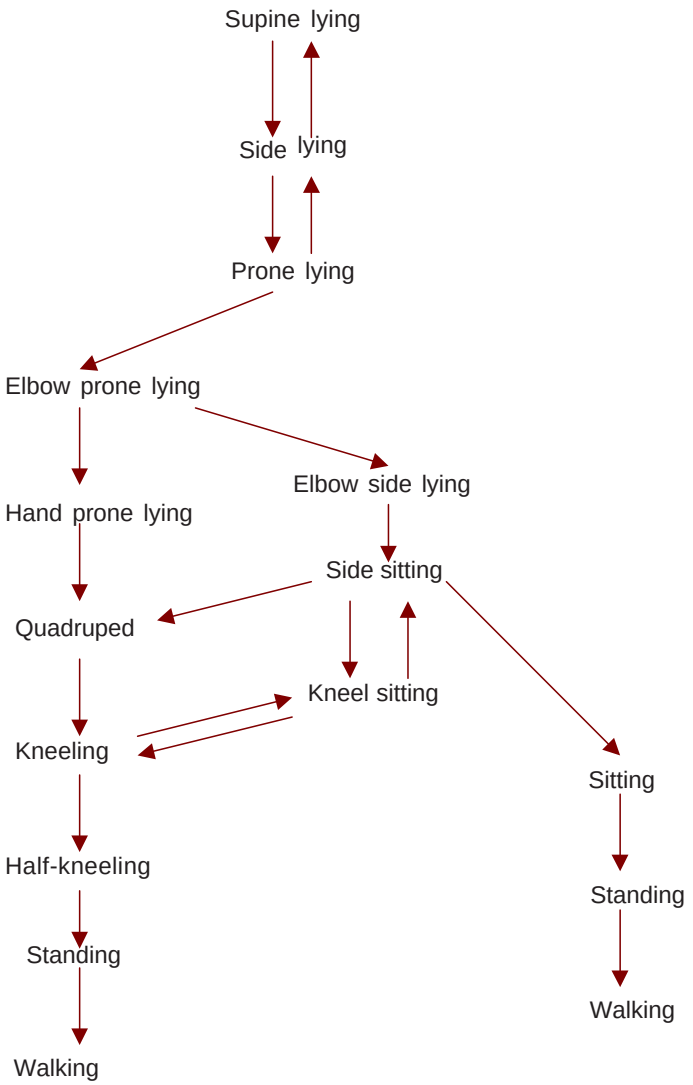


Fig. 12.13: Progressive positions in the functional re-educational training

of the light headedness, nausea due to postural hypotension.

Patient can be practiced below mentioned progressive exercises to improve the conditions.

- Patient is made to stand with the support of the parallel bar without the therapist's support in the early stage.
- *Weight shifting:* Shifting the weight lateral, anterior, posterior sides without altering the hand position in the parallel bar.
- *One leg standing:* Patient is recommended to stand with one leg support and transmitting whole weight over the supported leg.

- *One hand support:* Patient's one hand is removed from the parallel bar and makes him to stand with the one hand support.
- *Hip hiking:* Patient is asked to practice the hip hiking movements, which is helpful to clear the foot from the ground and the forward propulsion of the body during ambulation.
- *Stepping forward and backward:* Patient is practiced to keep one leg forward, bring back to the normal position and the one step backward movement, and bring back to the neutral position by standing in same place.
- *Parallel bar push-ups:* Patient's body is lifted with his upper limb support on the parallel bar is called as parallel bar push this is to be practiced to improve the upper extremity strength and power.
- *Turning technique:* The turning in the parallel bar is important and useful while turning in the normal floor walking. Normally, the patient is made to turn towards the normal side by avoiding the abnormal side. Avoiding pivot is also most helpful to show easy mastering in the turning technique. For example, while turning towards right side, right leg is raised and placed on the floor 90º to the previous position and the same was followed by the left foot, and kept parallel to the right foot next to that the left hand is removed from the left side and placed, on the right side parallel bar to attain perfect support. The therapist may help the patient supporting him by standing back to him.
- *Resisted toward progression:* Resistance force is applied over the chest region of the patient while walking in the parallel bar.
- *Backward walking:* Backward walking can be practiced of the patient to get good standing.
- Side walking also can be practiced to improve the stability and balance.
- *Air cycling:* Parallel bar push-ups have to be done first followed by the cycling activity with the lower extremity in the air.
- *Step-up:* Inside the parallel bar the step is placed and instructs the patient to practice the step-up activity. Standing on one leg and swing the opposite side unsupported lower extremity.

13
CHAPTER

Suspension Therapy

DEFINITION

Suspension is defined as suspending a part of the body or whole body with the supported slings and pulleys.

PRINCIPLES

It is working under the principle of (i) Friction, (ii) Pendulum, and (iii) Eliminating gravity movement.

Friction

It occurs during a particular surface moves on another. It is the force, which restrict the movement of an object. If the surfaces are more smooth and slippery will have less friction, in that surface the movement will be more and will cause slippery. If the surfaces are hard or rough results in more friction and the movements are opposed by the friction force. The same principle is used in the suspension which has less friction causes the smooth and easy movement.

Pendulum

Pendulum is heavy material suspended by the weightless thread. If the force is applied on the pendulum it results in to and fro movement. One complete swing is called as oscillation. During the oscillation, the arc of movement of the pendulum forms a segment of base of the cone. The oscillation will be continued until the force comes down. The oscillatory distance may come down step by step, by the resistance of the air and gravity. In the human body the pendular motion occurs mainly in the shoulder and hip joints, forward leg movement and the arm swing movement while walking is the simplest example. The simple muscular contraction is necessary to initiate the oscillation. The same mechanism is used in the suspension therapy to maintain the muscle property, increase the range of movement and strengthening the muscles.

Eliminating Gravity Movement

If the person has the muscle power 2 (gravity eliminated movement), can go for the suspension exercises. If the muscle power is less than 2. It is difficult to perform the suspension therapy exercises by the patient himself. So, the patient should have minimal muscle power of 2 to undergo for suspension therapy exercise. If the muscle power is above 3, the patient can go for against the gravity

exercises instead of suspension therapy exercises.

ADVANTAGES

1. It reduces the burden for the therapist.
2. Easy to lift the limbs.
3. Active movement can be performed easily with minimum friction.

SUSPENSION INSTRUMENTS

1. Suspension frame
2. Supporting ropes
3. Pulleys
4. Slings
5. S-hook and dog clips
6. Wooden cleat.

Suspension Frame

It is madeup of stainless steel or plastic coated steels. In the top and head end side presents the 5-centimeter metal mesh, and the remaining sides are kept open. The measurement of the frame is 1 m or 2 m width × 2 m length × 2 m height. In the middle of the frame 2 m length × 1 m width × 1 m height couch is placed for the patient's accommodation.

Supporting Rope

It is 1.5 meters length and 3-ply hemp ropes are used for the suspension to avoid slipping. One end of the rope consists of a fixed ring and another end of the rope passes through the wooden cleat and is knotted in half-hitched manner (Fig. 13.1).

There are 3 varieties of supporting ropes are used. 1. Primary supporting rope 2. Secondary rope 3. Vertical supporting rope. The primary rope, which is used to take the axis as the point of suspension and it supports the distal joint. The secondary rope is added with the primary supporting rope to support the proximal joint. Vertical ropes are used for vertical suspension and are supporting the mid-portion of the body segment.

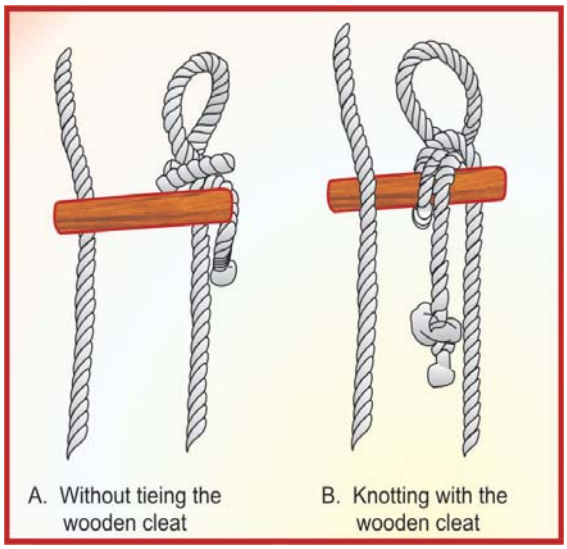


Fig. 13.1: Half-hitched knotting

Wooden Cleat

It is made up of wood and is used for altering the length of the rope. It has two or three holes for the rope passage, the rope itself holds the cleat by friction resistance. Sometime the wooden cleat is placed horizontally, for adjusting the length of the rope and the oblique alignment of the cleat for friction resistance by the rope to avoid slippery.

Pulley

It gives the mechanical advantage. Pulleys are used to reduce the burden of lifting whole body or body parts. Here sometime single or double pulleys are used depends on the situation. If the body part is big. For example, trunk, thorax, and thigh, double pulleys are used. Basis of the pulleys are explained in chapter 1.

Slings

The slings are made up of canvas. There are four varieties of slings are available.

1. Single sling
2. Double sling

3. Three-ring sling
4. Head sling.

Single Sling

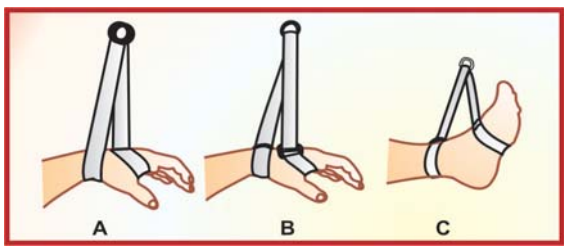
It is 68 cm length and 17 cm width, both the ends are having the D-rings for the attachment with the dog clip or S-hook. These types of slings are used for the elbow and knee region. It is sometime folded in figure of 8 manner to support the wrist and ankle.

Double Sling

It is bigger than the single sling, it will have more than two sides with the D-rings. It is more useful for supporting the bigger parts like thorax, trunk, and thigh. It hass 68 cm length and 28 cm width.

Three-ring Sling

It is 75 cm length and 3-4 cm width, it consists of three D-rings. Two at the both end of the sling and one in the middle kept moving. It is mainly used for wrist and ankle regions. There are three methods to support or apply the slings in wrist and ankle. It is shown in the Figure 13.2.



Figs 13.2A to C: Mode of applying the three-ring sling. A. Figure of 8 method in wrist, B. Middle moving ring alone used for supporting as seen in picture, C. As said for ankle

Head Sling

It is used for head support in the middle of the sling presents a slit for accommodation of occipital region while in supine or lower ear accommodation while inside lying.

Fig. 13.3: Dog clip

S-hook and dog clips: The S-hook and dog clips (Fig. 13.3) are used:

1. To attach the supporting rope with the mesh.
2. To attach the sling with the supporting ropes (Fig. 13.4).

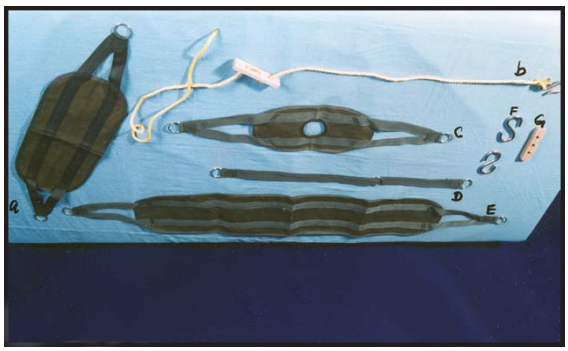


Fig. 13.4: Suspension accessories A. Single sling, B. Supporting rope, C. Head sling, D. Three ring sling, E. Single sling for trunk or thoracic, F. S-hook, G. Wooden cleat

PROCEDURE

One end of the supporting rope is attached by the S-hook with the mesh and another end is passes through the one hole of the wooden cleat, and taken out through another hole. The wooden cleat is used for adjusting the length of the rope, and another way of lengthening adjustment made by knotting the rope about

the cleat. And the one more S-hook attaches the sling with the supporting rope in-between the two holes of the wooden cleat. The knotting should be half-hitched, so that it can be removed easily while altering the support or movement. Sometime padding is needed mainly for elbow and knee joint to avoid flexion movement.

TYPES OF SUSPENSION

1. Axial suspension
2. Vertical suspension
3. Pendular suspension.

Axial Suspension

Joint axis is taken as the point of the suspension. The limb is supported by the slings above the axis of the joint. If the movement is initiated the limb moves both sides and the base of the swings shows the segment of the base of the cone shape. The part moves parallel to the floor.

Uses

1. Relaxation.
2. Maintain muscular property.
3. Increase the blood circulation.
4. Increase the venous drainage.
5. Increase the lymphatic drainage.

Vertical Suspension

The center of gravity of the body part or the body is taken as the point of suspension. The body parts can be supported in these types of suspensions rather than strengthening or performing pendular movement of the limb.

