- It is the movement that involves rotation of the arm in side with the shoulder in abduction and elbow in flexion in supine lying, so that the palm faces down wards, while the shoulder and elbow are in 90^0 of abduction and 90^0 of flexion respectively in supine lying position fixed.

Range of motion - Internal rotation-90^0.

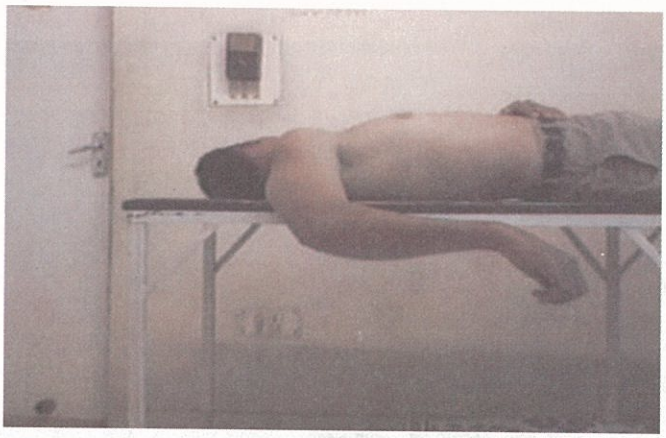


Fig. : Internal Rotation - 90^0 (70^0 - 80^0)

- It involves rotation of the arm in the outside direction. With the shoulder fixed in abduction and elbow in flexion in supine lying, so that back of the hand faces towards the ground while the shoulder and elbow are fixed 90^0 abduction and 90^0 of flexion respectively in the supine position.

Range of motion- External rotation-90^0.

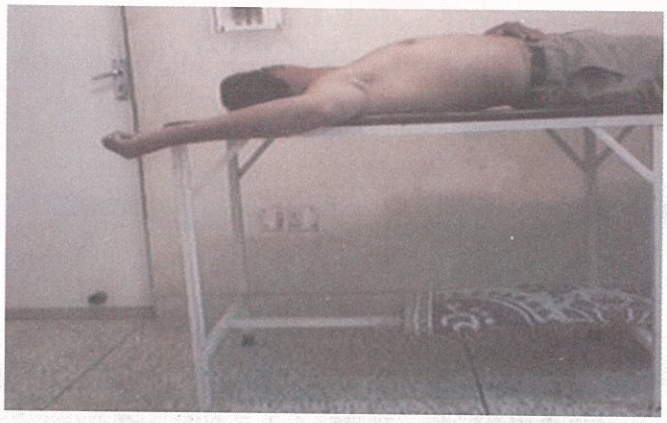


Fig. : External Rotation - 90^0 (70^0 - 80^0)

Circumduction (range of motion-180^0) : It is a multi directional movement which involves rotation of the shoulder in a clock wise or anti clock wise direction. The range of motion from starting position 180^0.

Elbow Joint

- Bending the arm at elbow joint, involves moving the forearm and hand towards the shoulder or face by fixing the shoulder either in neutral position or in 90^0 flexion.

  Range of motion- elbow flexion -145^0. (135^0)

Fig. : Flexion - 145^0

- It is the straightening of the arm at the elbow. It involves moving the fore arm and hand away from the shoulder by fixing the shoulder in neutral position or in 90^0 flexion.

  Range of motion- elbow extension -0^0.

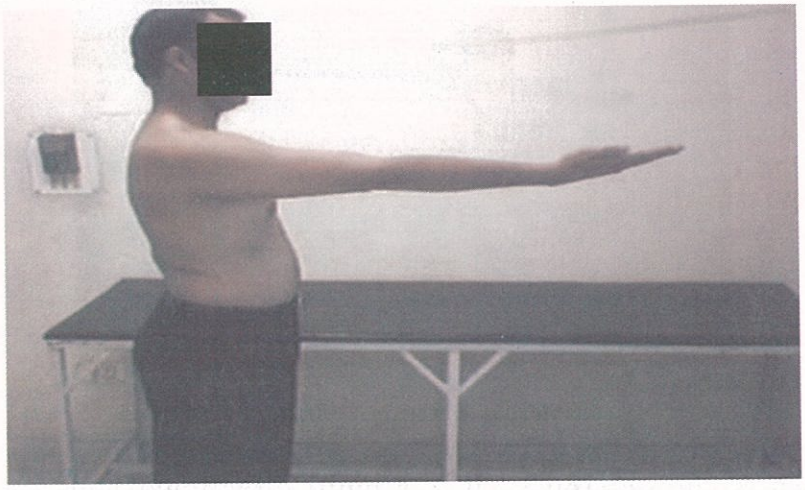


Fig. : Extension - 0^0

Radioulnar Joint

- It is the neutral position of the fore arm in which it is neither in pronation nor in supination. The shoulder and elbow joints should be fixed in neutral and in 90^0 of flexion respectively.

Fig.: Mid prone position of forearm

- It is the rotational movement which involves rotation of the forearm in a clock wise direction either from the mid prone position or from mid supination. The shoulder and elbow should be fixed in neutral and in 90^0 of flexion respectively.

Range of motion- Radioulnar joint -pronation - 90^0 (80^0)

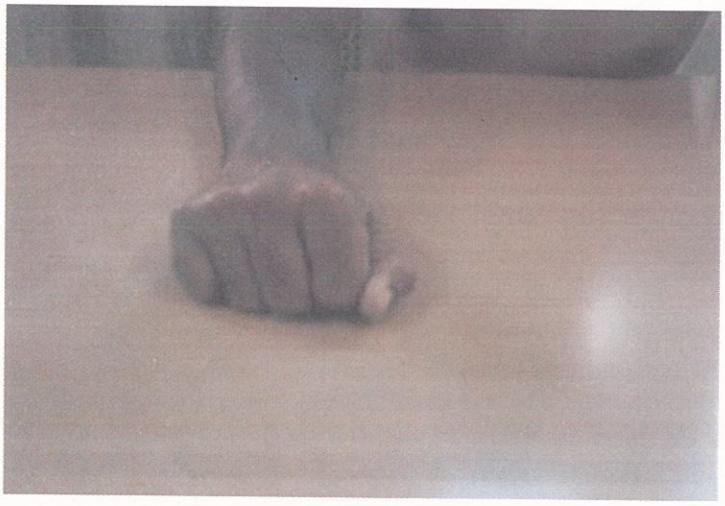


Fig. : Pronation - 90^0 (80^0)

- It is the rotational movement which involves rotation of the forearm is a anticlockwise direction from complete prone or from mid prone position, while the shoulder and elbow joint are fixed in neutral and in 90^0 of flexion respectively.

  Range of motion- Radioulnar joint -supination - 90^0.

Fig. : Supination - 90^0

Wrist joint

- It is movement of the hand towards the front of fore arm.

  Range of motion- wrist joint - flexion - 90^0.

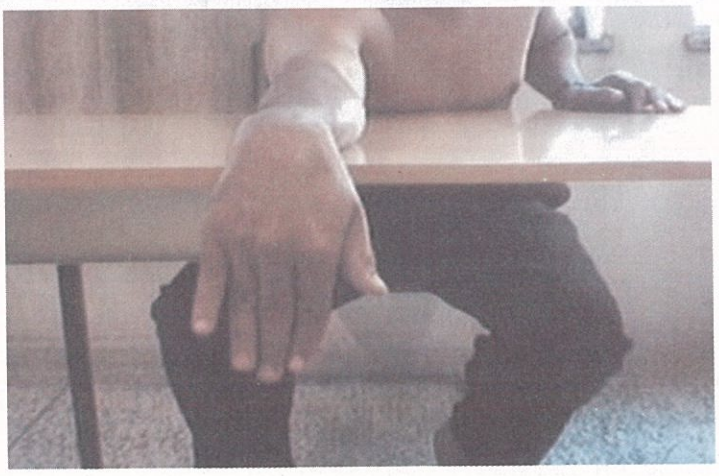


Fig. : Flexion - 90^0

- It is the movement of the hand towards the back of fore arm.

  Range of motion- wrist joint - extension - 80^0.

Fig. : Extension - 80^0 (70^0)

- It is the movement of the hand towards the midline of the body, while the forearm is in pronation. It is also called wrist abduction. Movement toward the little finger.

  Range of motion- wrist joint - ulnar deviation - 35^0.

Fig. : Ulnar deviation - 35^0 (80^0)

- It is the movement of hand away from the midline of the body while the forearm is in supination. It is also called as wrist abduction.

  Movement towards the thumb.

  Range of motion- wrist joint - radial deviation - 20^0.

Fig. : Radial deviation - 20^0

Metacarpo phalangeal joint of thumb

- It is the movement of the fingers towards the surface of the palm. At the end of the movement the thumb lies across the palm.

Fig. : Flexion - 80^0

- It is the movement of thumb away from the surface of the palm.

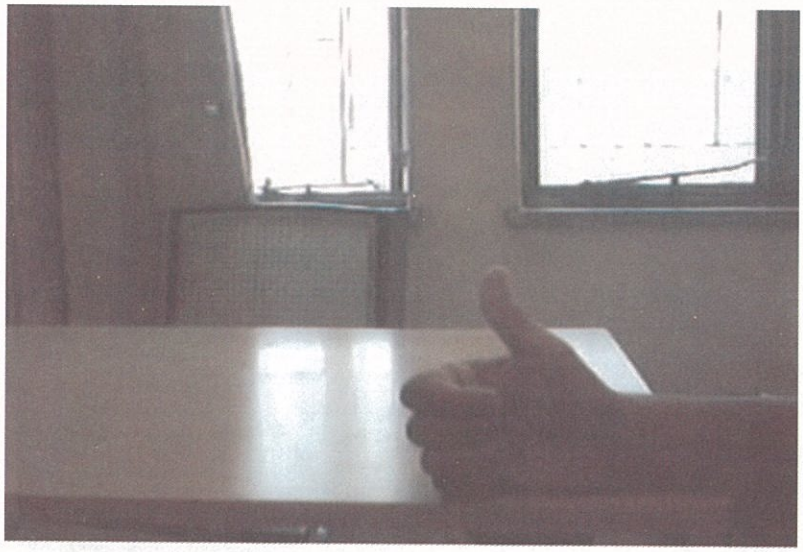


Fig. Extension - 0^0

- This is the movement of thumb away and up from the side of the remaining four fingers in the sideway direction.

  Range of motion- abduction - 20^0.

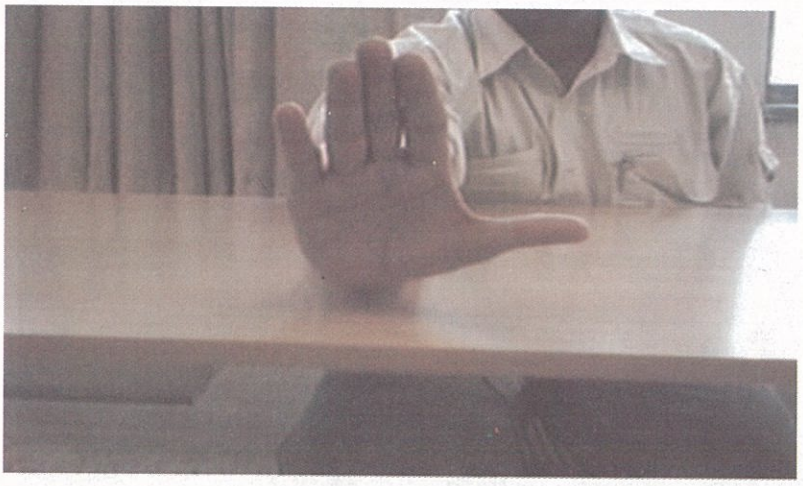


Fig. : Abduction - 20^0

- This is the movement of thumb towards the side or inline of the remaining fingers from the abducted position.

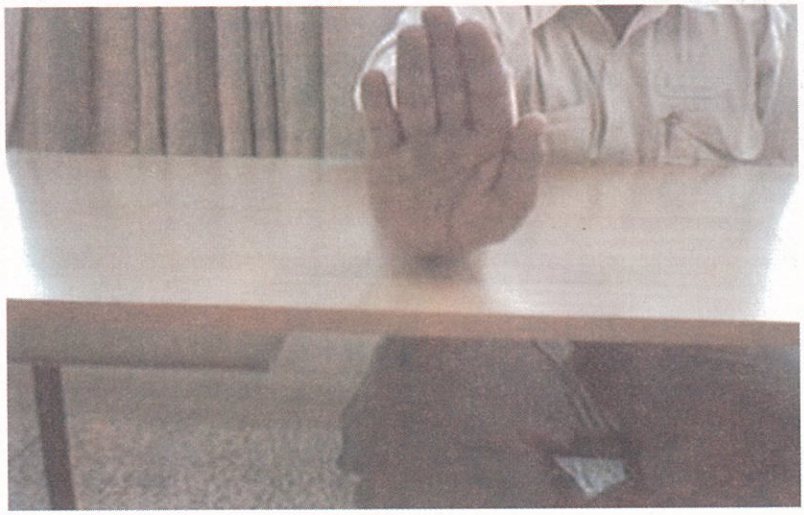


Fig . : Adduction - 20^0

- It is the ability of the thumb to touch the balls of all the fingers or the tips of all the fingers. It involves flexion, abduction and medial rotation of the thumb.

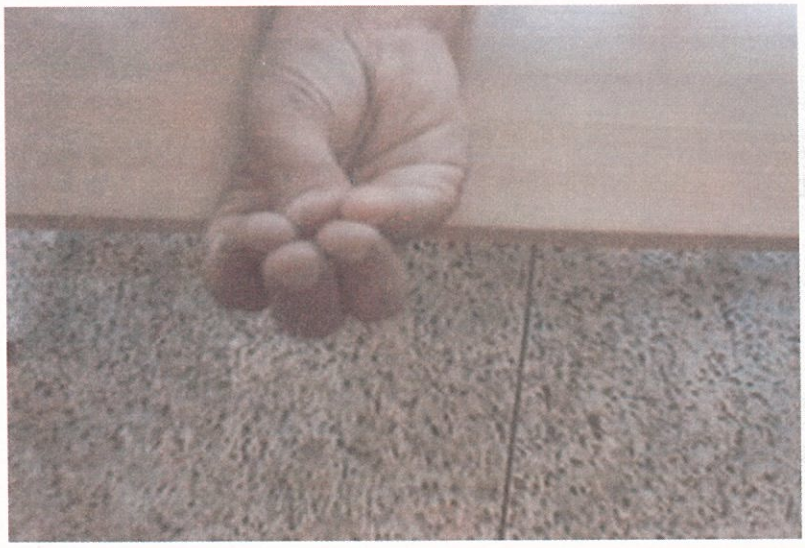


Fig. : Opposition - thumb.

Metacarpophalangeal joint of fingers

- It is the bending of the fingers at metacarpophalangeal joints towards the palm by fixing the interphalangeal joints in extension.

Metacarpophalangeal joint of fingers
Range of motion - flexion - 90^0.

Fig. Flexion - 90^0 (30^0)

- It is the moving of fingers at metacarpophalangeal joints away from the palm by fixing the interphalangeal joints in extension.

Metacarpophalangeal joint of fingers
Range of motion - extension - 0^0.

Fig. Extension - 0^0

- Movement of fingers towards the middle finger is called adduction.

Fig. : Adduction

- Movement of fingers away from the middle finger is called abduction. The movement of middle finger towards either side is called abduction.

Fig. : Abduction of fingers

Proximal interphalangeal Joint

Flexion - 130^0
Extension - 0^0

Distal interphalangeal Joint

Flexion - 90^0
Extension - 0^0

Flexion and extension at interphalangeal joint (both proximal and distal phalanges), involves bending the middle and distal phalanges by fixing the metacarpophalangeal joints. The distal phalanges cannot be flexed alone.

Hip Joint

- It is the movement of the lower limb in the forward direction in standing and in upward direction in supine lying.

  Hip joint - flexion with knee straight - 90^0.
  Range of motion with knee bent - 115^0 - 120^0.

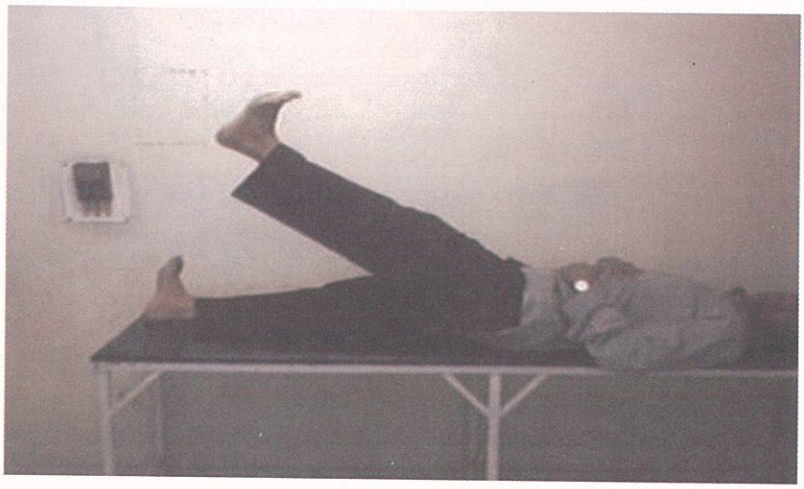


Fig. : Flexion - 90^0 with knee straight

- It is the movement of the lower limb in the backward direction in standing and in upward direction in prone lying.

  Range of motion extension - 40^0. (30^0 - 40^0)

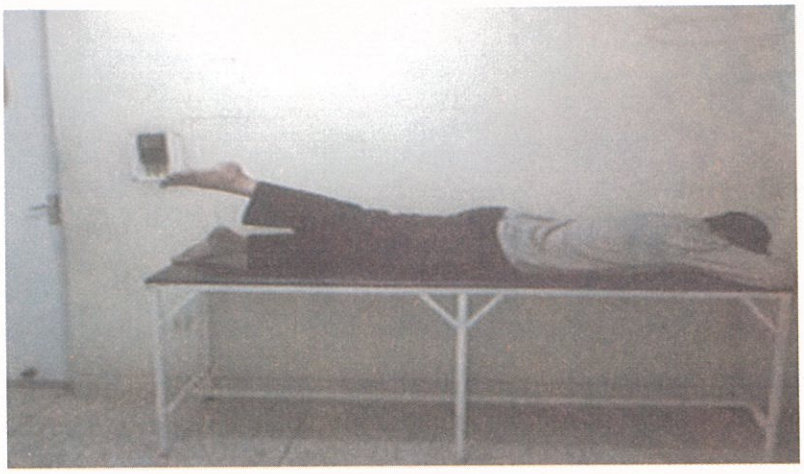


Fig. : Extension - 40^0

- It is the movement of the lower limb away from the midline from adducted position in standing and supine or in a upward direction in side lying position.

  Range of motion abduction - 45^0.

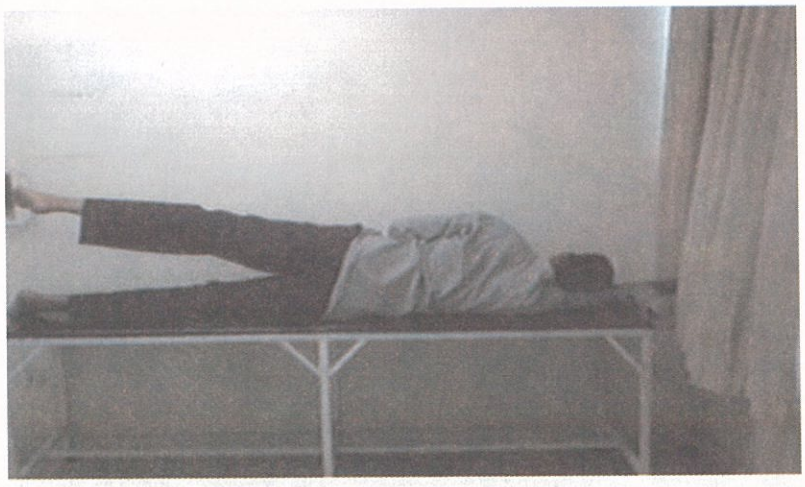


Fig.: Abduction - 45^0

- It is the movement of the lower limb towards the midline from abducted position either in standing or in supine lying position.

Range of motion adduction - 35⁰.

Fig.: Adduction - 35⁰

- It is the movement which involves rotation of lower limb outwards while the hip and knee are fixed in 90⁰ flexion in supine lying.

Range of motion internal rotation - 45⁰.

Fig.: Internal Rotation - 45⁰

- It is the movement which involves rotation of lower limb inwards while the hip and knee are fixed in 90^0 flexion in supine lying.

  Range of motion external rotation - 45^0.
  Circumduction 180^0 - combination of all movements.

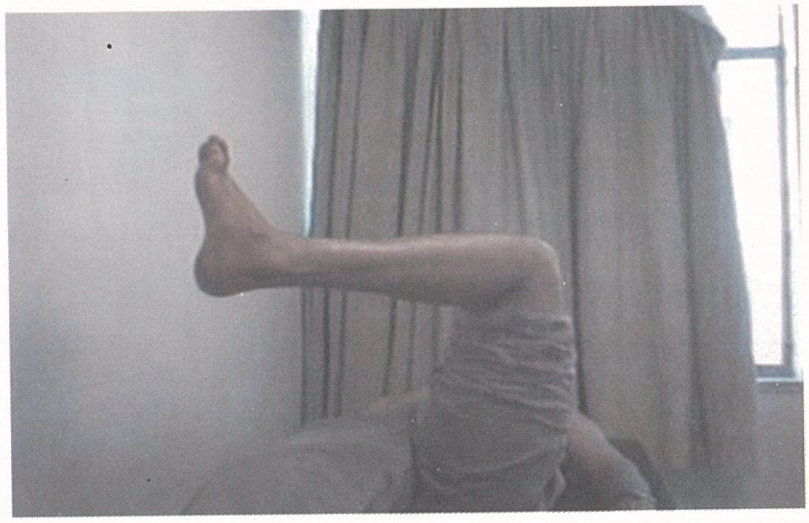


Fig. : External Rotation - 45^0

Knee Joint

- It is the movement of the lower limb towards the back of the thigh while the hip is fixed in 90^0 of flexion in supine lying and bending the knee.

  Range of motion - flexion - 125^0. (0 - 135^0)

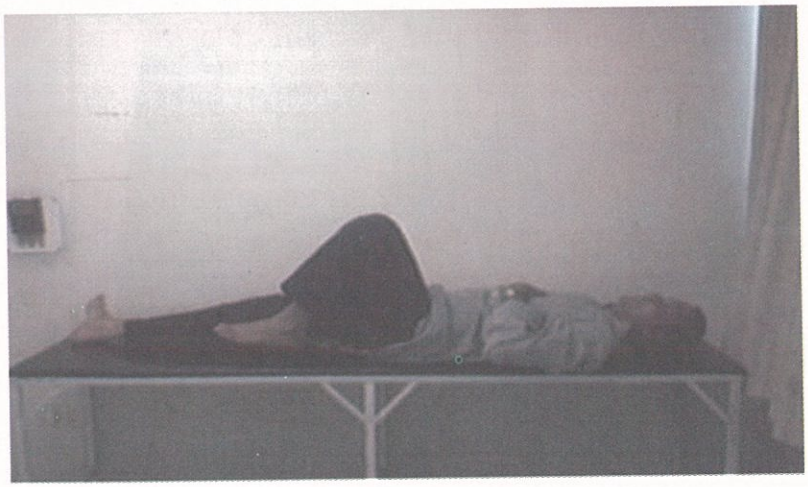


Fig. Flexion - 125^0

- It is the movement of lower limb away from the back of the thigh, while the hip is fixed in 90^0 of flexion in supine lying.

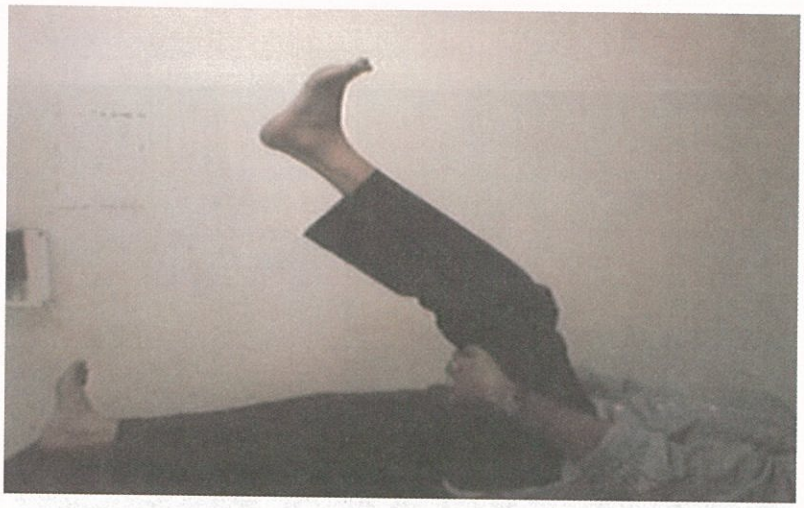


Fig. Extension - 0^0

Ankle Joint

- Movement of the foot towards the ground while hip and the knee are fixed in 90^0 of flexion in sitting position.