Uses

1. To support the body part
2. To reduce the pressure sore.

Pendular Suspension

Here at first the axis of the joint is taken as the point of suspension then depends on the strengthening of the muscle group, the axis is changing towards medially or laterally, anteriorly or posteriorly. The muscles will be getting resistance while movement if the axis is shifted opposite to that movement. For example, if the axis is shifted towards the abductor side the adductor muscles will be getting resistance during movement.

Uses

1. To strengthen the muscles.
2. To increase the muscle power.
3. To increase the endurance.

TECHNIQUES

Shoulder Abduction and Adduction (Fig. 13.5)

Position of the patient: Supine lying.

Point of suspension: One inch below the acromion process.

Fig. 13.5: Suspension for abduction and adduction of shoulder joint

Needed accessories:
- S-hooks—3 nos
- Three-ring sling—1 no.
- Single sling—1 no.
- Supporting-rope with wooden clit—2 nos.

Procedure:
- One inch below the acromion process is taken as the suspension point by primary supporting rope, which is connected by the s-hook with the mesh.
- Secondary supporting rope attached in the same s-hook.
- Three-ring sling is used to support the wrist.
- Single sling is used to support the elbow.
- The primary supporting rope is attached with the wrist sling.
- Secondary supporting rope is attached with the elbow sling.
- Patient is instructed to perform the abduction-adduction movement of the shoulder.
- For strengthening the abductor medial shifting of the axis is carried out, vice versa for adductor strengthening.

Shoulder Flexion and Extension (Fig. 13.6)

Position of the patient: Side lying.

Point of suspension: Greater tuberosity.

Needed accessories:
- S-hooks—3 nos
- Three-ring sling—1 no.
- Single sling—1 no.
- Supporting-rope with wooden cleat—2 nos.

Procedure:
- Greater tuberosity is taken as the suspension point by primary supporting rope. Which is connected by the s-hook with the mesh.
- Secondary supporting rope attached in the same s-hook.
- Three-ring sling is used to support the wrist.
- Single sling is used to support the elbow.
- The primary supporting rope is attached with the wrist sling.

Fig. 13.6: Suspension for flexion and extension of shoulder joint

- Secondary supporting rope is attached with the elbow sling.
- Patient is instructed to perform the flexion and extension movement of the shoulder.
- For strengthening the flexor posterior shifting of the axis is carried out vice versa for extensor strengthening.

Shoulder Medial and Lateral Rotation (Fig. 13.7)

Position of the patient: Supine lying.

Point of suspension: Olecranon process.

Needed accessories:
- S-hook—4 nos
- Three-ring sling—1 no.
- Single sling—1 no.
- Supporting-rope with wooden cleat—2 nos.

Procedure:
- Shoulder is flexed 90° with the elbow in 90° flexion the olecranon process is taken as the suspension point by primary supporting

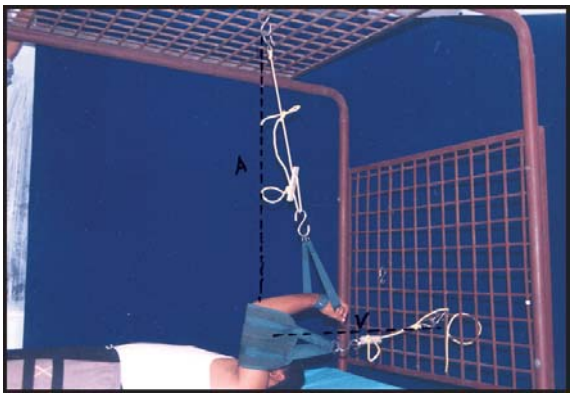


Fig. 13.7: Suspension for medial and lateral rotation of shoulder joint

rope which is connected by the s-hook with the mesh.
- Secondary supporting rope attached with head side mesh by another s-hook in the vertical suspension.
- Three-ring sling is used to support the wrist.
- Single sling is used to support the arm.
- The primary supporting rope is attached with the wrist sling.
- Secondary supporting rope is attached with the arm sling.
- Patient is instructed to perform the medial and lateral rotation movement of the shoulder.
- For strengthening the medial rotator, lateral shifting of the axis is carried out vice versa for lateral rotator strengthening.

Elbow Flexor and Extensor (Fig. 13.8)

Position of the patient: Sitting.

Point of suspension: Lateral epicondyle of the humerus.

Needed accessories:
- S-hooks—4 nos
- Three-ring sling—1 no.
- Single sling—1 no.
- Supporting-rope with wooden cleat—2 nos.

Fig. 13.8: Suspension for flexion and extension of elbow joint, one sling is used as vertical suspension and the another is as axial suspension

Procedure:
- Shoulder is abducted in 90° with the elbow in 90° position the lateral epicondyle is taken as the suspension point by primary supporting rope, which is connected by the s-hook with the mesh.
- Secondary supporting rope attached with the mesh by another s-hook in vertical suspension.
- Three-ring sling is used to support the wrist.
- Single sling is used to support the arm.
- The primary supporting rope is attached with the wrist sling.
- Secondary supporting rope is attached with the arm sling.
- Patient is instructed to perform the elbow flexion and extension movement.
- For strengthening the flexor lateral shifting of the axis is carried out vice versa for extensor strengthening.

Hip Flexion and Extension (Fig. 13.9)

Position of the patient: Side lying.

Point of suspension: Greater trochanter.

Needed acessories:
- S-hooks—3 nos
- Three-ring sling—1 no.
- Single sling—1 no.
- Supporting-rope with wooden cleat—2 nos.

Fig. 13.9: Suspension for flexion and extension of hip joint

Procedure:
- Greater trochanter is taken as the suspension point by primary supporting rope which is connected by the s-hook with the mesh.
- Secondary supporting rope attached with the same s-hook.
- Three-ring sling is used to support the ankle.
- Single sling is used to support the knee.
- The primary supporting rope is attached with the ankle sling.
- Secondary supporting rope is attached with the knee sling.
- Patient is instructed to perform the flexion and extension movement of the hip.
- For strengthening the flexor posterior shifting of the axis is carried out vice versa for extensor strengthening.

Hip Abduction and Adduction (Fig. 13.10)

Position of the patient: Supine lying.

Point of suspension: Two inches below the ASIS.

Needed accessories:
- S-hooks—3 nos
- Three-ring sling—1 no.
- Single sling—1 no.
- Supporting-rope with wooden cleat—2 nos.

Fig. 13.10: Suspension for abduction and adduction of hip joint

Procedure:
- Two inches below the ASIS is taken as the suspension point by primary supporting rope, which is connected by the s-hook with the mesh.
- Secondary supporting rope attached with the same s-hook.
- Three-ring sling is used to support the ankle.
- Single sling is used to support the knee.
- The primary supporting rope is attached with the ankle sling.

- Secondary supporting rope is attached with the knee sling.
- Patient is instructed to perform the abduction and adduction movement of the hip.
- For strengthening the abductor medial shifting of the axis is carried out vice versa for adductor strengthening.

Hip Medial and Lateral Rotation

Position of the patient: Supine lying.

Point of suspension: Apex of the patella.

Needed accessories:
- S-hooks—4 nos
- Three-ring sling—1 no.
- Single sling—1 no.
- Supporting-rope with wooden cleat—2 nos.

Procedure:
- Apex of the patella is taken as the suspension point by primary supporting rope. Which is connected by the s-hook with the mesh.
- Secondary supporting rope attached with the head side mesh by the another s-hook.
- Three-ring sling is used to support the ankle.
- Single sling is used to support the thigh.
- The primary supporting rope is attached with the ankle sling.
- Secondary supporting rope is attached with the thigh sling.
- Patient is instructed to perform the medial and lateral movement of the hip.
- For strengthening the medial rotator medial shifting of the axis is carried out vice versa for lateral rotator strengthening.

Knee Flexion and Extension (Fig. 13.11)

Position of the patient: Side lying.

Point of suspension: Lateral joint line.

Needed accessories:
- S-hooks—4 nos
- Three-ring sling—1 no.

Fig. 13.11: Suspension for flexion and extension of knee joint, one sling is used as vertical suspension and the another is as axial suspension

- Single sling—1 no.
- Supporting-rope with wooden cleat—2 nos.

Procedure:
- Lateral joint line is taken as the suspension point by primary supporting rope. Which is connected by the s-hook with the mesh.
- COG of the thigh is taken as the suspension point by the secondary supporting rope, which is attached with the head side mesh by the another s-hook in vertical suspension.
- Three-ring sling is used to support the ankle.
- Single sling is used to support the thigh.
- The primary supporting rope is attached with the ankle sling.
- Secondary supporting rope is attached with the thigh sling.
- Patient is instructed to perform the flexion and extension movement of the knee.
- For strengthening the flexor posterior shifting of the axis is carried out vice versa for extensor strengthening.

For Whole Body Suspension

The separate slings are suspending each and every limb in the vertical suspension with supporting ropes. The upper trunk, lower trunk, head, upper limb (right and left), lower limb (right and left) are suspended with separate supporting ropes in the vertical suspension to put the whole body suspension.

14
CHAPTER

Incoordination (Asynergia)

DEFINITION FOR COORDINATION

It is a smooth, rhythmical and accurate harmonial activity performed in correct sequence of action of the group of muscles called as coordination. Lack of coordination is said to be incoordination or asynergia.

Incoordination is the jerky, inaccurate non-purposeful movement done by the group of muscles.

CAUSES

Flaccidity

Any of the lower motor lesion results in the flaccidity. In this case the nerve impulses cut-off before reaching the muscles. Muscles said to be paralysed and are otherwise called as atonic muscles. There is loss of muscle action, due to less venous drainage, lack of blood supply and loss of muscle bulk. As the result of weakness the patient cannot perform the movement in coordinate manner. There will be a lack of fluency in performing an activity, so that these movements are said to be incoordinate movements.

Spasticity

Upper motor neuron lesion results in spasticity. Tone of the muscle is more and muscles are tight and contracted. Spasticity never occurs in one group of muscles. It is always part of a total flexor or total extensor synergy. Due to the spasticity in nature of the muscle it produces the abnormal movements. The movements may not be in rhythmical and coordinate manner.

Cerebellar Ataxia

Cerebellar lesion results in incoordinated movements. Normally, the muscles are hypotonic. There will be "ataxic" type of gait. A-without, taxic-order without the higher center order the body parts show swaying, ill-timed, dyssynergic movement. Teamwork of the muscles being lost. Dysarthria—difficulty in speech, scanning speech is the commonest feature in it. Intentional tremor, difficulty in achieving the accurate distance of movement (dysmetria), loss of the alternating the movements (Dysdiadokokinesia). For example, supination and pronation, oscillation of eyeball (Nystagmus) are the clinical features of this condition.

Loss of Kinesthetic Sensation

Loss of kinesthetic sensation seen in the neuropathic joints. These types of joints are called as Charcot's joints. This variety is seen in Tabes dorsalis, syringomyelia, leprosy, and diabetes mellitus.

Tabes Dorsalis

Otherwise called as posterior column disease. Posterior column of the spinal cord involved in this case, so that sensory loss is the major clinical feature of this condition. Pain over the girdle and the lightning type of pain presents.

Sensory ataxic gait: Patient feels like walking on the cotton wool due the loss of sensation. Eyes are fixed on the ground, legs lifted in the air and stamp on the floor forcibly. This type of walking is called as "space walking". There will be clumsiness and incoordinate movements. Joints lost its proprioceptor sensation and the joints are called as Charcot's joints. Photophobia, ptosis, diplopia, paralysis of the external ocular muscles, bowel and bladder problems are the other clinical features of this condition.

Syringomyelia

It is a chronic progressive disorder in which the cavitations develop in the spinal cord. It may extend up to cervical region sometime up to brainstem is called as syringiobulbia. Loss of sensation and motor loss presents throughout the upper and lower extremity. Small muscles of the hand involve more and the lower limb involve with the spastic paraperesis. Nystagmus, vertigo, and Horner's syndrome are common in it. Sensory loss over the joints leads to loss of proprioceptor functions (Charcot's joints). Normally, 5th cranial nerve involvement is seen, thickening of the subcutaneous tissues, necrosis of the bone, ulcer also one of the most commonest features.

Leprosy

It is caused by the *Mycobacterium leprae*. Small patches and hyperpigmented macules are seen all over the body. It is commonly of two types: (1) Tuberculoid, (2) Lepromatous. Skin over the face thickened, eyebrows and eyelashes becomes scanty, ear lobe enlargement, iritis, karatitis, destroying of nasal cartilage, hoarseness of voice, lymph node enlargement, testicular atrophy, gynecomastia, edema over the face and hand are the commonest features.

Peripheral neuritis and thickening of the nerve is commonly seen. Because of the inflammation of the nerve, sensory and motor loss over the extremity is seen. Mainly ulnar nerve and the common peroneal nerve affects more, clawhand deformity and footdrop presents. Joints loses its sensation, i.e. proprioceptor function (Charcot's joint). Joints are swollen and painless, patient feels like walking on the cotton wool.

Diabetes Mellitus

There are two types of diabetes mellitus, they are: IDDM (Insulin Dependent Diabetes Mellitus), NIDDM (Non-Insulin Dependent Diabetes Mellitus).