  Range of motion - plantar flexion (35^0 - 45^0)

Fig. : Plantar flexion - 35^0

- It is movement of the foot towards the ceiling while the hip, knee are fixed in 90^0 of flexion.

  Range of motion - Dorsiflexion - 20^0 - 25^0.

Fig. : Dorsiflexion - 20^0

Subtaloid joint

- It is inward elevation of the foot in which the sole of the foot faces inside. While ankle joint is fixed in neutral position.

  Range of motion - Inversion- 35^0.

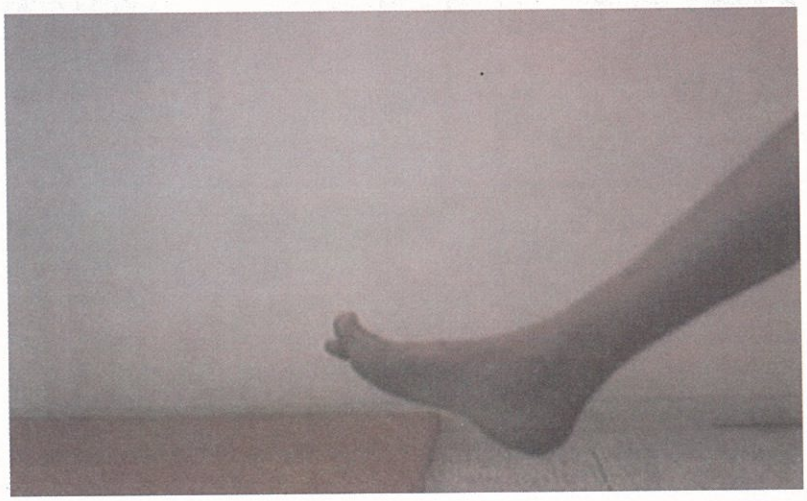


Fig. : Inversion - 35^0

- It is outward elevation of the foot in which the sole of the foot faces outside, while ankle joint is fixed in neutral position.

  Range of motion - eversion - 20^0.

Fig. : Eversion - 20^0

Metatarsophalangeal Joint

- It is the movement that involves raising the toes in the upward direction.

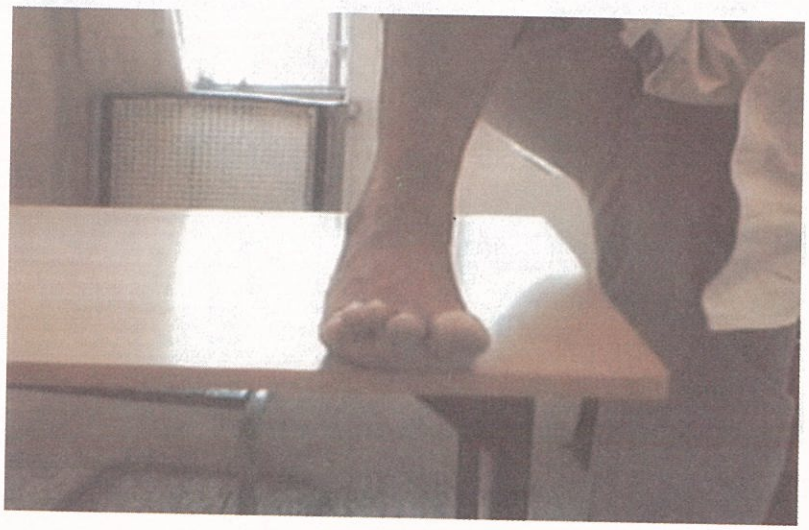


Fig. : Extension - 0^0

- It is the movement that involve clawing of the toes towards the plantar aspect.

Fig. : Flexion - 60^0

- It involves spreading of toes away from each other.

Fig. : Abduction - 20^0

- It involves drawing of toes close to each other towards the midline.

Fig. : Adduction 0^0

Iutervertebral joints of cervical region

- It is the tilting of head down in a forward direction so that the chin comes closer to the chest.

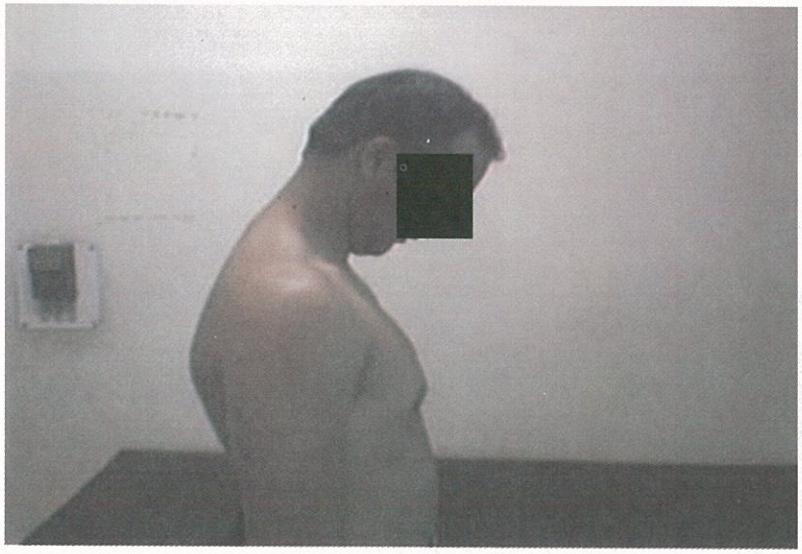


Fig. : Flexion 45^0

- It is the tilting of head up in a backward direction, so that the chin moves away from the chest.

Fig. : Extension 45^0

- It is the tilting of head on to the shoulder direction, so that the distance between the shoulder and earlobe decreases.

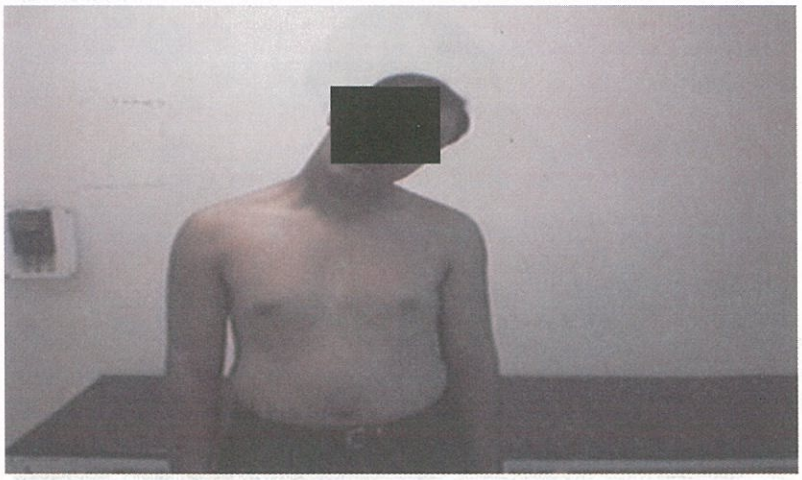


Fig. : Side flexion 45^0

- It is the rotation of chin laterally towards the shoulder, so that the shoulder, tip and the chin are closer to each other.

Fig. : Lateral rotation 60^0

Intervertebral Joints of trunk

- It is the bending forward towards the toes. The movement takes place mainly between the vertebrae of lumbar region and slightly at thoraco lumbar junction and lumbo sacral junction and at hip joints.

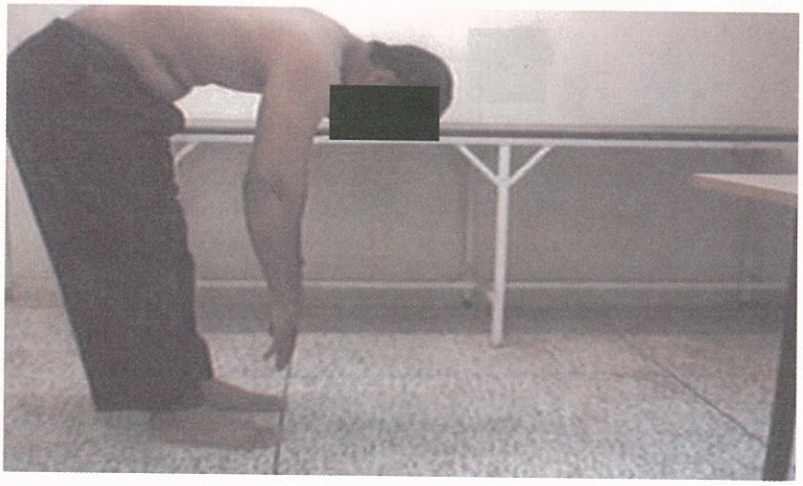


Fig. : Flexion 80^0

- It is the bending backward(opposite to that of flexion, the movement takes place mainly between the vertebrae of lumbar region, slightly at lumbo sacral junction and at hip joint.

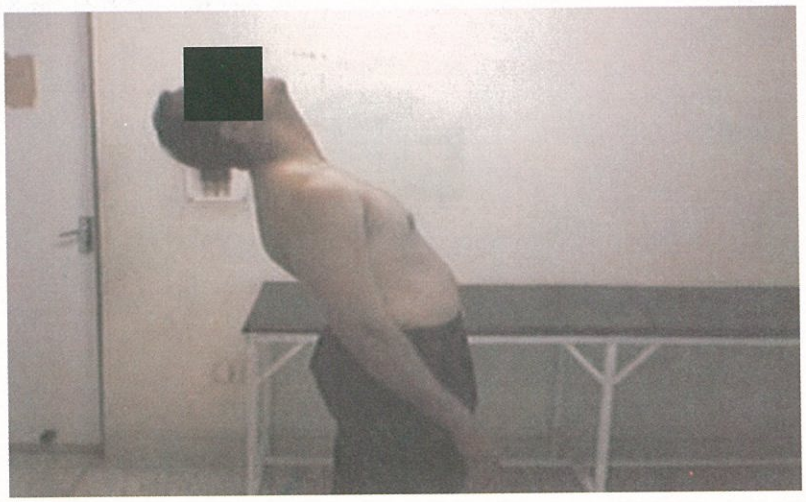


Fig. : Extension 25^0

- It is the movement that involves bending side ways to touch the knee joint, if not, the lateral malleolus.

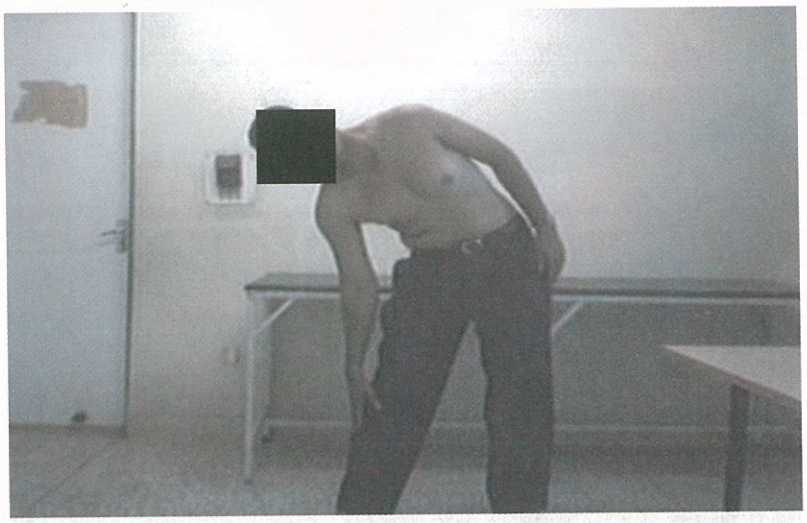


Fig. : Lateral bending 35^0

- It is the movement that involves rotation of the trunk in standing position to touch the object in the opposite side.

Fig. Lateral rotation 45^0

Procedure to evaluate joint range of motion

Position of the person: The person should be positioned according to the joint that is being measured. example : If the shoulder joint is under measurement, the person can be positioned in either sitting or standing position.

Measurement: The axis of the goniometer is placed on the joint line. The person is asked to move the part of the limb actively in the required direction that is being measured. The moveable arm of the goniometer follows the direction of the movement. Then the angle on the protractor of the goniometer is noted.

During movement the proximal bone of the joint is stabilized in order to measure the range of motion accurately.

If the joint range of motion is limited or exaggerated, then the management follows accordingly.

Description of goniometer

It's a semi circular shape protractor having 180^0 calibrations. It has a moveable arm and a fixed arm. The moveable arm usually parallel to the moving segment of the joint and fixed arm will be stabilized parallel to the stabilized segment of the joint.

* * *

CHAPTER 10

POSTURE

Introduction

After birth, the child passes through a number of postural stages before attaining the matureed and controled normal posture. The different postural stages are depicted below.

Definition : Posture can be discribed as an attitude assumed by the body either with support during muscular inactivity, or by means of the co-ordinated action of many muscles working to maintain stability.

Fig. Spine is flexed in C curve birth to 2 months.