Atherosclerosis, cataract, retinopathy, diabetic dermatopathy, diabetic neuropathy is the most commonest features. Mostly all the systems are involved in diabetes mellitus (cardiovascular, respiratory, digestive, nervous, renal, sensory, musculoskeletal, reproductive). Peripheral neuropathy is the most important feature in the chronic stage. It leads to motor and sensory loss over the extremities. Normally, lower limb affects more. There is proprioceptor dysfunction over the joints (Charcot's joint), because of the loss of sensation over the joints. Due to the proprioceptor dysfunction, the patient cannot recognize the posture of the limb. Muscles become hypotonic and lead to early tiredness, so that the patient

could not perform the purposeful, rhythmical and harmonious movement.

TESTS FOR INCOORDINATION

Upper Limb

Finger Nose Test

Patient is asked to touch the tip of the index finger of the one hand and the nose alternatively with the index finger of another hand. In cerebellar disease, the patient touches the nose with the wavy and oscillatory motion (here and there) and finally touches the nose. In posterior column disease, the patient can touch the nose accurately with eye-opening but he cannot with closed eyes.

Finger-to-Finger Test

Patient is asked to abduct both the shoulders 90° with elbow in extension and ask the patient to bring both the index finger towards midline and touch each other. Cerebellar diseased patient may touch each other by the wavering and oscillating fashion. But the posterior column diseased person can touch accurately with opened eyes, but not with closed eyes.

Rapid Alternating Movement

The patient is asked to do the pronation and supination movement alternatively. In cerebellar lesion the patient feels difficulty in performing this movement, this phenomena is called as dysdiadochokinesia.

Lower Limb

Finger Toe Test

The therapist's finger is pointed two feet above the patient's great toe and instructs him to touch with the great toe. The cerebellar disease patient can touch the finger with the oscillatory or light bouncing movements. But it can be done accurately with the opened eyes but not while closed by the posterior column diseased patient.

Heel-Shin Test

Patient is asked to touch the knee with the opposite side heel and is sliding on the shin towards the great toe. Same test is asked to the patient to perform without rubbing on the shin. In cerebellar disease, the heel is carried up to overshoot the knee. If the heel is carried down, it begins to execute an action tremor. In posterior column disease the patient cannot perform it due to the inability to recognize the position of the joint.

Romberg's Test

Patient is made to stand straight with the eyes opened. Then the patient is instructed to shut the eyes. Patient may begin to sway and may even fall if he is not supported, it occurs the patient with posterior column disease. But cerebellar diseased patient can stand even the eyes are closed also.

CORRECTION OF INCOORDINATED MOVEMENTS

Flaccidity

Muscle weakness and the muscular paralysis can be analyzed with help of the muscle power grading techniques. Whenever the muscle is weak and paralyzed the person should undergo strengthening and endurance exercises. Strengthening program is modified depends on the muscle power and has to be performed by the patient with the supervision of the therapist to increase.

Spasticity

Aim of the treatment is to reduce the tone and relax the muscles while treating the spasticity cases. Soft tissue stretching, PNF techniques

and spasticity relieving techniques are used to reduce the spasticity. Regular active movements also may reduce the spasticity. Reduction in spasticity is mentioned in the stretching and active movement chapters.

Loss of Kinesthetic Sensation

Neuropathic joint patients are normally unaware of the joint movement and posture due to the loss of proprioceptor activity. Their walking patterns like the "space walk". They raise their foot up in the air and stamp on the floor forcibly. Loss of joint sense leads to disuse of the limb, which leads to the hypotonia of the muscle. This lack of joint sense and the hypotonia of the muscle together results in the incoordinated movement of the limb. To improve the joint sense and convey the kinesthetic sensation, the alternative nervous pathway has been selected. To improve the kinesthetic sense and coordination due to posterior column disease Frenkle's exercises are mostly used.

Cerebellar Ataxia

The main aim of the treatment is to improve the stability and balance of the trunk and the proximal joints while treating the cerebellar ataxic case. The stability as well as balancing training has to be practiced by the patients depends on the degree of the disability. According to the degree of disability patient may adopt some particular posture. Stability and balancing trainings are explained for each and every position in the "Functional Re-education" chapter.

Hypotonia is the main clinical feature in this disease. Isometric exercise program, strengthening and endurance, PNF techniques have to be practiced by the patient to improve the coordinated movement, some of the coordinated exercises can be followed from the Frenkle's exercise also which is mostly used for the sensory ataxia.

FRENKLE'S EXERCISE

This is the specialized exercise regimen for the sensory ataxia patient. It was presented by Dr HS Frenkle who was the Medical Superintendent of the sanatorium, Freihof in Switzerland in the end of the last century. He made the special study on the Tabes dorsalis patients and derived the procedure for treating the sensory ataxia. These sensory ataxia patients are having chief complaints of loss of impulses, lack of voluntary control of movements. These two problems are compensated by the sensory mechanism, which is intact, i.e. vision, hearing, and touch.

Principles

1. Concentration
2. Precision
3. Speed and range
4. Command
5. Repetition
6. Complication.

Concentration

The patient has to be positioned to watch the every movement, which he performs. Normally, half-lying position is adopted during the treatment session. The patient must give full attention on the movement, which he performs. This attention of the movement may create the proprioceptor activities over the joint. The visual watching the movements are recorded in the brain and it may improve the kinesthetic sense. Regular movements of the joint also may induce the proprioceptor activity.

Precision

The movements should be accurate and rhythmical. There should not be any jerky, arrhythmic, and inaccurate movements. Because the movement which the patient performs will be recorded in his brain through the visual pathway. The alternative sensory

pathway will set depends on the movements which the patient performs.

Speed and Range

Quick movement needs less control than the slow movements. So, normally slow movements are recommended to perform by the patient. The speed should maintain slow and in even tempo throughout the exercise regimen. Larger joints are concentrated more than the smaller joints; and also big movements are concentrated than the small movements. Selected attain range should be reached during each and every movement accurately and slowly. The therapist directs speed by using the command, using hand, counting number or by using music.

Range will be selected depends on the functional useful range, i.e. normal day-to-day activity. The range need not to be in fullest range, selected range movements indicated by marking the spot over the couch or by the therapist placing the finger in the air.

Command

Audition is another source of the sensory mechanism to compensate the proprioceptive activities and involuntary movements. Commanding is the very much necessary source to perform and progress the activity. With the command we can alter the speed, range of the movement, which the patient perform. All the instructions are mostly given by the form command in this exercise regimen.

Complexity

Complexity introducing in the exercise regimen improves the coordination as well as proprioceptive activities. It may increase the concentration power and memorizing capacity of the brain on particular movement pattern. Complexity made by commanding the patient to touch the specific numbered mark alternatively.

Repetition

The movements are repeated until the accurate movement performed by the patient. The repetition of the accurate movement improves the kinesthetic sense and the coordination. The exercise will be discarded whenever the patient feels tired. Frequent rest period must be allowed, repeating the movements are helpful for the cerebrum to record and memorize one particular movement perfectly.

Preparation of the Patient

- Patient is positioned in convenient posture normally half-lying posture by which the patient can watch the movement performed by him.
- Selected range is decided and the distances between two points are marked in the couch by the chalk according the agreed count. Normally, 4 counts are made, if the patient attains the range, the additional count will be added.
- Untreated parts should be covered by the blanket to protect privacy of the patient.

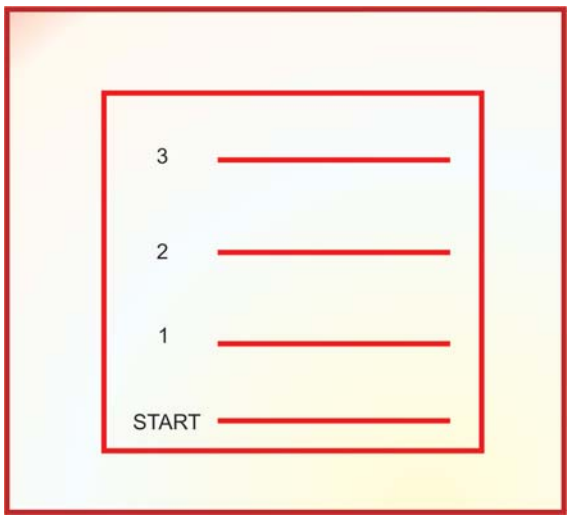


Fig. 14.1: Marks for counting

- Proper demonstration about the exercise program to the patient. The patient must know the correct picture about the exercise (Fig. 14.1).

Progression in the Exercise Program

A polished re-education board or non-slippery surface is used for the exercise programme.

1. Dragging the limb on the board and touching the marked spot with the voluntary halt.
2. Dragging the limb on the board and touching the marked spot with the halt on command.
3. Limb unsupported movements.
4. Unsupported movements touching the marked spot with voluntary halt.
5. Limb unsupported touching the marked spot with the halt on command.
6. Limb supported touching the opposite side body specific points with the heel or finger by voluntary halt. (For example, with the heel, touching the opposite side toes, ankle, shin, knee. With the finger, touching the opposite side fingers, wrist, forearm, elbow, arm, shoulder).
7. Limb unsupported touching the opposite side body specific points with the heel or finger by halt on command.
8. Touching the finger, which is placed in the air by the therapist.

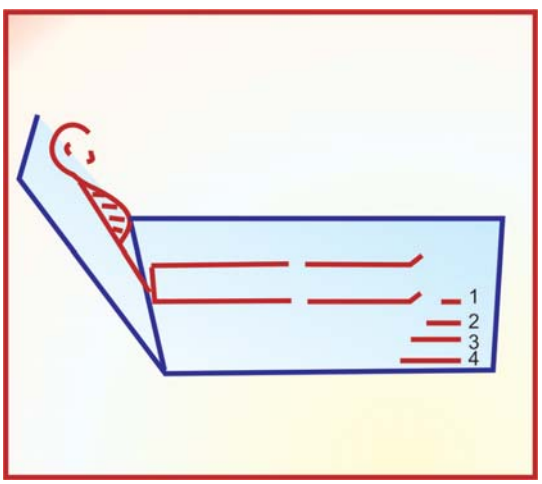


Fig. 14.2: Hip abduction and adduction movements

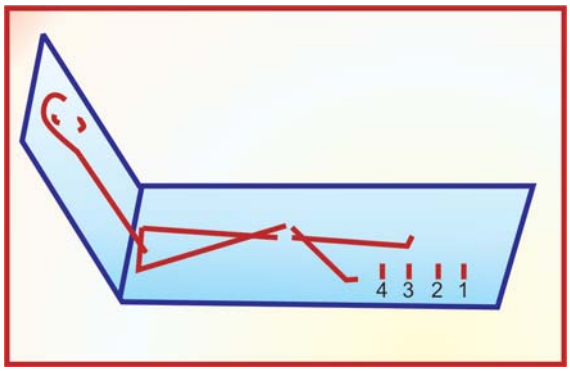


Fig. 14.3: Hip and knee flexion and extension movements

9. Therapist placing finger in the air and moving here and there, the patient reaches the point.

According to the grade of disability the exercise is started (Figs 14.2 and 14.3).

Lying

Upper limb

- Half-lying—Abduction and adduction of shoulder.
- Half-lying—Wrist flexion, extension, ulnar and radial deviation.
- Side lying—Flexion and extension of elbow.
- Side lying—Flexion and extension of shoulder.

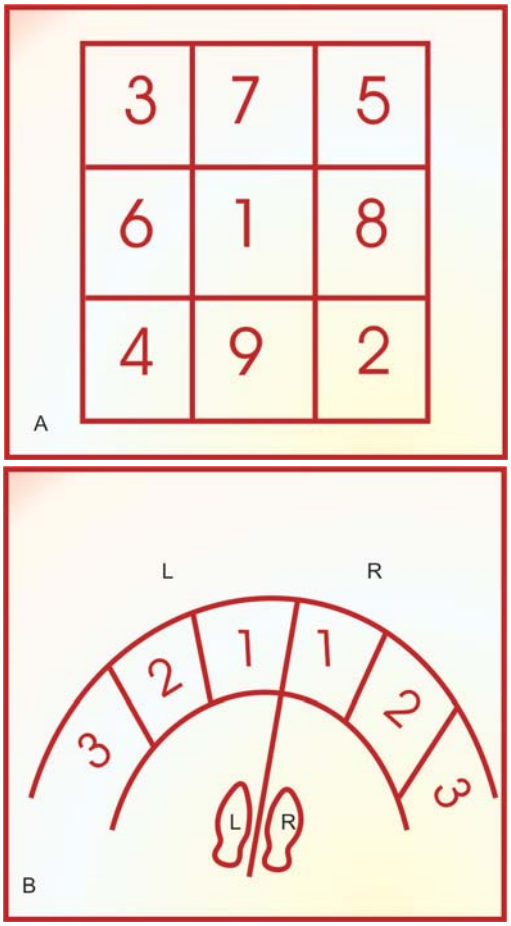
Lower limb

- Half-lying—Abduction and adduction of hip.
- Side lying—Flexion and extension of hip.
- Side lying—Flexion and extension of knee.
- Half-lying—Flexion and extension of hip and knee.

Sitting

Lower limb

- Sitting—Knee flexion and extension.
- Sitting—Hip abduction and adduction.
- Sitting—Dragging the foot and placing over the marked point or numbered board half and halt on command.



Figs 14.4A and B: Lower limb movements in sitting

- Sitting—Foot unsupported and placing over the marks.
- Sitting—Unsupported foot and touching the therapist's finger, which is placed in air.
- Sitting—Standing and sitting down.
- Sitting—From long sitting toilet training.
- Sitting—Hitching, hiking movements.
- Sitting—Walking on the buttocks.
- Sitting—Beginning stage sit with the upper limit support later without the upper limb support.

Upper limb

- Sitting—Alternating the movements like supination and pronation, flexion and extension, closing and opening the fist, touching the finger tips with the thumb.
- Sitting—Reaching the therapist's finger, which is placing in the air.
- Sitting—Pegboard exercises.
- Sitting—Separating the same colored blocks from the box.
- Sitting—Constructing some objects with help of the blocks.
- Sitting—Transferring the ball from one hand to another hand.
- Sitting—Pushing and punching movements.
- Sitting—Elbow flexing and touching the shoulder with the palm.
- Sitting—Combing, drawing, tying the shoelace and normal household activities (Figs 14.5 and 14.6).

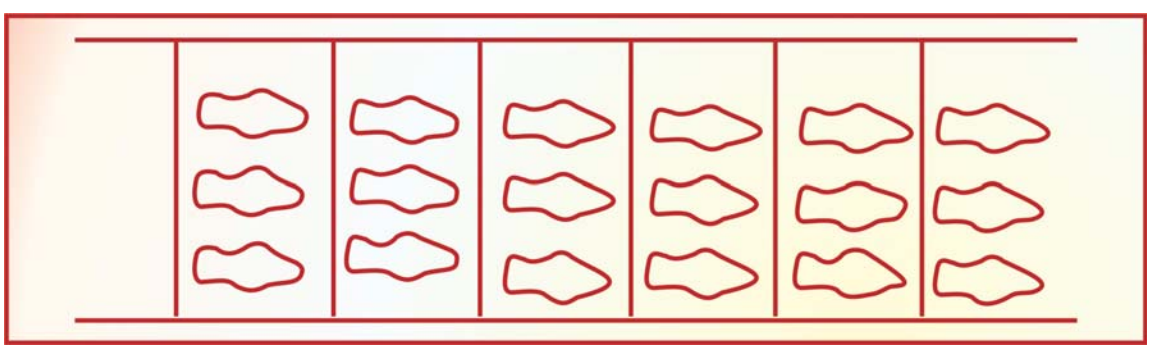


Fig. 14.5: Frenkle's mat

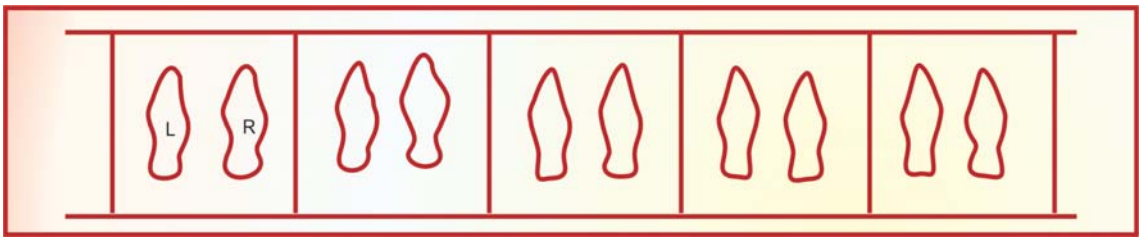


Fig. 14.6: Side walking training

Standing

- Standing with the support is practiced first.
- Walking training with help of the parallel bars.
- First train the walking with wider base later changed into narrow base.
- Frenkle's mat is used to improve the walking skill.
  1. Walking on the both side footprints by leaving the middle footprints with the "swing to" gait, i.e. right foot forwards and left foot up to it.
  2. As said above with the "swing through" gait, i.e. right foot forwards and left foot through and forwards. This type of walking increases the base.
  3. Walking on the middle and one-side footsteps to reduce the base with the 'swing to' gait, same like 'swing through' gait. Sideways walking can also be practiced.
  4. Turning can be practiced with pivoting and lifting and placing on the footmarks.

Pivoting (Fig. 14.7)

The turning is done towards the weak side. The weak side will be stable in one point and rotating with the fixed axis and another leg is lifted and kept on the marked place, e.g. right side. Right foot is rotated or turned 90° and the left foot is raised and placed parallel to the right foot.

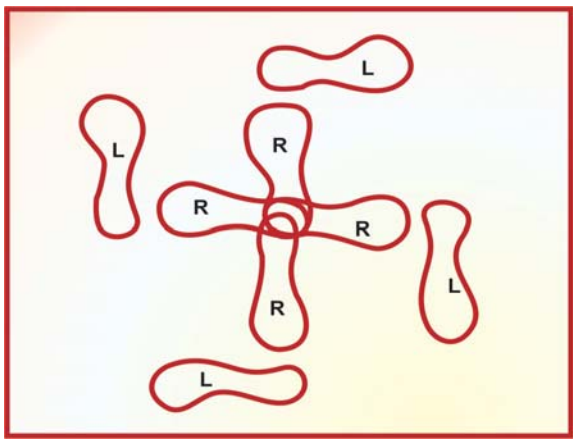


Fig. 14.7: Pivot turning

Lifting and Turning

This is the progression from the pivoting, e.g. right side. Right side is lifted and turned 90° and placed on the floor and the left leg also lifted and placed parallel to it. Some of the coordination, balancing and stability exercises for each and every posture are explained in the 'Functional Re-education' chapter.

15
CHAPTER

Mobility Aids

DEFINITION

The appliances or devices, which are useful for the mobility as well as stability purpose of an individual who cannot walk independently without any support, called as mobility or walking aids.

These devices are mostly prescribed for the below mentioned cases :

- Pain
- Muscle weakness
- Problem in balancing
- Fractures
- Joint diseases
- Injured or inflamed limb
- Lack of proprioception.

(*In simple view:* Mobility aids useful for muscle skeletal and neuromuscular problems). These mobility aids reduce the weight-bearing from the lower limb. There are six (6) major varieties of mobility aids:

1. Crutches
2. Canes
3. Walkers
4. Wheelchairs
5. Braces and splints (orthosis)
6. Prothosis.

Arthosis and prostheses also useful for the mobility as well as support. These are not described in this book (Fig. 15.1).

Fig. 15.1: (A) Elbow crutch, (B) Cane, and (C) Axillary crutch

CRUTCHES

Crutches are used mostly to relieve the weight-bearing in the one or both the lower extremities and provide additional support where the balance is impaired for the patients. At present three types of crutches are available:

1. Axillary crutch
2. Elbow crutch
3. Gutter crutch.

Axillary Crutch

Axillary crutch provides the maximum stability and support to the patient than any other crutches. It gives more than 80 percent of stability. So that it can be recommended for the patient having marked instability in walking. It is made of aluminium, steel materials, and sometime by the wood.

Parts of Axillary Crutch

Axillary pad: Axillary pad situated at the top portion of the crutch. It should be placed 5 cm below the axilla, if not the axillary pad compresses the axilla causes the neuropraxia of the axillary nerve, radial nerve or brachial pluxes. Normally, this axillary pad is made-up of metal and is covered by the cushion materials to avoid the damage to the lateral aspect of the chest wall. The axillary pad placed in the lateral wall of the chest to provide the improved lateral stability.

Handgrip: It is made-up of plastic material, and sometimes covered by the cushion material. Handgrip normally comes around the greater trochanter area of the person using it. It has the adjustable clips or screws to adjust the height and push button handgrips also available.

Rubber ferrule: It is situated in the lower end of the crutch. This rubber tip provides more grip for the patient while walking in the normal/ slippery surface.

Axillary Crutch Measurement

Before giving the crutch to the patient, it should be measured perfectly because lengthier crutch may cause the compression over the axilla, which leads to neuropraxia. Sometimes if it is small, the patient's gait pattern may change or it may cause some other complication like backache.

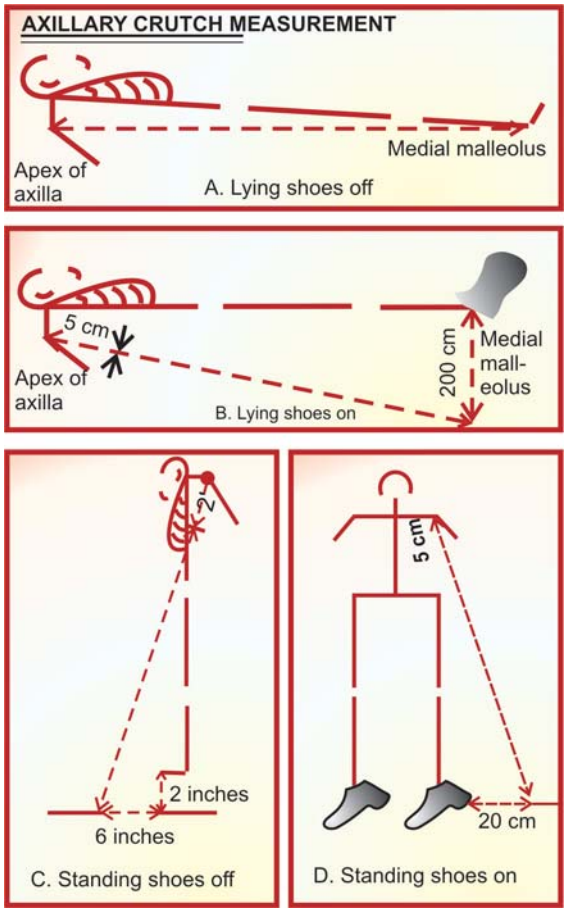


Fig. 15.2: Axillary crutch measurement

Measurement

1. Shoes off
   - Lying
   - Standing.
2. Shoes on
   - Lying
   - Standing.

Shoes off

Supine lying: While patient is in bare foot this type of measurement has to be taken the measurement from the apex of the axilla to

the medial malleolus. It is the accurate method to measure the crutch length.

Standing: 2 inches below the axilla to the 2 inches lateral and the 6 inches anterior to the foot when the patient is standing.

Shoes on

Supine lying: This type of measurement taken to the patient wearing the shoes. The measurement taken from the 5 cm below the apex axilla to the 20 cm lateral to the heel of the shoe. It is not accurate method of measuring the crutch length.

Standing Same like the shoes off method measurement has to be taken in the standing position.

Handgrip Measurement

The measurement taken from the 5 cm below the apex of the axilla to the ulnar styloid process in the elbow in 20°-30° flexed position.

Weight Transmission

Elbow is extended and the weight is transmitted to the handpiece. So that the pressure over the axilla is reduced.

Elbow Crutch

It gives less stability than the axillary crutch. It renders 60 percent of stability to the patient using it. So, elbow crutches recommended for the patient having the minimal in stability in walking. It is made up of aluminium or plastic sometime stainless steel metals.

Parts of Elbow Crutch

Forearm cuff: The forearm cuff made by metals and is coated by the plastic or cushion materials. Forearm cuff placed just below the elbow joint.

Single upright: It has the proximal adjustable press clips and the distal adjustable press clips. The proximal press chips adjust the height of the forearm cuff and the digital press clip helps to adjust the height of the crutches.

Handpiece: Handpiece placed junction between the proximal and digital adjustable press clips and the handpiece comes around the greater trochanter region of the person using it.

Rubber ferrule: It affords more grip even while walking in the slippery surface too.

Weight Transmission

Same like axillary crutches the weight is transmitted to the handpiece when the elbow is extended.

Elbow Crutch Measurement

The measurement taken from the ulnastyloid process with the elbow in 20°-30° flexion to the 20 cm lateral to the heel or the heel of the shoes.

Gutter Crutch

This is also made up of metal and it contains the forearm pad with the supporting strap, adjustable handpiece and rubber ferrule. These types of crutches are mainly used for the rheumatoid hand and those who cannot weight bear through the wrist and hand for example, fracture wrist or dislocation. The length of the crutch and handpiece position can be adjustable.

Measurement

In standing: The measurement is taken from the elbow to the floor.

In lying: The measurement taken from the point of the flexed elbow to 20 cm lateral to the heel (shoes on).

Pre-crutch Training

Before making the patient walk with the crutches, the therapist has to assess the patient whether the patient is capable of using the

crutch by his own or not. The important thing that is needful walk the crutches should be assessed mainly.

- Psychological state of the patient
- Crutch muscles
- Balancing
- Gait pattern

Psychological state: The mental acceptance is the very important factor to make the patient practice the crutch walking. First of all patient has to cooperate with the therapist to learn the gait pattern with the help of his mental stability and support. If the patient doesn't have the mental acceptance of the crutches, the therapist should explain about the problems and the needs of the crutch for the ambulation and independent. Mainly the therapist has to gain the confident of the patient to make him practice the crutch walking. Normally, many of the patients doesn't accept to adopt the crutch due to the social status and their economical status. Making the mental acceptance of the patient plays the main role in the gait-training program.