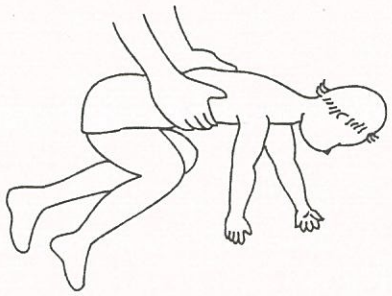


Fig. Reflex stretching out of arms until about 6 months.

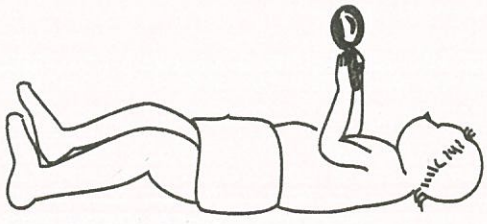


Fig. Extensor tone increases and cervical curve begins to appear.

Fig. Early sitting with head control about 6 months

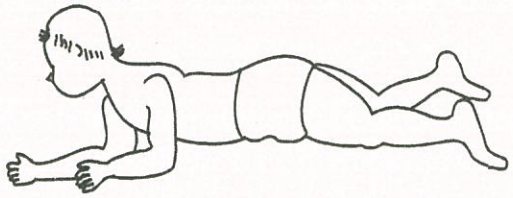


Fig. Prone-on-elbows crawling position reinforces development of cervical curve.

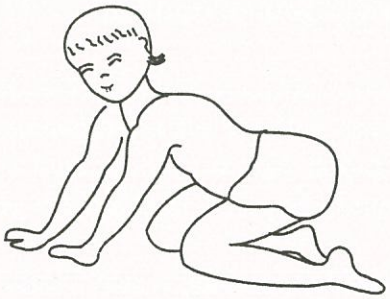


Fig. Creeping - 8 months

Fig. Early standing with support shows flat back posture.

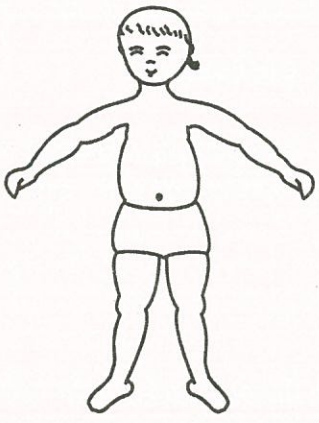


Fig. Lumbar curve appears about 14 months

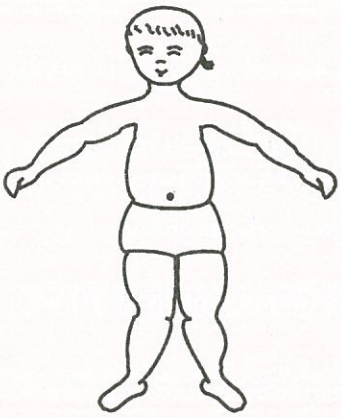


Fig. Knock knees is normal in early walking.

At birth, the entire spinal column of the infant is flexed in a single C-curve. The cervical curve develops at about 4 to 5 months of age, while the lumbar curve begins to develops sometime after the child begins to walk.

Toddler and young children with disabilities presents upright locomotion characteristically have flat backs. The condition is normal during few months when the child is gaining confidence in walking and running activities. If flat back persists beyond the toddler stage. It is considered a postural deviation.

The normal preschool child tends to develop an exaggerated lumbar curve, which may persist throughout schooling. This condition is caused by the imbalance in the strength of the abdominal muscles and the hip flexors. It is normal for the abdominal musculature of the preschool child to be too weak to maintain the pelvis in a neutral position.

The resulting lordosis characterizes the young child's posture until sufficient abdominal strength is developed to counter act the downward pull of hip flexors. Lordosis, therefore, is normal in young children and should not be labeled as a postural deviation until adolscence. The degree of lumber curve should, however, lessen from year to year.

Exact, extended carriage result's when thoracic and sacral flexion curves are in balance with cervical and lumbar hyperextension curves. Whenever one curve increases, the other curves tend to increase also, to compensate the imbalance.

When postural problem becomes evident, it is important to analyze the imbalance of muscle groups by considering following points.

1. Muscles on which surface are too tight.

2. Muscles on which surface are too loose.

3. What role gravity is playing in the muscle imbalance.

Posture and balance are interrelated. Some postures require more muscle work to maintain than other. Balance should be maintained, what ever the position may be, to prevent the force of gravity, impose on change of posture.

POSTURES IS OFTWO TYPES

A) INACTIVE POSTURES : These are the postures which maintain the body in resting position that is in lying, resting etc here the muscular activity required will be very less.

B) ACTIVE POSTURES

These are the postures, which require maximum muscular effort and will be used as a starting position or to maintain the balanced posture.

Static postures. It work in opposition to gravity and assist in maintaining the balance.

Dynamic postures. This type of active posture is required to form an efficient basis for movement and activity.

THE POSTURAL MECHANISM

The muscles The muscles play a vital role in maintaining the postures both the agonists and antagonists, synergists and Fixators also work in accordance with each other and provide an efficient basis for movement or balance.

Nervous control Postures are maintained or adapted as a result of neuromuscular co-ordination, the appropriate muscles being innervated by means of a very complex reflex mechanism.

The postural reflexes A reflex is, by definition, a stereotypical efferent response to an afferent stimulus. The efferent response in this instance is a motor one which supplies the gravity muscles. Afferent stimuli arise from a variety of sources all over the body, the most important receptors being situated in the muscles themselves, the eyes and the ears.

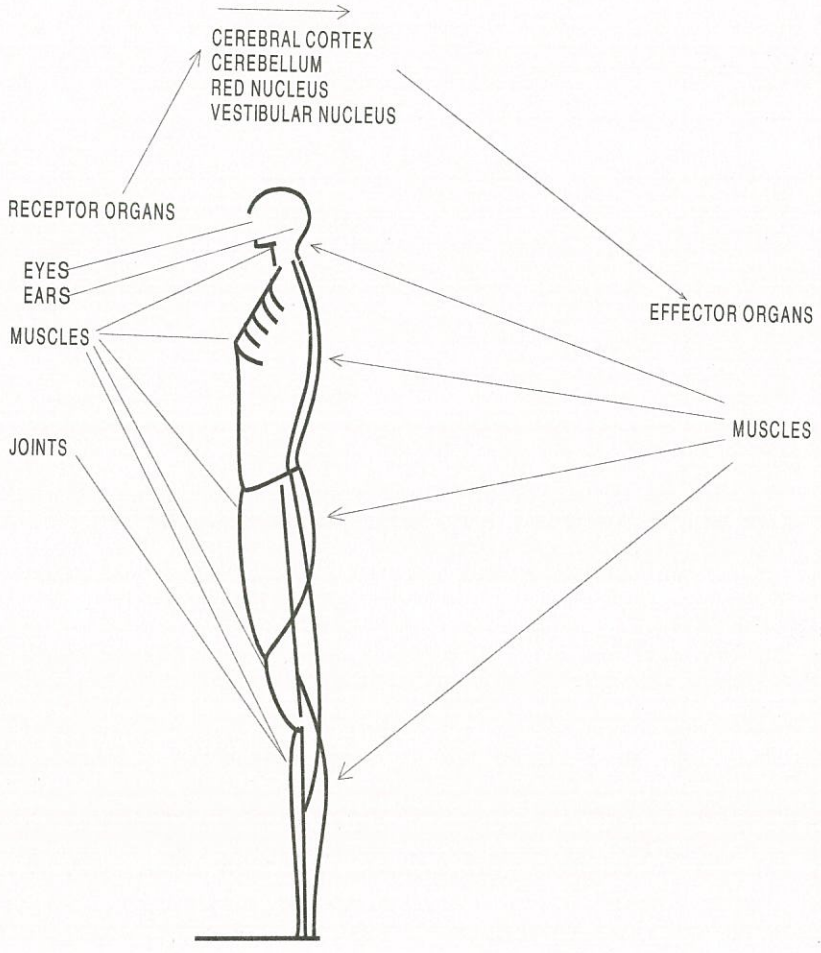


Fig. Sources of Sensory input

Good posture

Posture is said to be good when it fullfils the purpose for which it is used with minimal muscular effort and maximum efficiency.

Development of good posture

Efficient posture develops quite naturally, provided the essential mechanisms for its maintenance and adjustment is intact and healthy.

The chief factors which predispose to the health, development of the muscles and the postural reflex are given below : -

i) A stable psychological background.

ii) Good hygienic conditions.

iii) Opportunity for natural free movement.

iv) Tone, bulk and muscle power.

Importance of good posture

- Effort, workload on soft tissues and joints is less.
- Soft tissues are working in harmony.
- Equal distribution of work on all soft tissues / joints.
- These factor helps to maintain posture for a longer period hence the productivity will be more.
- Tiredness, fatigue will be after longer period.
- Stress, strain, sprain, soreness and muscle pull can be prevented.
- Symmetry of body looks good.
- Deformities can be prevented.

Poor posture

Posture is poor when it is inefficient, that is, when it fails to serve the purpose for which it was designed, or if an unnecessary amount of muscular effort is used to maintain it.

Faulty alignment of the body segments in the erect positions may lead to the necessity for additional muscle work to maintain balance. On the other hand, efficient compensation may take place, in which case no additional muscular effort is required.

Tension in the muscles other than those required to act, either to produce movement or to maintain posture hinders the efficiency of both and wastes energy.

Factors which predispose to poor posture

The causes of poor posture are often very obscure and even if they are known, are difficult to remove. The various factors are given below:

1. Localized pain
2. Muscular weakness
3. Poor hygienic conditions
4. Occupation
5. Postural abnormalities
6. Various pathological conditions
7. Contractures and deformities
8. Leg length differences

Fundamental positions

'Posture follows movement like a shadow' - Sherrington. As every movement begins in posture and ends in posture.

Following are three basic postures from which the remaining are derived.

1. Lying

This is the easiest of the fundamental positions as the whole body can be completely supported in the supine position and it is as stable as possible, the whole body is supported. In this position muscles work isometrically and joints are in neutral position.

When the lying position is used as a starting position for exercises, it is usually taken on a firm surface and muscle groups work slightly.

Fig. Lying

2. Sitting

Sitting is acquired on a large base of support on gluteal region and support of the thighs. This position can be taken either on chair or on floor.

1. Sitting on chair

This position can be taken on a stool or chair. The thighs are fully supported and hips and knees are flexed at right angles. The knees are apart sufficiently to allow the femur(thighs) to be parallel and the feet rest on the floor with the heels vertically below the knees.

- The position of the head should be in neutral.
- The back is rested against the back of the chair.
- Arms are at the side of body rested on the armrests.
- Elbow semi flexed.
- Wrist and hands in a functional position.
- The thighs are fully supported on the chair.
- The knees are flexed at right angles.
- The foot is supported on the floor or on foot rest.

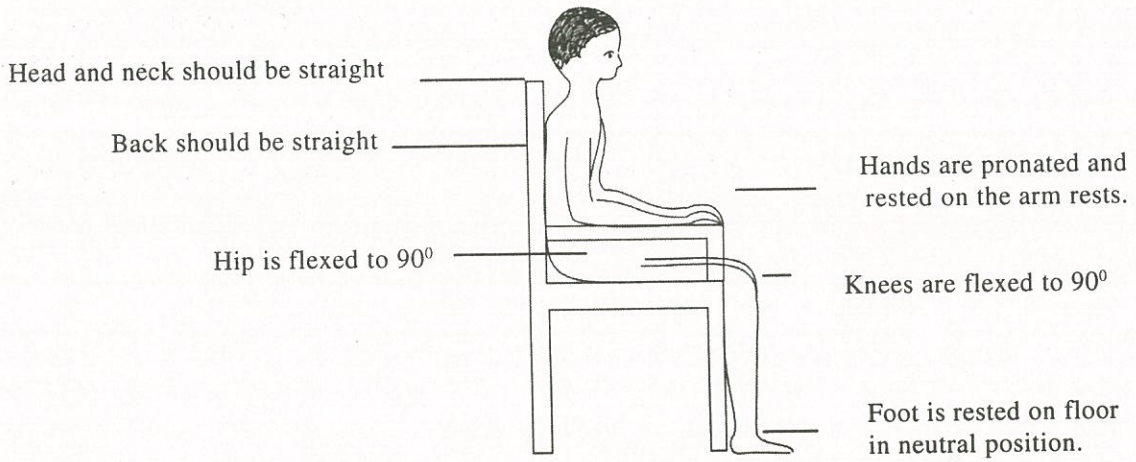


Fig. Sitting on chair

2. Cross sitting on floor

This position is taken on a floor with even surface. The subject sits with straight back and folds his legs by flexion, abduction and lateral rotation at hips and flexion at knees so that the lower legs crosses each other. In this position weight bearing falls on the ischial tuberosity.