Crutch muscles: To walk with the crutch the patient needs the good strength or power in some group of muscles. So, the therapist should assess the crutch muscles whether it has normal power or not. They are:

- Shoulder: Depressors, extensors, adductors
- Elbow: Extensors
- Wrist: Extensors
- Finger: Flexors
- Hip: Extensors, adductors
- Knee: Extensors
- Ankle: Plant flexors
- Toe: Flexors.

If the muscle power is less, it should be strengthened. The strengthening programme can be given with the crutches itself, instead of strengthening with weights, springs and other resisted instruments.

Examples

- *Supine lying:* Shoulder abduction, adduction, elevation, depression can be done with the crutches.
- *Side lying:* Shoulder flexion and extension can be done with crutches.
- *Standing:* All the above mentioned exercise can be done.
- Hanging ropes or chains can be fixed in the top of the bed. It is helpful for the patient's bed activities as well as for strengthening the upper limb.

Balancing: Balancing is the important criteria to be assessed, because lack of balance leads to falling while walking which causes some other complication like injury or re-fracture. If the patient lacks balance in sitting or standing, it has to be treated first before going for crutch walking .The balancing training has to be given as mentioned in the chapter functional re-education training.

The therapist or the assistance has to support the patient while walking first time to avoid the inbalance of the patient. Until he gets the stability and balance the same has to be continued, making the patient walking in the parallel bar also can do another alternative.

Gait Pattern

The therapist should teach the gait pattern which patient has to walk. The therapist teaches the needed gait pattern depends on the condition of the patient that is non-partial, full weight-bearing walking. All the instructions like do's and don't in the crutch walking and about the progression techniques and changing of the pattern has to be taught. The therapist himself should walk in front of the patient, how the patient has to walk with the crutches.

Pattern of Crutch Walking

The therapist or the assistant has to hold or support the patient while he walks for the first

time. The therapist has to give the instruction when the patient does any mistake.

- Non-weight-bearing gait—Good first (Crutch or limb)
- Partial weight-bearing gait—Bad first (Crutch or limb)
- Full weight-bearing gait—Bad first (Crutch or limb)

Floor walking rules:

a. Non-weight-bearing—Good first (Crutch or limb)
b. Partial weight-bearing—Bad first (Crutch or limb)
c. Full weight-bearing—Bad first (Crutch or limb)

Non-Weight-Bearing Gait

Patient stands with the triangular base. The affected side leg never carries the weight is non-weight-bearing gait. The patient with the brace, long cast, POP, fracture limb. Early stage of joint replacement surgery open reduction internal fixation needs this type of non-weight-bearing gait.

- 3-point gait
- 2-point gait
- Shadow walking (4-point gait).

3-point gait

a. Unaffected side crutch
b. Affected side crutch
c. Unaffected leg.

In the early stage the patient has to keep his unaffected leg behind the crutch line is called as 'swing-to' gait. Once the patient mastered it can keep the leg beyond the crutch line is called as 'swing-through' gait.

2-point gait: It is the progression from the 3-point gait (Fig. 15.3).

a. Unaffected side crutch and effected side crutch.
b. Unaffected side leg.

Progression

Early stage—Swing-to gait
Later—Swing-through gait.

Shadow Walking

This is the progression from the 2-point gait. In this the affected leg contacting the ground but not carrying the weight on it.

a. Affected and unaffected side crutch.
b. Unaffected leg.
c. Affected leg without weight-bearing.

Partial Weight-Bearing Gait

This is the progression from the shadow walking. The weight added gradually and the amount of the bearing the weight can be measured by the weighing machine. Patients who are recovered from fractures, internal fixation, joint replacement surgery and early stage from removal of POP are eligible to recommend for the partial weight-bearing walking. The grade of the weight-bearing protocol may vary from surgeon to surgeon.

a. Four-point gait
b. Three-point gait
c. Two-point gait.

Four-point gait

1. Affected side crutch
2. Unaffected side crutch
3. Affected leg
4. Unaffected leg.

Progression

Early stage—swing-to
Later—swing-through.

Three-point gait

1. Both the crutches
2. Affected leg
3. Unaffected leg.

Progression

Early stage—swing-to
Later—swing-through.

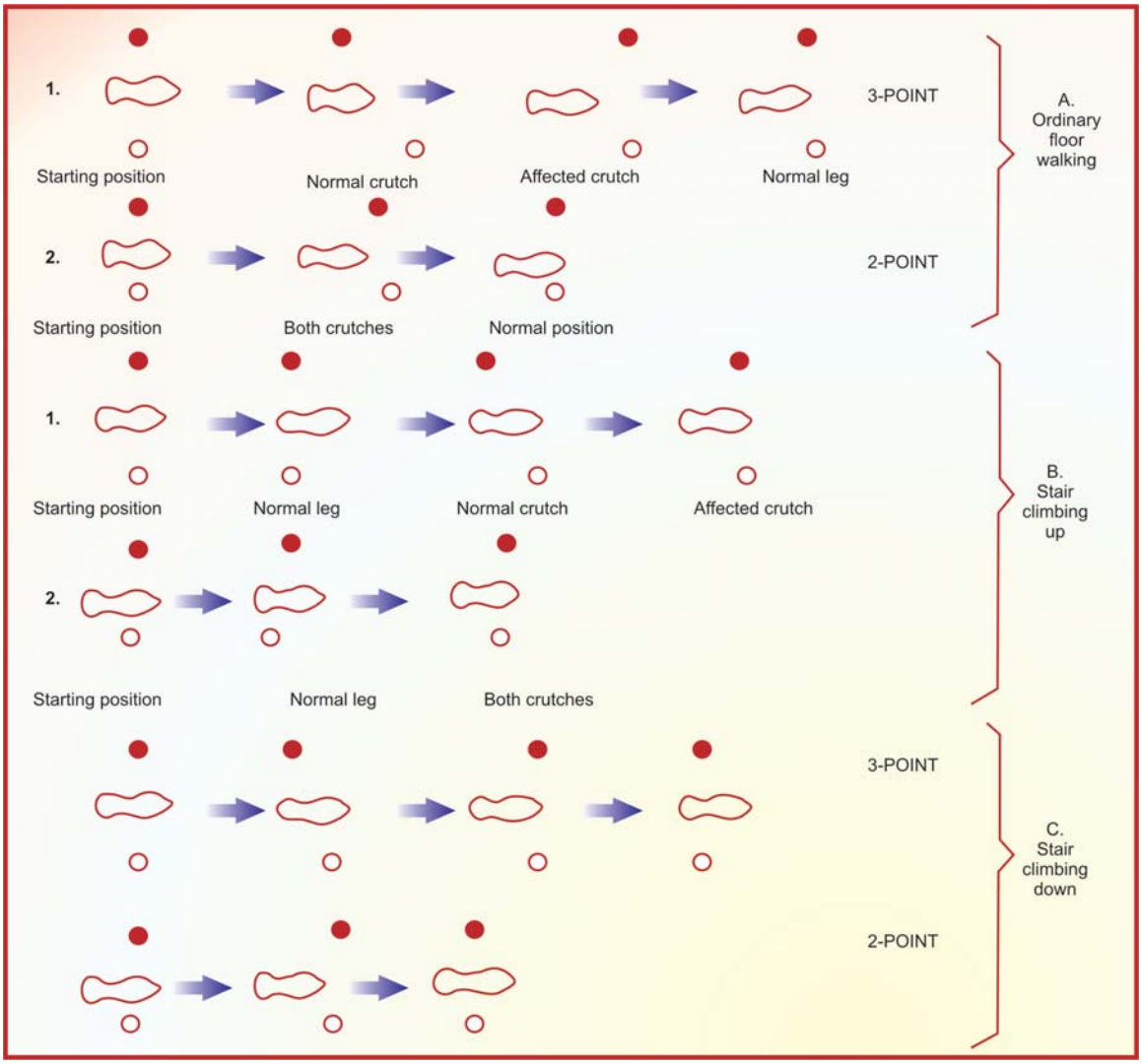


Fig. 15.3: Non-weight-bearing walking

Two-point gait

In this two-point gait, two methods are used.

Method I

i. Affected and unaffected crutch with affected leg.
ii. Unaffected leg.

Method II (Fig. 15.4)

i. Unaffected crutch with affected leg.
ii. Affected crutch with unaffected leg.

Full Weight-Bearing Gait

This is the progression from partial weight-bearing. The walking pattern is same like the

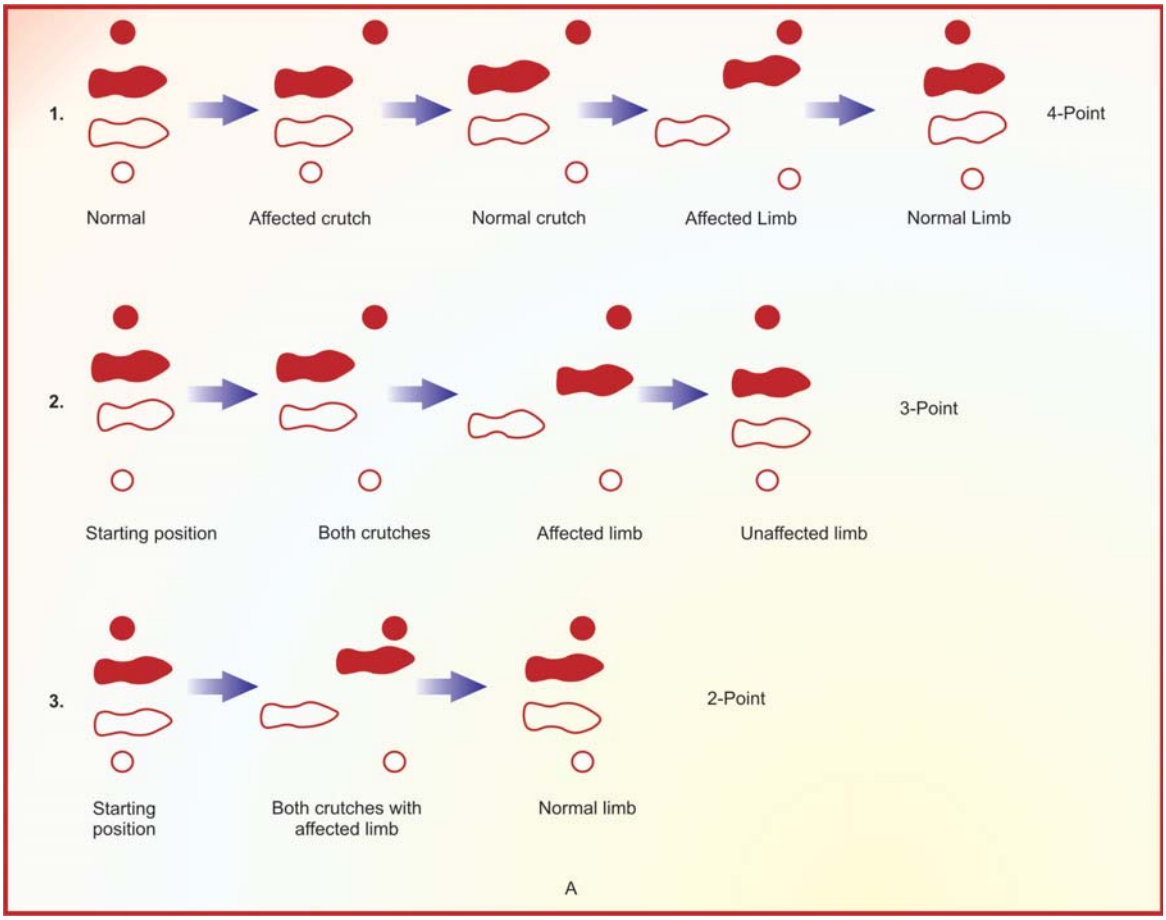


Fig. 15.4A

partial weight-bearing walking. The patient who can able to transfer more weight to the affected side after immobilization are eligible for this type of weight-bearing walking.

Stair Climbing

Rules

- Good to heaven bad to hell.
- Leg placed first while climbing up.
- Crutch placed first while coming down.

Climbing-up

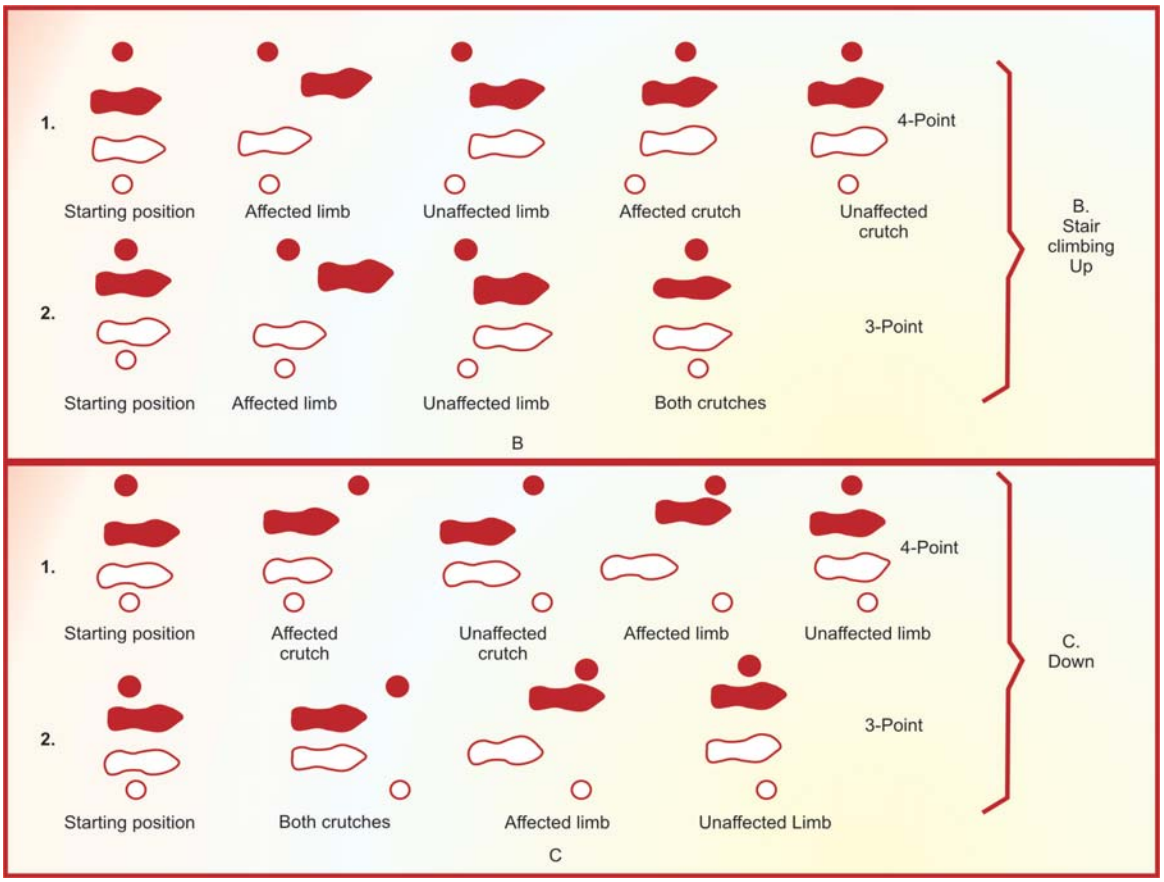
- Non-weight-bearing
- Partial weight-bearing
- Full weight-bearing

Non-weight-bearing.

- Three-point
- Unaffected leg
- Affected crutch
- Unaffected crutch

Two-point

- Unaffected leg
- Affected and unaffected crutch



Figs 15.4B and C
Figs 15.4A to C: Partial weight bearing walking

Partial weight-bearing
- Four-point gait
  - Unaffected leg
  - Affected leg
  - Affected crutch
  - Unaffected crutch.
- Three-point gait
  - Unaffected leg
  - Affected leg
  - Affected and unaffected crutches.

Full weight-bearing is like partial weight-bearing gait (Figs 15.5 and 15.6).

Climb Down (Figs 15.7 and 15.8)

Non-weight-bearing
Partial weight-bearing
Full weight-bearing

Non-weight-bearing
Three-point
- Unaffected side crutch
- Affected side crutch
- Unaffected leg.

Two-point
- Unaffected and affected crutches
- Unaffected leg.

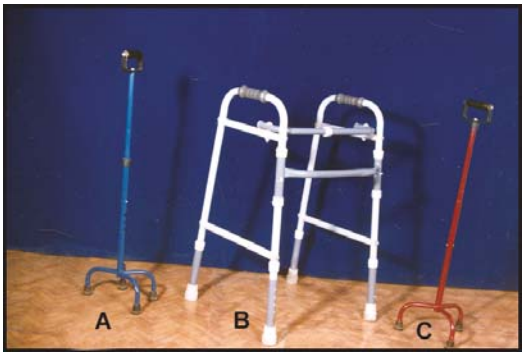
Figs 15.5 and 15.6: Supporting the patient while climbing up and down

Partial weight-bearing

Four-point

- Affected crutch
- Unaffected crutch
- Affected leg
- Unaffected leg.

Fig. 15.7: A. Standard canes, B. Standard adjustable canes, and C. Adjustable offset canes



Figs 15.8A to C: A. Tripod, B. Walker, and C. Quadruped

Three-point

- Affected and unaffected crutch
- Affected leg
- Unaffected leg.

CANES

Canes are not normally recommended for the non-weight-bearing and partial weight-bearing cases. It is useful for increasing the base of support and to improve the balance. Canes are preferred to provide opposite to the affected side. During the normal gait, the stance hip

abductors counterbalances the swinging hip and prevent it from tilting. It may create the compressive force in the stance hip. Providing the canes in the stance side upper limb reduces this force and straining in the stance side hip.

Types of Canes

1. Standard canes
2. Standard adjustable canes
3. Standard adjustable offset canes
4. Tripod canes
5. Quadruped canes.

Standard Canes

- It is made-up of aluminium, wood and plastic.
- It has the curved or half-circled handpiece.
- It is not a height adjustable one. It has to be made depends on the height of the patient.
- It is inexpensive and can be carried anywhere.
- Normally, it is recommended for the elderly patients.

Standard Adjustable Canes

- It is also made-up of aluminium and may be having the plastic covering.
- It has the curved or half-circled handpiece.
- It is having the height adjustable press clips.
- This is also easy to carry anywhere else.

Adjustable Aluminium Offset Canes

- Upper half of the cane is offset anteriorly so that the LOG falls on the cane and it gives more stability. It may be available in the standard and standard adjustable canes.
- It too has the adjustable screws or press clips.

Commonly all the sticks are having the handpiece and the rubber ferrule except the wooden made standard canes. The handpiece comes up to the greater trochanter level for the person using it.

Quadruped and Tripod Canes

- It has the 4 or 3 leg with the rubber tip and it gives the broader base. As the result the BOS in this varieties of canes are huge.
- Sometime the upper portion of the cane is offset anteriorly.
- It gives more stability than any other varieties.
- This is more useful for the neurological cases like hemiplegia and other elderly patients who had the injury of the lower limb.
- Height adjustable clips or screws are available.
- It is difficult to carry the cane in the staircase if the base is broader.

Gait Patterns

The patient's muscle power, stability, and the psychological state should be assessed as said in crutch training. If needed all the factors should be rectified before going for the gait training. Normally, while using the canes, the patient must have the maximum weight-bearing capacity. The canes are used in the unaffected side and it is placed close to the body-line, otherwise the dynamic stability may be decreased. There are two types of gait patterns.

- Three-point gait
- Two-point gait.

Three-point gait

- Cane
- Affected leg
- Unaffected leg

Progression

- Early stage—swing-to
- Later—swing-through

Two-point gait

- Canes and affected side leg
- Unaffected side leg

Stair climbing technique

Three-point gait

Ascending

- Unaffected leg
- Affected leg
- Cane

Descending
- Affected leg
- Cane
- Unaffected leg

Two-point gait

Ascending
- Unaffected leg
- Affected leg and cane

Descending
- Affected leg and cane
- Unaffected leg.

WALKERS AND WALKING FRAMES

It may be useful for the non-weight-bearing, partial weight-bearing, and the full weight-bearing gait pattern. It gives more stability as it has the broader base. Since the COG falls within the base of support, it gives anterior as well as lateral stability. The walker is having two anterior and two lateral bars, the horizontal bar connects all the vertical bars in three sides, and one side is kept opened.

Normally, the therapist and the doctor avoid prescribing walker to the patients because if the patient practice with the frame never walk proper gait pattern, while progressed to the cane, crutches, sticks. It takes more time to adopt other walking aids by the patient.

1. Rigid walking frame
2. Foldable walker
3. Gutter walker
4. Rollator
5. Reciprocal walker.

Rigid Walker

This is the standard type with above said features it has the handgrip and rubber ferrule. The patient has to lift and place it front and walk. It is difficult to carry easily in and out of the house.

Foldable Walker

It has all the features of rigid walker except the folding nature. It is easily foldable and kept in a store place. It is also easy to carry while traveling.

Gutter Walker

It is also having the entire feature like rigid walker and additionally it has the forearm platform instead of the handgrip. It is more helpful for the patient who has the problem over the wrist (RA, wrist bone fracture, wrist or hand injuries).

Reciprocal Walker

This is designed to allow unilateral forward movement of one side of the walker. These types of walkers are useful for the patients who cannot lift and walk with the walker. There will be swivel joints present between the vertical and horizontal bars. One side of the walker moved forward with the opposite side leg followed by it, and the other side of walker with the another leg. So alternatively, each side of the walker moves forward.

Rollator

The anterior vertical bars having the caster and lateral bar remains same as said in rigid walker. While walking the patient has to lift the rear bars off the ground and the wheels moved forward and ends with the rear bar placing on the ground. Rollator is helpful for the patients who cannot lift the walker or needs more stability. It may not be recommended to the elderly patients because it may move fast if the patient looses his stability. Commonly, it is recommended for the children.

Modifications in the Walker

Baskets

Baskets can be attached to the anterior portion of the walker to carry some of their personal items. Sometimes instead of baskets plastics or nylon bags may be used.

Seating Surface

It can be attached in the inner portion of the walker. Generally, it is foldable inside. It is needed for the patient who has the less endurance, e.g. post-polio syndrome.

Glides

The plastic attachment made instead of the rubber ferrule. With the help of the plastic attachment, the patient can drag or slide the walker forward in smooth surface. It is useful for the patient who is unable to lift the walker.

WHEELCHAIR

This is one of the variety of the mobility aids. The patient who has both lower limbs non-functioning or partial functioning has to be recommended for the wheelchair. It is the secondary house for the patient, because he has to spend most of the time with it. It may be modified depends on the condition of the patient. It gives 100 percent stability to the patient. Normally, wheelchairs are recommended for paraplegic, quadriplegic, muscular dystrophy, spinal cord injuries, and fracture conditions. It provides physical as well as mental support to the patient.

Fig. 15.9: Wheelchair

Types of Wheelchairs

1. Rigid
2. Foldable
3. One arm driven wheelchair
4. Powered wheelchair.

The rigid wheelchairs are having the solid frame and also it is lighter. It is mainly used for the sports. It is difficult to carry while traveling.

Foldable wheelchair contains foldable frames and it is very much heavier. It occupies less space, so it is very much easy to carry while traveling also.

One arm driven wheelchairs are used for the patient those who are not able to use their one side upper limb mainly in hemiplegia. This wheelchair is activated and steered by one upper limb. The wheelchair contains two hand rims in one side. One controls (outer ring) the same side wheel; another (inner ring) controls the opposite side wheel. If both the rings are simultaneously used the wheelchair propels in straight line.

Powered wheelchairs are the sophisticated one and are more used in the developed countries like the United States, United Kingdom, and European countries. It can be steered, propelled, adjust the seat hand rest, back rest by the power control.

Parts

Wheels

There are two types of wheelchairs: (1) Solid metal wheel, (2) metal wheel with spokes. In the first variety there is no spokes, it is totally moulded by the metal with some gaps or hole in the flat surface. It never looses its shape due to its solid moulding. Second variety having the spokes instead of moulded flat surface. It is

very much easier to propel forward with this wheelchair. The spokes may break easily with the minimal forced violence. The rim of the wheel may loose its shape if the spokes are broken. The wheel size may change depends on the weight of the patient. The smaller size wheelchair may require more energy to propel forward than the larger variety.

Tyres

Hard polyurethane tyres or pneumatic tyres are used in wheelchairs. Hard polyuerethane with smooth thread are designed for the indoor use or smooth surface maneuverability and does not provide the shock absorption. The pneumatic are air-filled tyres are generally used for the outdoor uneven surface. It gives more shock absorption and smooth mobility. It needs more energy to propel.

Wheel Locks

Wheel locks or brakes can be helpful for slowering or stopping the movement of the wheelchair. Normally, high or low mounted brakes can be used in the wheelchair. High mounted brakes are mainly provided for the limited upper limb activation person.

Casters

These are the small wheels, which are two in numbers and allowing all directional movement. The caster wheel also may contain the polyurethane, pneumatic or semi-pneumatic tyres. Sometimes it also may have the wheel lock or brake.

Hand Rim

There are three types of hand rims, (1) standard metal rim, (2) friction rim, (3) projection rim. Standard rims can be used when the patient has no problem of grip. Friction rims are nothing but the standard rim with the surgical plaster tubing added for the additional grip. Projection rim can be used for the patient with the problem of gripping. It has the number of projection knobs; these knobs are perpendicular to the rim. If the knobs are more, more the inconvenience. Only disadvantage is it increases the width of the wheelchair.