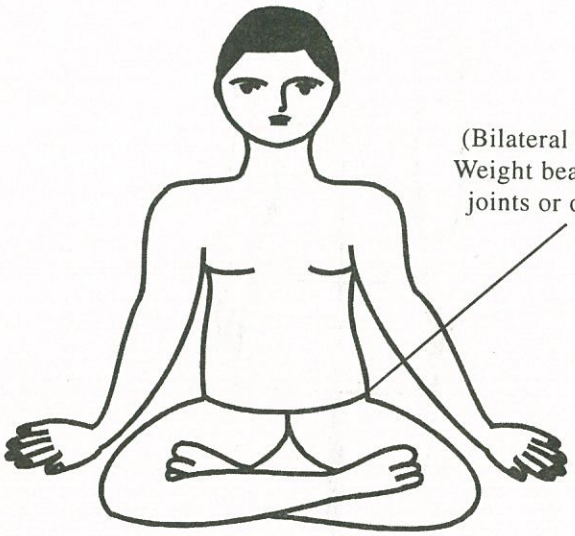


Fig. Cross leg sitting

3. Standing

This is the most difficult of the fundamental positions to maintain, as the whole body must be balanced and stabilized in correct alignment on a small base by the coordinated work of many muscle groups. The position may be described as follows:

i) The heels are together and on the same line, the toes slightly apart (so that the angle between the feet does not exceed 45^0).

ii) The knees are together, straight and neutral position.

iii) The hips are extended and laterally rotated slightly.

iv) The pelvis is balanced on the femur.

v) The spine is stretched to its maximum length.

vi) The vertex is thrust upwards, the ears are level and the eyes look straight forwards.

vii) The shoulders are down and back.

viii) The arms hang loosely at the sides, palms facing inwards towards the body.

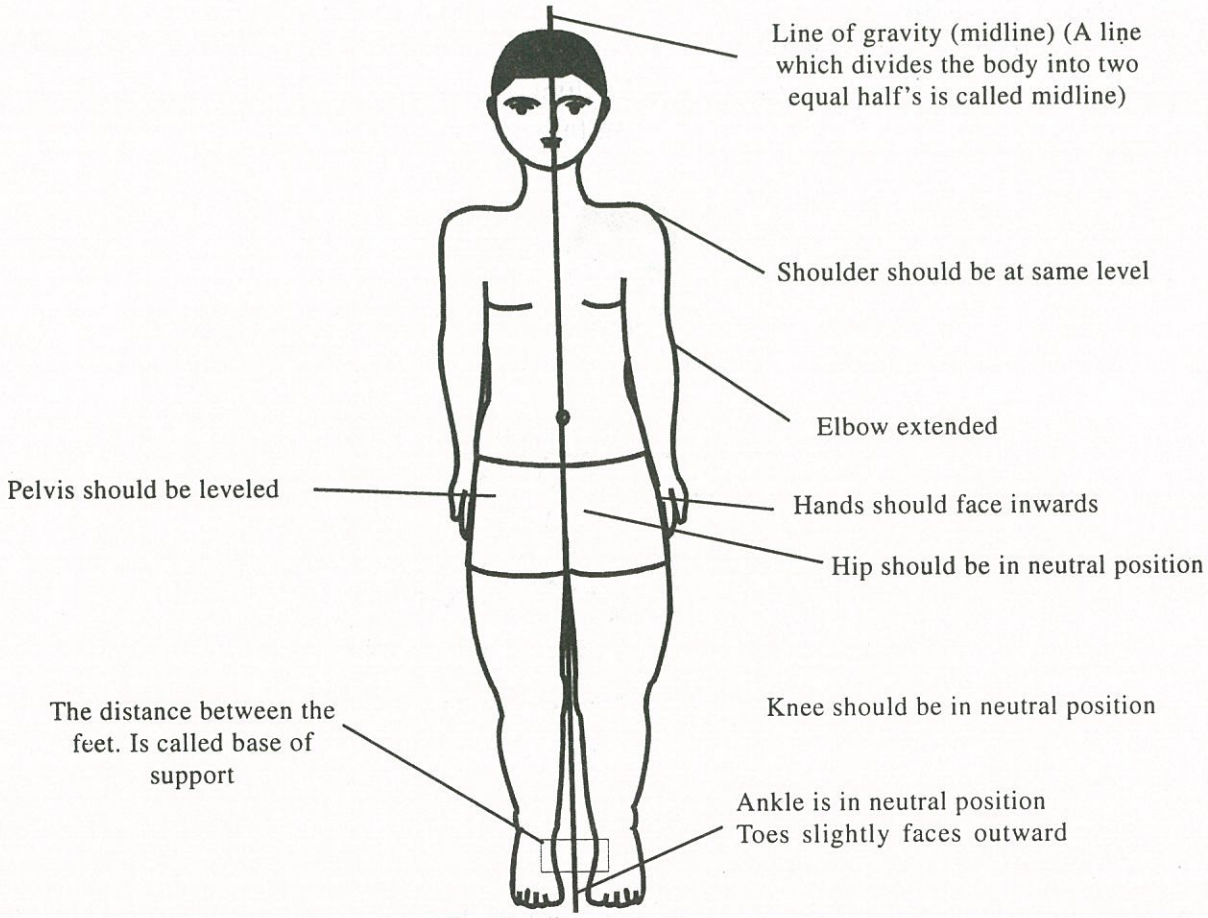


Fig. Standing posture

It is usually preferable to modify the position of the legs so that the heels are slightly apart and the inner borders of the feet are parallel, as this is the natural functional position. Normally, line of gravity (midline) passes through the tip of the nose, tip of the chin and center of the sternum, umbilicus, center of the anterior superior iliac spine, between the knee joints and fall at the center of base of support.

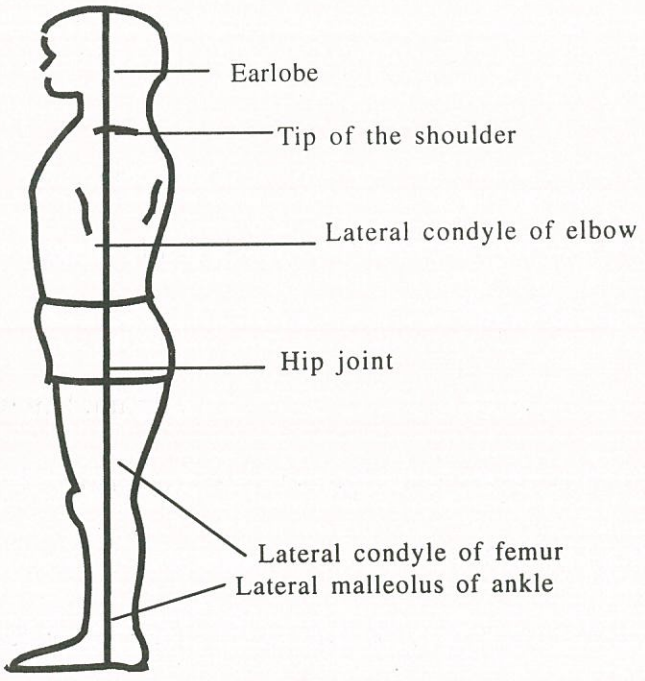


Fig. Standing-lateral view

The line of gravity or the reference line for postural assessment(lateral view) passes from the earlobe through the tip of the shoulder, olecronon process at elbow and greater trochanter at hip, lateral condyle of femur at knee and lateral malleolus at ankle.

Postural deviation

Any deviation of the normal posture can be identified by observing, any change in the above mentioned basic positions. The observations can be made from anterior view, posterior view and lateral views. The different postural deviations leads to deformities and vice versa.

1. Forward head and neck : This can be observed in side view either in standing or sitting position. The earlobe is not aligned (it should be in normal posture) with the tip of the shoulder.

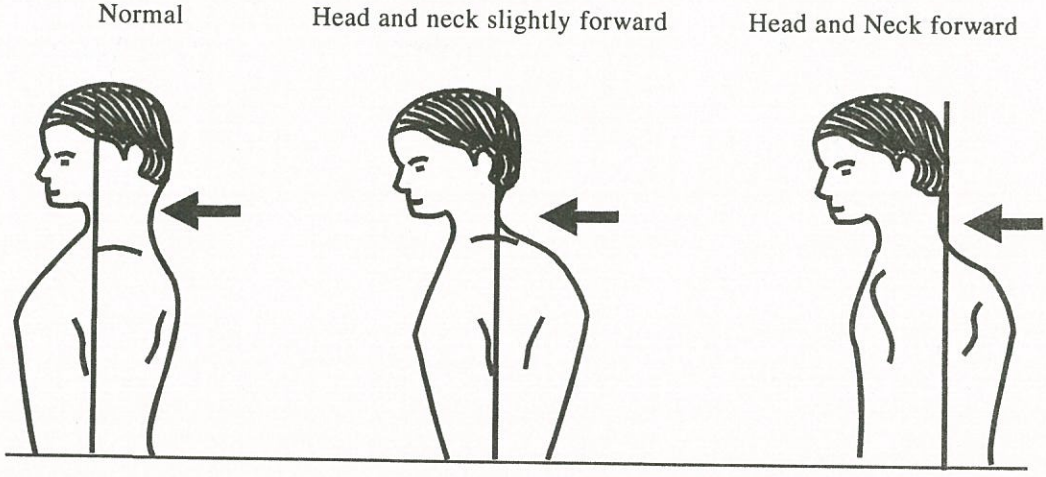


Fig. Head and neck positions (normal and deviated)

2. Excessive head tilt : This can be observed in the posterior and anterior views. In the posterior view, the alignment of the occipital protuberance with the spine is disturbed. From the anterior view, the alignment of the point of chin and nose are deviated from the straight length passing along the xiphoid process, mid points of anterior superior iliac spines, knee's and malleoli at the ankle.

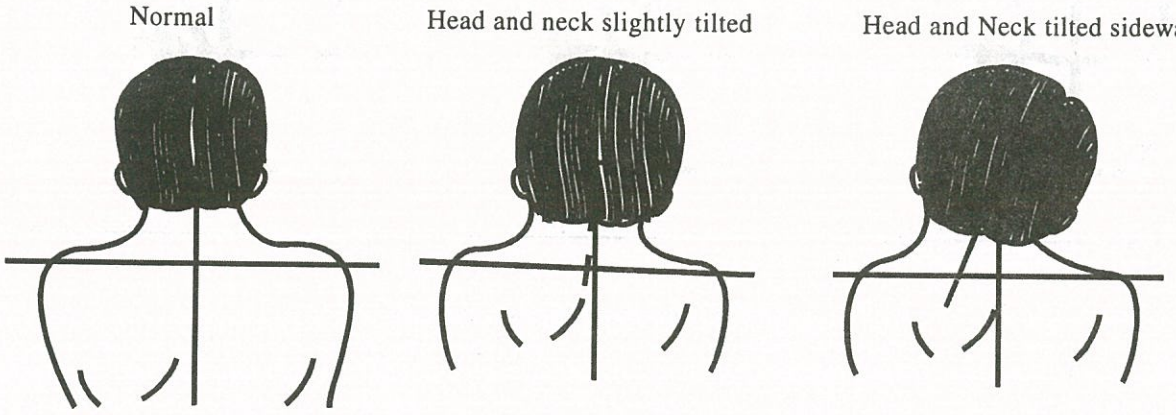


Fig. Excessive head tilt

3. Kyphosis : It is best identified lateral view either in sitting or standing. The normal Kyphotic curve in the thoracic region in exaggerated. The tip of the shoulder bends forward from the line and that passes along earlobe, tip of the shoulder, olecronon process at elbow, greater trochanter at hip and the lateral condyle of femur at knee, and lateral malleolus of tibia.

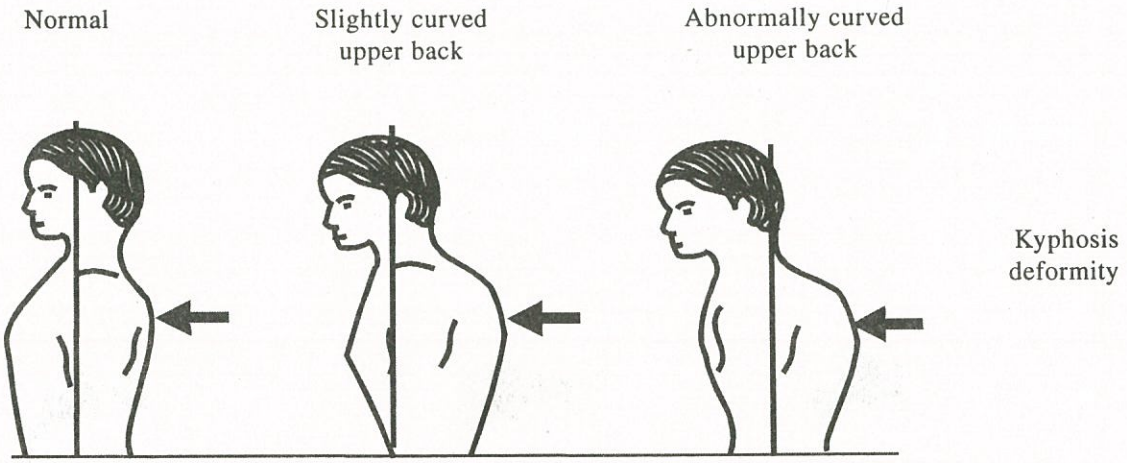


Fig. Deviations of upper back

4. Lordosis : It is the exaggeration of normal lordotic curve in lumbar region. It is also best observed in the lateral view, where the tip of the shoulder is pushed backwards and the lumbar region is pushed forward.

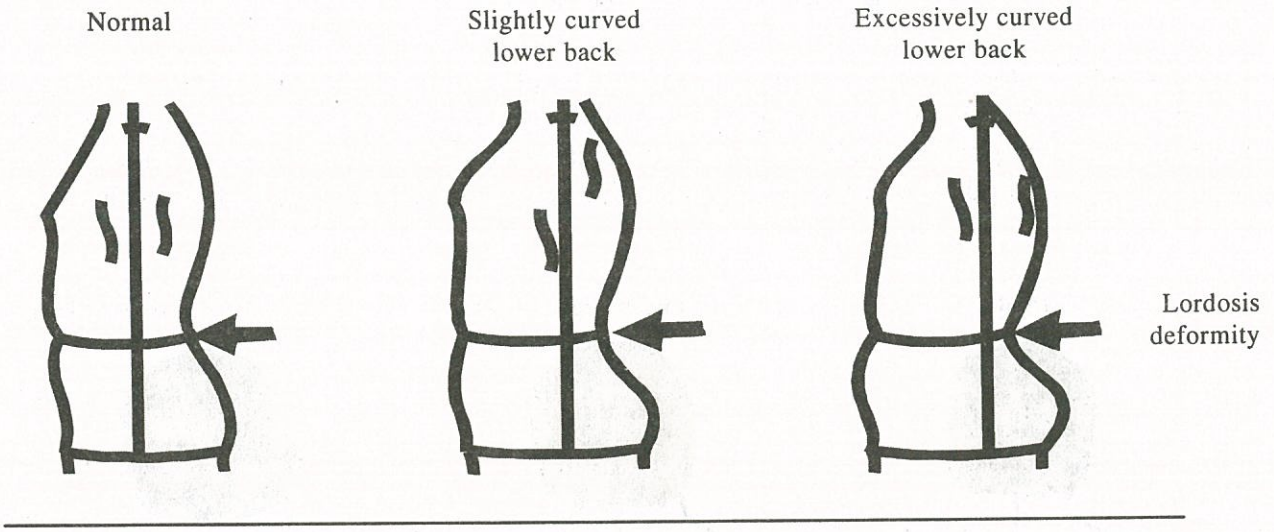


Fig. Curvature of lower back

5. Flat back : It is either a decrease or absence of the normal anteroposterior curves. This can also be best observed in the lateral view, where the pelvis is tilted posteriorly. Back appear too flat, no protrusion of the buttocks. Low back muscles are weak.

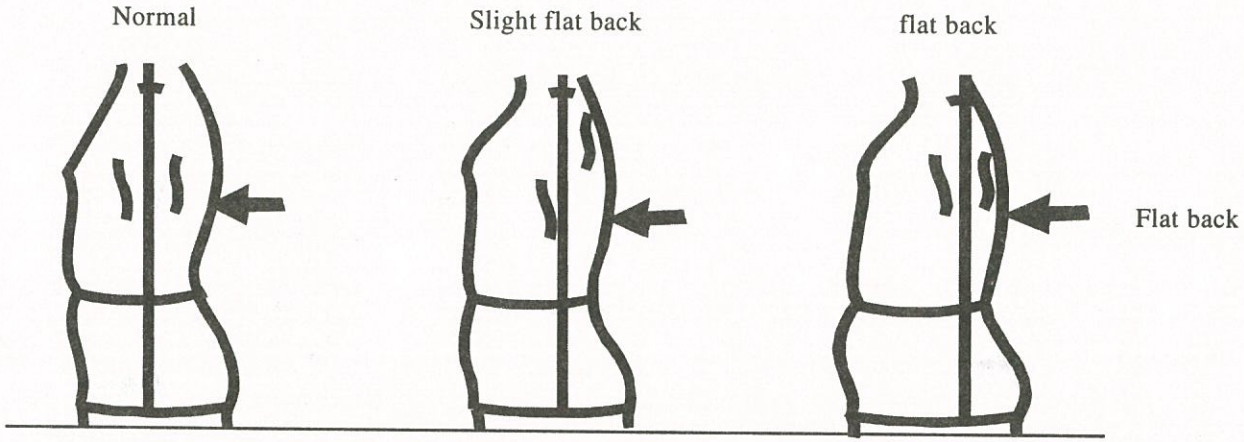


Fig. Decreased curvatures of lumbar spine

6. Scoliosis : It is the lateral curvature of the spine. It can be best observed from the back. The straight appearance of the spine is lost and shows a C-curve appearance. The shoulders and hips are uneven in height.

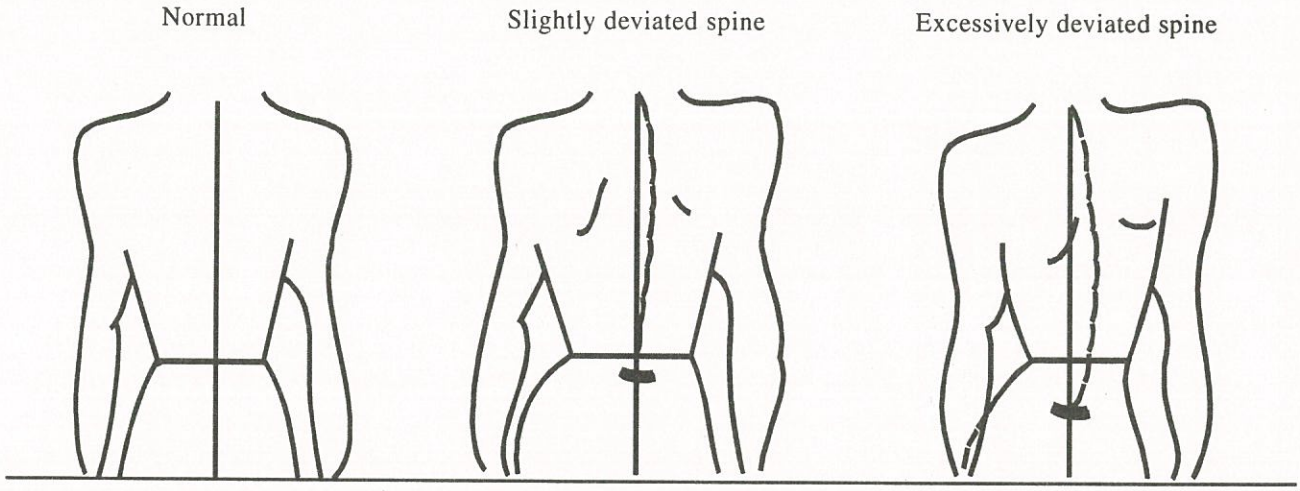


Fig. Lateral deviation of spine

7. Knock knees, bow knees can be observed in standing and lying positions, the knees deviate inwards, towards the midline in knock knees and the knees deviated outwards, away from the midline in bow knees.

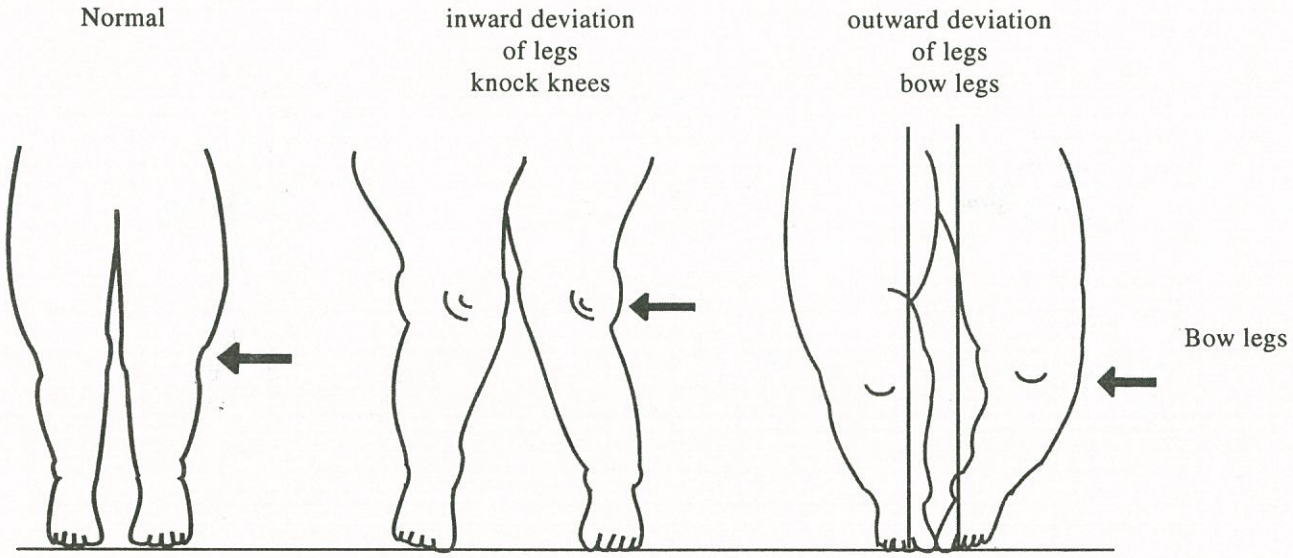


Fig. Deviations of lower limb at knee

8. Genu recurvatum : This can be observed in standing position where the knees deviate backwards. It can occur due to laxicity of joint capsule, ligaments, spasticity in calf muscles and weakness in quadriceps.

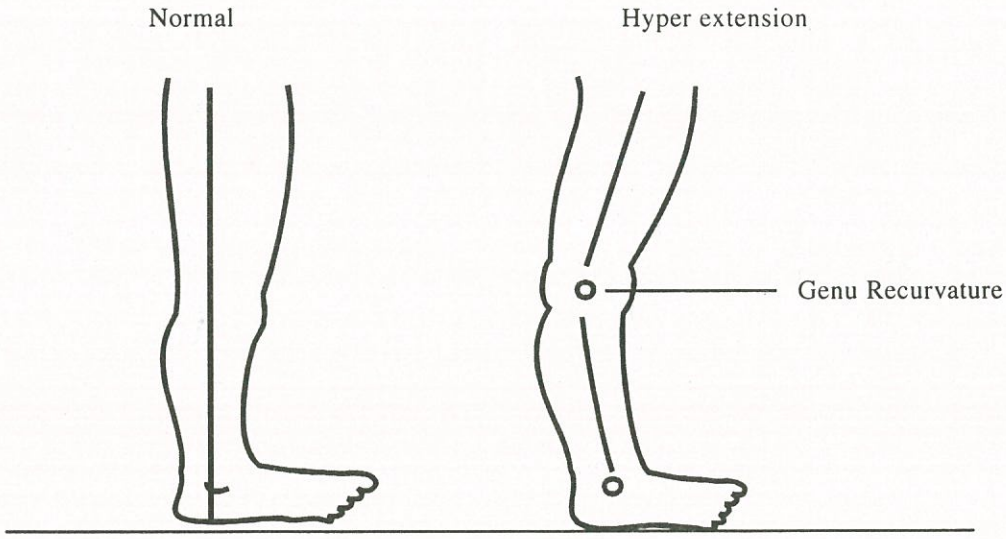
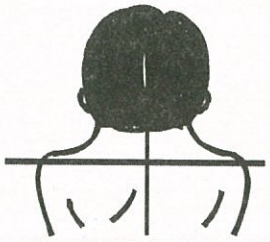
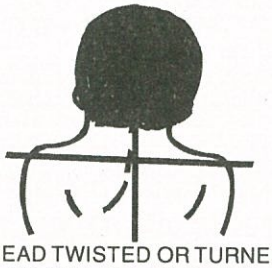
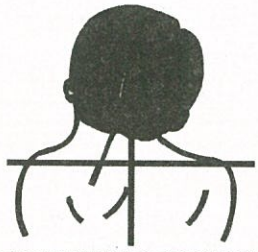
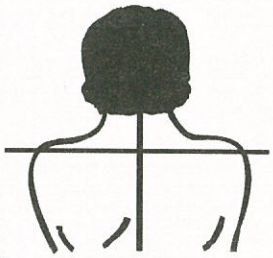
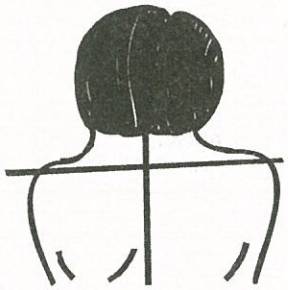
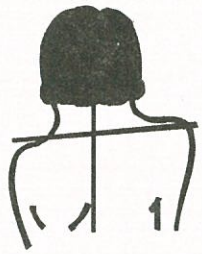
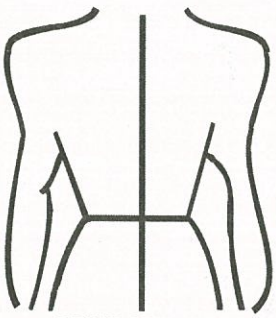
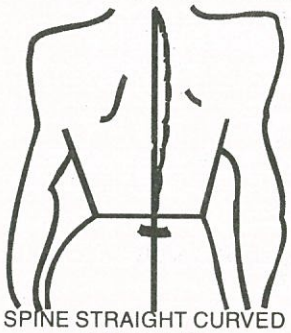
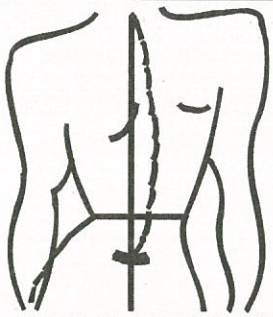
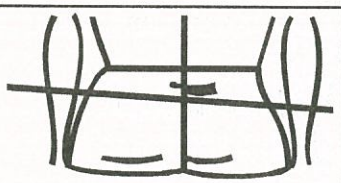
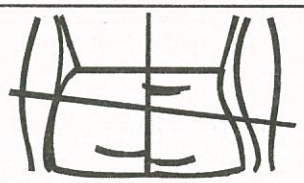
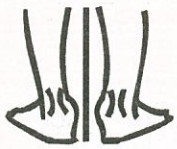