Footrest

It may be fixed or movable. It keeps the foot in neutral position. The footrest with heel loop is leg strap can be added for maintaining the foot in neutral position. It may increase the length of the wheelchair, so that it affects the maneuverability of the wheelchair.

Tilt Bar

It is the projection from the frame, which presents in the back portion of the wheelchair. It is used by the person who pushes the wheelchair. By pushing down the tilt bar with the leg, the wheelchair can be tilted backwards by lifting the caster up.

Seat and Backrest

The seating and the backrest normally are made-up of cushion, sometime metal or canvas seating may be made by depending on the economical state of the patient. The cushion is used for the comfortability and to prevent the pressure sore and these cushions may be air filled or contour foamed. The height of the backrest can be increased for the quadriplegic and high level spinal cord lesion patients.

Indications

1. Quadriplegia
2. Paraplegia
3. Hemiplegia
4. Spinal cord injury
5. Muscular dystrophy
6. Amputation
7. Lower limb fractures.

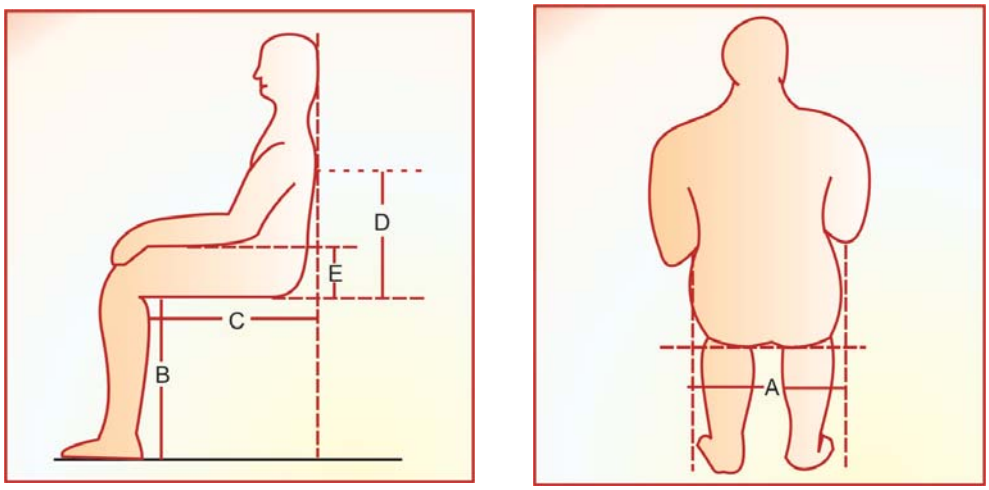


Fig. 15.10: Wheelchair measurement

Measurements (Fig. 15.10)

Seat Width (A): 1 or 2 inches added with the width of the widest part of the buttocks.

Seat height (B): Two inches added with the distance between the bottoms of the heel to the popliteal area.

Seat depth (C): Two inches added with the measurement taken from the popliteal area to the level of the buttocks.

Backrest height (D): Two inches less than the distance between the inferior angle of the scapula and the inferior part of the buttocks.

Arm rest height (E): Elbow kept in 90° flexion and the measurement taken from the buttocks level to the elbow level.

16 CHAPTER

Gait

DEFINITION

It is the forward propulsion of the body by the lower extremity with the coordinated rotated movements of the body segment. The lower extremity support and carries the head, trunk and arm.

Gait is the style, manner, or a pattern of walking. The walking pattern or style may differ from individual to individual. It depends on the age, sex, mood, of an individual and may be due to some diseases. The head, neck, upper limb and trunk contributes of 75 percent of body weight, among this head and upper limb contributes 25 percent of the total body weight, neck and trunk contributes 50 percent of the body weight, and lower extremity contributes 25 percent of the body weight. This activity requires more coordination, balance, kinesthetic sense, proper muscle strength.

GAIT CYCLE

It is the activity, which occurs between the points of the initial contact of the same extremity two times. Gait cycle consists of two phases.

1. *Stance phase:* The activity, which occurs during the foot having the contact with the ground.
2. *Swing phase:* The activity, which occurs during the foot when is not having the contact with the ground.

In normal walking the stance phase contributes 60 percent of the gait cycle and the swing phase 40 percent. When the one lower extremity begins its stance phase, another extremity ends in the stance phase. The

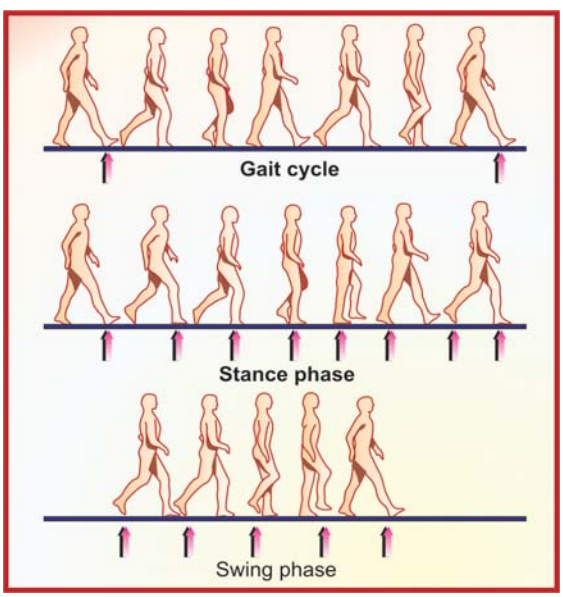


Fig. 16.1: Gait cycle and its phases

Table 16.1: Activities occur during stance phase

Traditional method	*RLA*
1. Heel strike: Heel of the loading extremity touches the ground. This is the beginning of the stance phase results in double support.	1. Initial contact: Heel of the leading extremity strike the ground.
2. Foot flat: The foot totally contacts the ground after the heel strike.	2 Loading response: Starts with the double support and it starts after the initial contact and continues till to the contralateral extremity clears the ground.
3. Mid-stance: This is the stage where the weight is totally transmitted to the weight bearing lower extremity.	3. Mid-stance: It begins when the contralateral lower extremity clears the ground and end when the body comes straight line to the supporting limb.
4. Heel-off: This is the stage at which the heel of the stance phase lower extremity clears the ground after total weight-bearing.	4. Terminal stance: Starts from the end of the mid-stance to the initial contact of the contralateral lower extremity.
5. Toe-off: The stage at which the toe of the reference lower extremity clears the ground.	5. Pre-swing: It is the period of the contralateral lower extremity initial contact and the reference extremity clears from the ground.

Table 16.2: Activities occur in swing phase

Traditional method	*RLA method*
1. Acceleration: It starts immediately from the toe-off of the reference lower extremity to the same extremity comes directly under the body.	1. Initial swing: It starts from the point of foot clearing from the ground to the maximum knee flexion of the same extremity.
2. Mid-stance: When the swinging lower extremity swings directly beneath the body.	2. Mid-stance: It starts from the maximum knee flexion to the vertical position of the tibia.
3. Deceleration: It starts from the limb, which swings beneath the body to the knee extension and the preparation for the heel strike.	3. Terminal swing: It is the period from the tibia vertical position to the preparation of the initial contact of the heel.

traditional method and Rancho Los Angious (RLA) medical center, California, defines activities, which occur during the stance phase and swing phase. Activities, which occur during the stance phase, are given in Tables 16.1 and 16.2.

DOUBLE LIMB SUPPORT (Figs 16.2 to 16.4)

This is the period at which both the lower extremities having contact with the ground. The double limb support is possible between heel-off or toe-off of the one extremity and the heel strike or foot flat of another extremity. The double limb support takes up about 22 percent of the gait cycle. In fast walking or running the double support time reduces and in the slow walking, double support time increases.

SINGLE LIMB SUPPORT

It is the period at which single limb contacts the ground. The single limb support has seen during the reference extremities in the mid-stance phase.

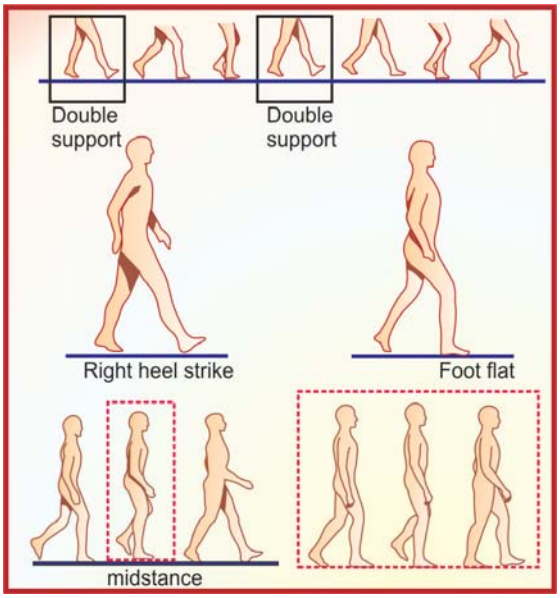


Fig. 16.2

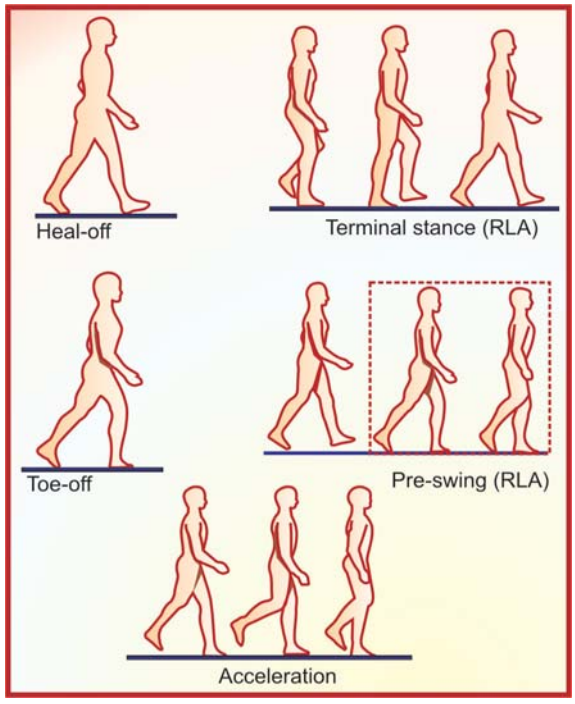
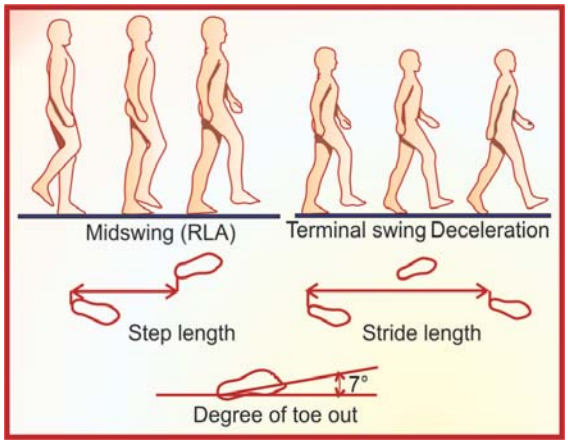


Fig. 16.3



Figs 16.2 to 16.4: Limb support

STEP LENGTH

This is the distance between the heel strike of one lower extremity to the heel strike of another extremity.

STRIDE LENGTH

This is the distance between the heel strike of one lower extremity to the heel strike of the same lower extremity once again to the ground.

STEP DURATION

It is the time taken for completion of one step.

STRIDE DURATION

It is the time taken for completion of heel strike of one extremity to the heel strike of the same extremity again. The stride duration and the gait cycle duration are same.

CADENCE

It is the number of steps taken per minute

Cadence = no. of steps / minute

Determination of Cadence

1. *Step length:* Larger the step length results in reduction in cadence, and the shorter the step length vice versa.
2. *Sex:* Normally, in females the cadence is more due to their shorter step length and it is reverse in male. In normal walking the cadence in female is 116 and in male is 110.
3. *Speed of walking:* The cadence may differ depends on the speed of walking. In normal walking the cadence is between 80-120. If it goes more than 180 it is said to be running and if it falls below 70 is called slow walking.

WIDTH OF BASE OF SUPPORT

In normal walking we don't place our one foot front to another, there will be some gap between each other while placing on the ground. Linear distance between the mid-point of the one foot to the other foot is called as width of base of support, and it is about 2 to 4 inches.

DEGREE OF TOE OUT OR FOOT ANGLE

It represents the angle of foot placement. The lines intersecting the center of heel and the second toe is called as foot angle. In normal walking the foot angle is 7° it may decrease in fast walking.

DETERMINATION OF GAIT

The description of the gait mainly monopolic towards the lower extremity. But apart from the lower extremity participation in gait, other events are happening to achieve the proper gait pattern. There is the coordinated movement of the trunk, upper limb, head to render the good gait pattern. The components are:

1. Lateral pelvic tilt.
2. Knee flexion.

3 & 4. Knee, ankle, foot interaction.