Fig. Posterior deviation of leg at knee

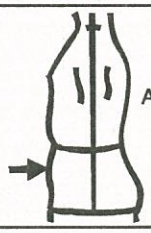
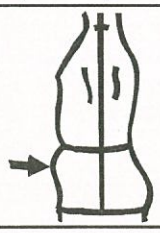
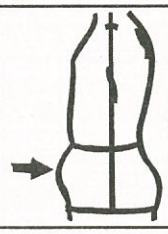
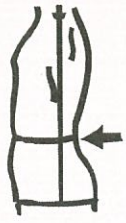
POSTURE
SCORE SHEET NAME _____

	GOOD - 10	FAIR - 5	POOR - 0
HEAD LEFT RIGHT	 HEAD ERECT GRAVITY LINE PASSES DIRECTLY THROUGH CENTER	 HEAD TWISTED OR TURNED TO ONE SIDE SLIGHTLY	 HEAD TWISTED OR TURNED TO ONE SIDE MARKEDLY
SHOULDERS LEFT RIGHT	 SHOULDER LEVEL (HORIZONTALLY)	 ONE SHOULDER SLIGHTLY HIGHER THAN OTHER	 ONE SHOULDER MARKEDLY HIGHER THAN OTHER
SPINE LEFT RIGHT	 SPINE STRAIGHT	 SPINE STRAIGHT CURVED LATERALLY	 SPINE MARKEDLY CURVED LATERALLY
HIPS LEFT RIGHT	 HIPS LEVEL (HORIZONTALLY)	 ONE HIP SLIGHTLY HIGHER	 ONE HIP MARKEDLY HIGHER
ANKLES	 FEET POINTED STRAIGHT AHEAD	 FEET POINTED OUT	 FEE POINTED OUT MARKEDLY ANKLES SAG IN (PRONATION)

In above given postural score sheet (good posture with a score of 10) the line of gravity passes directly erect through the head at the shoulders, it passes horizontally at the spine straight and at the hips horizontally at ankles and it passes straight ahead with foot pointed down.

With the postural score sheet of 5 which is said to be fair. In head the line twisted and turn to one side slightly at shoulders, shoulder is slightly higher than the other, spine straight curved laterally, hip slightly higher than the other and the foot pointed out.

With the postural score of 0 said to be poor in which head twisted or turn to one side markedly, one shoulder markedly higher than other, spine markedly laterally, one hip markedly higher, foot pointed out markedly ankles sag in (pronation).

NECK	 NECK ERECT CHIN IN HEAD IN BALANCE DIRECTLY ABOVE SHOULDERS	 NECK SLIGHTLY FORWARD, CHIN SLIGHTLY OUT	 NECK MARKEDLY FORWARD, CHIN MARKEDLY OUT
UPPER BACK	 UPPER BACK NORMALY ROUNDED	 UPPER BACK SLIGHTLY MORE ROUNDED	 UPPER BACK MARKEDLY ROUNDED
TRUNK	 TRUNK ERECT	 TRUNK INCLINED TO REAR SLIGHTLY	 TRUNK INCLINED TO REAR MARKEDLY
ABDOMEN	 ABDOMEN FLAT	 ABDOMEN PROTRUDING	 ABDOMEN PROTRUDING AND SAGGING
LOWER BACK	 LOWER BACK NORMALLY CURVED	 LOWER BACK SLIGHTLY HOLLOW	 LOWER BACK MARKEDLY HOLLOW

With postural score of 10, head, neck erect and balance directly above shoulders. Upper back is normally rounded, trunk erect, abdomen flat, lower back normally curved.

With the postural score of 5, neck slightly forward, chin slightly out, upper back slightly more rounded, trunk inclined slightly, abdomen protruding, lower back slightly hollow.

With the postural sheet 0 which is said to be poor, neck markedly forward, chin markedly out, upper back markedly rounded, trunk incline, abdomen protruding, lower back markedly hollow.

* * *

CHAPTER 11

PHYSIOTHERAPY ASSESSMENT FORM

Name _____ Age _____ Sex _____

Diagnosis _____

A) Posture

a) Lying
b) Sitting
c) Standing
d) Crawling
e) Kneeling

(Give the details of the posture in each position)
(Write only brief description of what you observe)

B) Gait

(Write only brief description of what you observe)

C) Muscle Tone (Normal / Hypertone / Hypotone / Fluctuating)

(Examine tone at least at Elbow & Hip joints)
(Assess the nature of the tone on activity)

D) Involuntary movements

E) Nutritional status of muscles
Muscle wasting
Atrophy of muscles

F) Tone, Bulk and Girth of muscles

G) Joint range of motion and muscle power

Range of Movement (in degrees)

(For ROM, please mark only those joints where ROM limitations i.e. stiffness is observed)._

Shoulder Joint

Extension	- 45^0
Flexion	- 90^0 + Elevation - 90^0 = 180^0
Abduction	- 90^0 + Elevation - 90^0 = 180^0
Adduction	- 70^0
Internal Rotation	- 90^0
External Rotation	- 90^0 (70^0 - 80^0)
Circumduction	- 180^0

Elbow Joint

Extension	- 0^0
Flexion	- 135^0

Radioulnar Joint

Pronation	- 90^0
Supination	- 90^0

Wrist Joint

Extension	- 80^0
Flexion	- 90^0
Ulnar deviation	- 35^0
Radial deviation	- 20^0

Metacarpophalangeal Joint of Thumb

Flexion	- 80^0
Extension	- 0^0
Abduction	- 20^0
Adduction	- 30^0
Opposition	- Ability to touch tip of the thumb against the tip of fingers.

Metacarpophalangeal Joint of Fingers

Flexion	- 90^0
Extension	- 0^0

Upper limb	
Right	Left

Proximal interphalangeal Joint
Flexion - 130^0
Extension - 0^0

Distal interphalangeal Joint
Flexion - 90^0
Extension - 0^0

Hip Joint
Extension - 15^0
Flexion - 90^0 with knee straight & with knee bend - 115^0.
Abduction - 45^0
Adduction - 35^0
Internal Rotation - 45^0
External Rotation - 45^0
Circumduction - 180^0

Knee Joint
Extension - 0^0
Flexion - 135^0

Ankle Joint
Plantorflexion - 35^0
Dorsiflexion - 20^0

Subtaloid Jt.
Eversion - 20^0
Inversion - 35^0

Metacarpophalangeal Joint
Extension - 0^0
Flexion - 60^0

Proximal interphalangeal Joint
Flexion - 90^0
Extension - 0^0

Distal interphalangeal Joint
Flexion - 60^0
Extension - 0^0

Intervertbral Joints of Cervical Area
Flexion - 45^0
Extension - 45^0
Side flexion(Right / Left) - 45^0
Lateral Rotation(Right / Left) - 45^0 - 60^0

Lower limb	
Right	Left

Intervertbral Joints of trunk

Flexion	- 80^0
Extension	- 25^0
Lateral Rotation(Right / Left)	- 45^0
Side flexion(Right / Left)	- 35^0

(Please Note: Movements at individual intervertebral joint can not be measured because the movements never takes place in single joint, it's a combined action of all joints.)

Muscle Power Grade (M. P. in grades)

(For M.P. Please mark all muscle groups. Enter the grade 0-5 for the same.)

0 - No muscle contraction.
1 - Flicker muscle contraction.
2 - Muscle contraction sufficient to move the Joint fully (full ROM) with reduced gravitational force or gravity eliminated position.
3 - Muscle contraction sufficient to move the Joint fully (full ROM) against gravity.
4 - Muscle contraction sufficient to move the Joint fully (full ROM) against gravity + minimal resistance.
5 - Muscle contraction sufficient to move the Joint fully (full ROM) against gravity + maximum resistance.

H) **Contracture and Deformity**

a) Fixed - Tightness, contracture and deformities can be full / partially.
b) Stretchable - Whether it is passively, actively stretchable or not.

(Write only the type wherever applicable)

I) **Primitive Reflexes :** (Mark those reflexes which are present)

Grasp reflex of fingers and toes	:
Moro	:
Galant	:
Rooting	:
Sucking	:
ATNR(Asymmetrical Tonic Neck Reflex)	:
STNR(Symmetrical Tonic Neck Reflex)	:
Extensor thrust	:

Cross extensor	:
Righting reaction	: (Head / Neck / Trunk)
Equilibrium reaction	:
Balance reaction	:
Protective reaction of arm	: Parachute reaction
(Forward / Backwards / Sideway's)	
Flexor withdrawal	:
Stepping	: Neonatal reaction
Placing	:
Tonic labyrinthine	: Abnormal reaction

[Note : Maintain the positive and negative signs depending upon age of the child and pathological factors.]

Motor Functions

Gross motor functions :

1. Supine
2. Prone
3. Head raising in prone and supine
4. Head control
5. Rolling
6. Sitting with support
7. Coming up to sitting with support or without support
8. Sitting
9. Crawling
10. Standing
11. Walking
12. Standing on one leg
13. Climbing up
14. Climbing down
15. Running

Fine motor functions

1) **Reach -** Forward
Sideways
Backwards
Vertical
Upward
Initially it is unilateral then child learns bilateral control.

2) **Grasp -** Palmar
Ulnar
Radial
Functional
Functional tripod
Mature grasp-cylindrical grasp or power grasp.
Hook grasp
Key grasp, inferior pinch
Spherical grasp / pincer grasp
Opposition
Plate grasp
Pinch grasp
Disc grasp

4) **Release -** Involuntary release
Voluntary release

5) **Sensations -** Touch / tactile two point discrimination
Pain
Temperature
Stereognosis
Barognosis

6) Any other salient features

Other associated problems - Congenital abnormalities
MR
Speech + Hearing impairment
Perceputal loss
Drooling
Visual impairment
Optic atrophy
Nystagmus
Epilepsy
Hyper activity
Behaviour problems
(cooperative/non cooperative, behaviour at child during therapy)

(Mark only those functions which are present)

3

Parents are to be observed how they are handling the child at home.