5. Pelvic forward and backward rotation.
6. Physiological valgus of knee (Fig. 16.5).

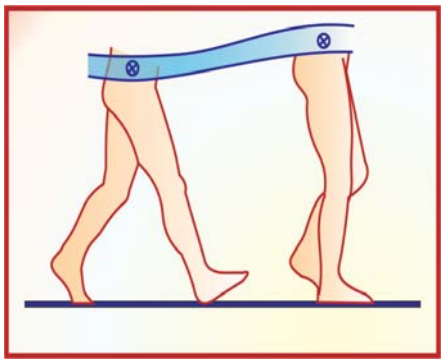


Fig. 16.5: Sinusoidal curve

These determinants are much more helpful to keep the COG in the minimal level to produce the efficient gait. First four determinants are helpful to maintain the vertical raising of the COG to a minimum. The fifth determinant prevents the COG drop and the sixth determinant reduces the sideways movement of the COG. In normal walking pattern vertical displacement of the COG produces the sinusoidal curve. This is drawn by marking the COG level in each phase and the line connecting all the points gives a wavy curve called as sinusoidal curve. Disturbance in this curve results due to some diseased pathology.

Lateral Pelvic Tilt

During the midstance period the COG reaches the peak level and the total body is supported by one lower extremity. To reduce the COG level, opposite side, i.e. swing phase pelvis tilts laterally. So that the COG comes little down, meanwhile the stance phase hip abductors helps to prevent the swing phase side pelvis drop.

Result: Lateral pelvic tilt helps to reduce the COG level during the midstance period.

Knee Flexion

It is the another determinant which helps to reduce the COG level during the midstance period. If the swinging lower extremity knee

remains in extended position, the COG still more increases in the midstance phase.

Result: Knee flexion helps to reduce the COG level during the midstance period.

Knee, Ankle-foot Interaction

The knee, ankle-foot interaction prevent the abrupt hike of the upward displacement of the COG when the foot passes from the heel strike to foot flat. Normally, after the heel strike huge upward displacement of COG occurs. To reduce that, there is some interaction between the knee, ankle, foot takes place (Knee flexion, ankle plantar flexion, foot pronation) and also the same interaction takes place during the midstance to heel off. After the midstance there is sudden dropping of COG. To maintain the sudden drop of COG there is some changes happening in the knee, ankle and foot (ankle plantar flexion, knee extension, foot supination).

Forward and Backward Rotation of Pelvis

It occurs in the transverse plane. The forward rotation occurs during the relative extremity in swing phase. The forward rotation starts during the acceleration and ends in deceleration. During the midswing the pelvis comes to the neutral position, meanwhile opposite pelvis goes for backward rotation. After the midstance there will be sudden dropping of the COG level. The forward and backward rotations help to prevent further reduction of the COG level. During deceleration the lower extremity lengthens and the same time the stance phase lower extremity (midstance) also relatively lengthened. The same time lengthening of both the lower extremities prevent the further reduction of the COG. The lengthening of the legs is possible due to the forward and backward rotation of the pelvis.

Result: Forward and backward rotations help to minimize the hyper-reduction of the COG.

Physiological Valgus

Generally, during walking forward placing leg will have mild-knee valgus is called as physiological valgus, but the vertical alignment of the limb (Vertical alignment of the tibia and fibula) provides more BOS than the normally placed limb. To overcome from the reduced BOS by the physiological valgus, i.e. normally placed limb, the lateral shifting of the body occurs to shift the COG from one lower extremity to another.

CAUSES FOR LOCOMOTION (GAIT) IMPAIRMENT

Age

Depends on the age difference, there is some marked changes occur in gait pattern. During the crawling stage of the child the base of support is more and COG is in lower level and the position is called quadruped position. After some days the child adopts toddler walking with wider base. The child adopts the wider base to avoid falling. There will be reduced single limb support, shorter step length and more cadence. After five years there will be some other changes can be observed in the gait pattern. Normally, in this stage increased cadence, increases velocity, reduced step length, more arm swing and less pelvic tilt can be noticed. The normal gait pattern is focused towards the adults age group people. The normal gait is achieved and derived from the adult, because in this age the person has well-developed muscles, skeletal system, proprioceptive response, power and strength. The old age group will be having reduced velocity, reduced cadence, decreased step length due to their weakness of the musculoskeletal and nervous system.

Sex

Sex plays the major role in the gait. By observing an individual's gait we can easily

identify the sex difference. As said in cadence to decreased step length, increased steps, decreased stride length can be seen in the female. The cadence is more in female than in the male and also due to wider pelvis there will be some difference in arm swinging in the female. There will be more pelvic rotation noticed in female.

Occupation

The occupation also plays the main role in determining the gait pattern. Continuous adaptation of one position may cause some changes in the muscles and soft tissues, which leads to some difference in the gait pattern. In some particular occupation-setting the person is forced to adopt some posture or habituated for different varieties of gait pattern it may lead to changes in normal gait pattern. For example, the sailors who has to adopt the wider base while sailing in the ship to get the stability. Continuous adaptation of the hip abduction posture may lead to abductor tightness and adductor lengthening or elongation. Due to the changes in the muscle property the person is forced to adopt the same variety of gait pattern during the normal activities also. Some other examples are soldiers with raised chest, *Dhobis* (Washerman) with kyphosis, rikshaw pullers with kyphosis, bangle sellers with lordosis.

Clothing

The cloth, which we wear also, may change our gait pattern. The tight clothing may cause some deviations in the gait pattern and some unusual dresses, which causes gait deviations psychologically.

Assistive Devices

The gait seen in the patients who uses the assistive devices relatively shows different gait pattern from the normal person. Caliper, prosthesis, walkers, crutches gives its own characteristics of walking, which is totally different from the normal gait pattern and problem in the assistive devices may show its own characteristics of walking pattern.

Body Structure

Depends on the structure of the individual the walking pattern may change. For example, slim person walks with increased step length, decreased steps, increased arm swing, decreased pelvic rotation and the obese individual walks with decreased step length, increased steps, decreased arm swing, increased pelvic rotation and also each and every individual will have own character of walking pattern.

Footwear

The person who wears the shoes from birth may have the proper, straight and non-deviated hip, knee and ankle interaction gait. But it is reverse in person who uses slippers for longer period and shows the slight hip rotation and some other deviation in the ankle and knee. Due to the problems in the footwear may also cause the deviation or improper gait pattern.

Psychological State of Individual

Much more difference can be seen in the gait pattern depends on the psychological state of an individual. The person with depressed mood may have the decreased step length, decreased stride length, reduced steps, and decreased velocity, less upper limb swinging, less pelvic rotation and more neck flexion. This may be reversed in the joyful mood.

Diseased State

Some pathological changes may cause the improper gait pattern and abnormality in the gait.

i. Neurological gait
ii. Muscular weakness gait
iii. Joint or muscular limitation gait
iv. Leg length discrepancy gait
v. Painful gait.

Neurological Gait

Parkinson gait: The gait pattern is said to be shuffling gait or festinant gait or festinating gait. The patient adopts the flexed posture of neck, trunk, hip and knee due to the rigidity of the muscles. Because of the flexed posture, the COG falls anteriorly. The initiation of movement also difficult by the patient to chase the COG and to keep it in same position and regain balance, the patient tends to have the rapid shuffling gait. The patient will have short steps, lack of heel strike and toe off, loss of arm swinging and lack of pelvic rotation. In this gait heel strike is absent, so toe strikes first hence called as Toe-heel gait. This type of gait may be seen in Parkinson's disease, Wilson's disease, cerebral atherosclerosis.

Hemiplegic gait: The patient rotates the hip sideways during the swing phase due to the hip flexor tightness and places the foot in flattened manner or toe first before heel strike. There is absence of heel strike due to the plantar flexor contracture. Upper limb is flexed in the affected side. The steps are lengthened towards the affected side comparatively with the unaffected side. Otherwise called as circumduction gait.

Ataxic gait: There are two types of ataxic gaits are seen in cerebellar and sensory ataxia.

Cerebellar ataxia: Hypotonia and the ataxic gait are the main features of the cerebellar lesion. There will be lacking of the coordinated movements. The gait pattern resembles like 'drunker gait'. The patient sway here and there without stability and balance. This gait is otherwise called as 'reeling gait'. If the patient is having one side cerebellar lesion shows the lesion side swaying and normal walking pattern in the normal side.

Sensory ataxia: It can be seen in tabes dorsalis, diabetes mellitus, leprosy and syringomyelia. The patient raises the foot in the air, through forward in uncertain manner and stamp on the floor slowly due to the lack of kinesthetic sensation. The gait pattern looks like 'space walk'.

Scissoring gait (crossed-leg gait): It is seen in the cerebral palsy and in exaggerated form of paraplegia. The legs are crossing each other while walking due to the adductor tightness. The knee might may be flexed in the spastic diplegia is called as 'couch gait'. During the swing phase of one lower extremity cross the stance leg.

Muscular Weakness Gait

Gluteus medius gait: One side gluteus medius paralysis results in Trendelenburg gait, both the side paralysis results in duck walking.

Trendelenburg's gait: During the swing phase of one lower extremity the opposite side hip abductors help to prevent the tilting of the pelvis of the swinging extremity. Weakness or paralysis of right side gluteus medius results in pelvic drop over the left side while going for the swing phase. So, the patient while walking bends his trunk towards the paralyzed side, i.e. opposite to the dropping gait.

Duck walking gait: When both the abductors of the hip paralyzed the patient bends his trunk laterally towards the stance phase. Lower extremity, whenever the same side lower extremity goes for swing phase. To prevent the over dropping of the pelvis and to clear the foot from the ground, this adjustment made by the patient. Both side lurching of the trunk happens while walking is called as 'duck walking' or 'waddling gait'.

Gluteus maximus gait: The gluteus maximus causes posterior pelvic tilting gait and shifting the COG towards the stance hip. While the body propels forward during the midstance phase if the gluteus maximus paralysed the trunk is lurched posteriorly to cause the posterior tilting and shifting the COG towards to stance hip. So, while walking forward and backward movement of the trunk occurs is called as 'rocking horse gait'.

Quadriceps (hand to knee gait): This type of gait is possible typically in the patients with quadriceps paralysis. During the midstance, to transmit the weight on the stance lower leg extremity, the knee should be locked. This locking is not possible if the quadriceps is paralysed so that the patient himself is locking the knee by placing his hands above the knee joint.

High stepping gait (foot drop gait): During the heel strike the ankle goes for dorsiflexion. If the dorsiflexors are paralyzed, the plantar flexors overacts. During heel strike due to foot drop the toes goes and contact the ground first, to avoid this the patient flexes his hip and raises the foot and slap on the floor forcibly. It is seen in some neurological conditions like polyneuritis, muscular dystrophies and peroneal muscle atrophy. In some exception case, the patient started walking with the dragging the toes on the floor without flexing hip and raising foot called as toe 'dragging gait'.

Genu Recurvatum gait: If the hamstring muscles paralyses, the knee goes for hyperextension in the midstance while transmitting weight through the stance leg, the knee goes for hyperextension due to the lack of counteraction of the hamstring. And also during the late stage of swing phase slowering of the swing due to the hamstring paralysis and the knee will snap into extension. It is commonly seen in polio.

Joint of Muscular Limitation Gait

Toe tip gait: Foot remains in plantar flexion due to the contracture of the plantar flexor or may be due to paralysis of dorsiflexors so that the patient walks on the toe tip and the ball of the metatarsals. This type of gait can be seen in some neurological conditions like DMD and spastic diplegia.

Calcaneal gait: Contracture of dorsiflexor or paralysis of plantar flexor may cause the stable dorsiflexed foot. So, while walking there is absence of foot flat, midstance, toe-off stages. Instead of that the patient walks with heel or the calcaneum. This type of gait is said to be calcaneal gait.

Hip flexor contracture gait: The hip flexor plays main role to propel the swinging extremity forwards. If it is contracted or hip joint is ankylosed the flexion movement will be restricted. To compensate that the patient hikes his pelvis and laterally half-circumducts his hip and propels forwards as well as due to hip flexor contracture, hip extension is also restricted to compensate that the patients do more anterior pelvic tilt and lordosis to swing the extremity forwards.

Stiff knee gait: Normally, during the early stage of swing phase the knee should go for flexion to clear the foot from the ground. If the knee is stiff the patient hikes his hip and clears the foot from the floor and swing sideways with hip circumduction of abduction to propel the limb forward to reach the heel strike. This type of gait is called as 'Circumduction gait' or 'hip abductor gait'.

Leg Length Discrepancy Gait

When the leg length difference is half inch it can be negligible and it may be compensated by pelvic tilt while walking. If the shortening of leg goes up to one and half inch it can be adjusted with slight equines position, meanwhile if the shortening is more than two-inch leads to marked pelvic tilt and equines deformity at the foot. This type of gait is called as equines gait.

Painful or Antalgic Gait

When the patient has pain over the joint of the lower extremity to avoid to stand on the involved side. So, the time taken for the stance phase on the involved side shortens, and shortened step length, shortened reciprocal arm swing, shortened stride length, increased velocity of steps also can be noticed. The patient limps while transmitting weight over the involved side so it may be called as limping gait.

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