Date : Signature

* * *

CHAPTER 12

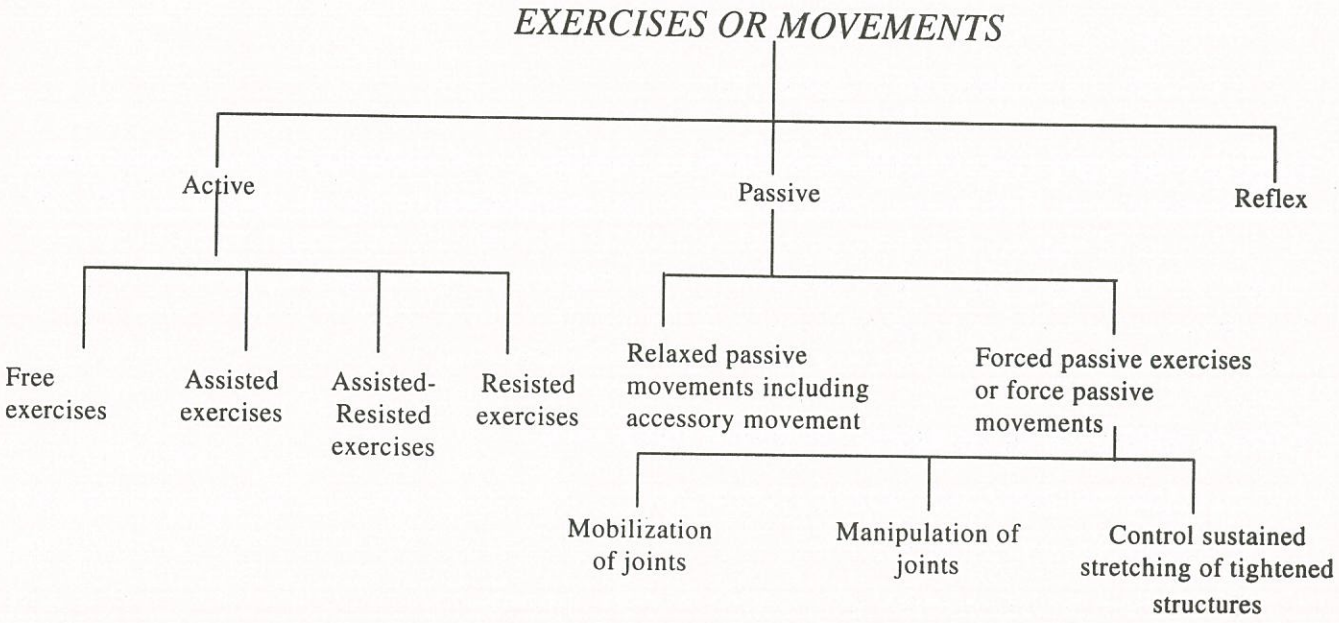
EXERCISE THERAPY

Definition

It is defined as, an application of various graded exercises, methods and techniques in order to improve the muscle strength, mobilize the joints so that the lost or impaired function of the musculo skeletal system can be regained adequately, to facilitate locomotor function and activities of daily living.

Exercises means any form of movement which is alternate, rhythmical contraction and relaxation of muscles which produces movement which is repeated number of times according to the ability of the person.

CLASSIFICATION OF EXERCISES OR MOVEMENTS



1. **Active movements:** Exercises performed or done by the person himself by voluntarily contraction of muscles. This is possible only when there is a sufficient muscle strength and power to move the joint. Active exercises or movements are subdivided into four categories.

   [These exercises are possible only when there is a sufficient muscle power and joint mobility]

a. *Free exercise.* These movements are performed voluntarily by muscular effort, without assistance or resistance of any external force except the gravitational force.

Effects and uses of free exercises

- It is useful to keep the general body fitness.
- Improve joint range of motion
- Induce relaxation
- Improve neuromuscular coordination
- Maintains muscle power and tone.
- It is useful in Mentally Retarded person.

b. *Assisted exercise.* Movement of any part of the body is assisted by the application of external force to compensate or overcome the deficiency due to inadequate muscular strength or coordination.

Effects and uses of assisted exercises

- Increases the strength of weak muscles.
- It helps to correct pattern of movement.
- To increase joint range of motion.
- It is useful for persons with Cerebral Palsy.

c. *Assisted-resisted exercise.* These exercises are combination of assistance and resistance during a single movement. It is applied when the person cannot produce the full movement or complete the full range of motion with resistance. Here assistance is given at that stage, where the person cannot move the body part or joint and resistance at that point of the range of movement in which he is able to move the body part and complete the movement(assistance is given to weak muscle and resistance to strong muscles, during a single movement).

Effects and uses of assisted - resisted exercises

- Increases the joint range of motion of the joint.
- It corrects the pattern of movement.
- To improve power, strength and endurance of the muscles.

d. *Resisted exercise.* Resisted exercises are performed when there is sufficient muscle power but not normal (External force is applied in the form of springs, body weight, dumbbells, sandbags weights, elastic, tubes, etc). It is applied when the person has adequate muscle power to move the joint. Resistance means applying a force manually or mechanically which acts in opposite direction to that of movement.

Effects and uses of resisted exercises

- Improves muscle tone
- Prevents muscles wasting.
- Improves muscle bulk.
- Increase muscle Power
- Increase Endurance
- Increase Volume or girth of the muscle.
- Increase Speed of contraction
- Increase Coordination
- Increase blood circulation, nutrition and metabolism and enhances the capacity of the soft tissue.
- Prevents and corrects contractures and deformities.
- Maintain or increases range of motion, regains the properties of muscle tissue like contractibility and extensibility.

2. Passive movements. These movements are done by the therapist by applying external force, when the person himself can not move the joint due to lack of sufficient muscle power and strength in the muscles.

a. Passive movements are classified into the following categories

1) *Relaxed passive movements, including accessory movements:* The therapist performs these movements accurately and smoothly. These movements are applied only when a person cannot perform movement voluntarily by contracting the muscles.

Effect and uses of relaxed passive movements

- To maintain normal range of joint motion by preventing formation of adhesions.
- Preserves the memory of movement patterns.
- The venous and lymphatic return can be maintained.

2) *Accessory movements:* These are minute movement that occur, as a part of the normal joint movement. These can be gliding or rotational movement.

Effects and uses of accessory movements

- Maintenance of normal joint functions.
- Joint range of motion can be maintained or regained by restoring the accessory range of motion in the joint.

b. Passive manual mobilization techniques.

1) *Mobilization of joints.* These are small rhythmical oscillatory repetitive localize accessory or functional movement, performed by the therapist in various amplitudes in the available range and under persons control.

2) *Manipulation of joints.* These are accurate, localized, single movements, to bring the joint or part of body in a neutral or functional position.

3) *Controlled sustained stretching of tightened structures.* Soft tissues such as muscles, ligaments are gently stretched to increase the joint range of motion.

Effects and uses of accessory movements

- Increased joint range of motion.
- Increase the elasticity or extensibility of muscle tissues.
- To prevent soft tissue injuries prior to vigorous activities such as in sports.

The exclusive uses of passive exercises are given below

- It helps to educate or reeducate the person in the activities which he has lost.
- It helps to teach the person, how to perform movement on his own.
- It prevents muscles wasting and atrophy of muscles during the period of inactivity.
- It prevents or corrects contractures and deformities.
- It maintains blood circulation, nutrition to the muscles.
- Helps to regain or maintain joint range of motion.
- Prevents joints stiffness.
- Slow rhythmical passive exercises helps to reduce tone.
- Gives relaxation effect.

3. Reflex Movement. It is involuntary motor response to sensory stimulation which are protective in nature. At birth all the movements are reflex in nature upto certain age. These reflexes will be integrated and gets controlled from the central nervous systems.

Uses of reflex movement

- Reflex movement promotes the activity of the neuromuscular mechanism.
- Extensibility of muscles and movement are maintained by this type of reflexes, relaxation of spastic muscles, provides the opportunity for the development of voluntary ability to perform movement.

- Contraction of muscles improves blood circulation.
- Postural reflexes are conditioned, to produce a satisfactory pattern of posture by repeated use of these pattern.
- By using this reflex movement response, a movement can be gained and is used for skilled activity.
- Therapy can be planned by using the reflex mechanism.
- Person can be trained in the activities.
- Motor development can be facilitated.

* * *

CHAPTER 13

BALANCE

Balance : Balance means the correct alignment of one part of the body upon another is called balance.

A body is said to be in balance, when the base of support, and the position of the centre and line of gravity are maintained is known as balance (or) equilibrium.

Balance is the base of all static and dynamic postures and should be considered when planning any therapy programmes. As balance and posture are inter-dependent, balance must be maintained otherwise the force of gravity may impose the change on posture. Balance reactions are used to facilitate the contraction of selected muscle groups and therefore it is used as a part of the muscle strengthening programme.

The maintenance of balance is dependent on one hand, upon the integration of sensory input from exteroceptors, proprioceptors and the special senses-the eyes and the vestibular apparatus, and on the other, on an integrated motor system and the basic postural reflexes(emerging reflexes).

There are two approaches to balance, both of which are necessary for normal functions-

1. Static balance
2. Dynamic balance

Static Balance

Static balance is the rigid stability of one part of the body upon another and is based upon isometric co-contraction of muscle.

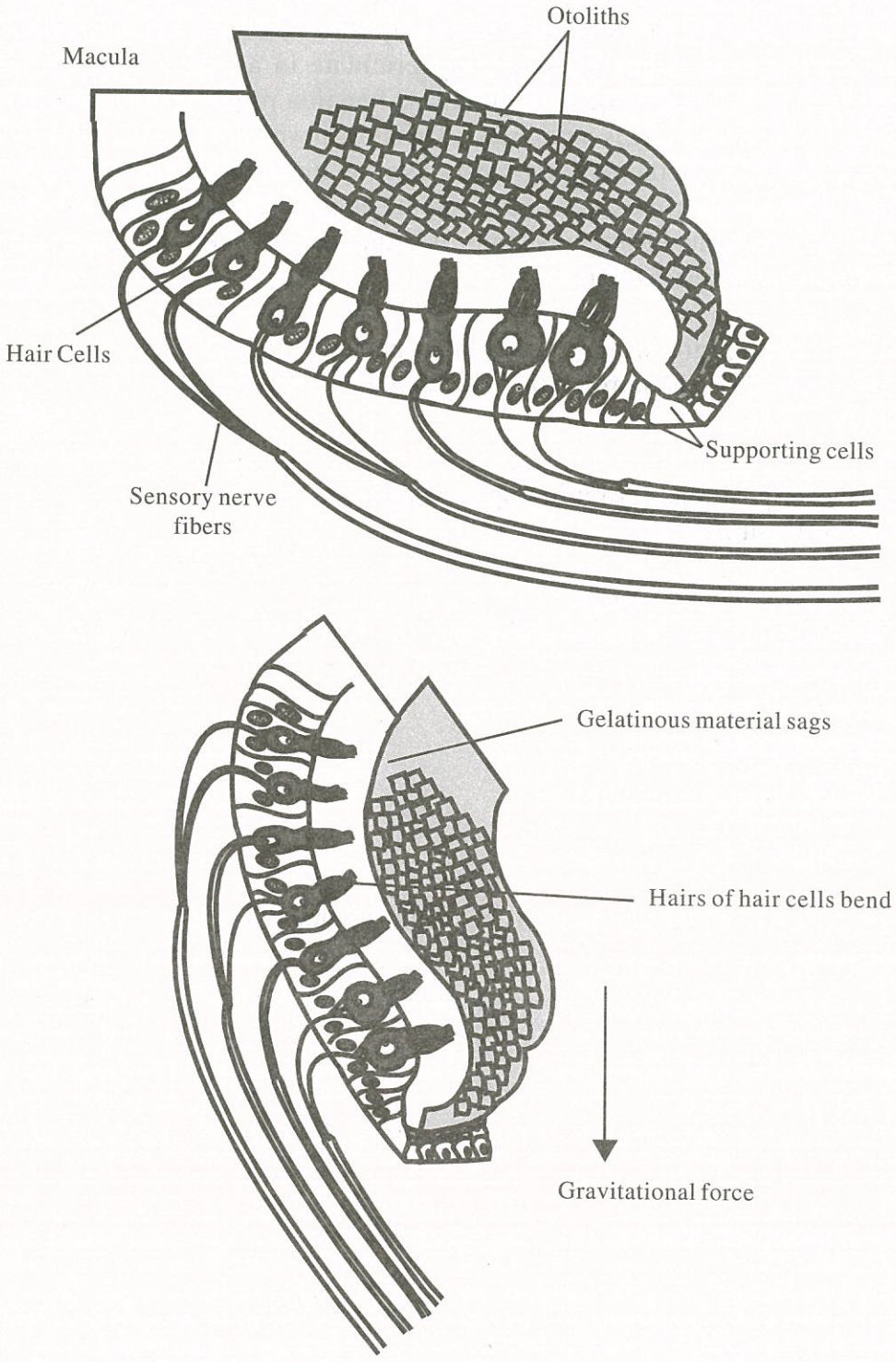


Fig. Organs of static balance (equilibrium)

Organs pertaining to static equilibrium include the vestibule, utricle, saccule, and macula. The vestibule is the bony chamber between the semicircular canals and the cochlear. The membranous labyrinth(tube) inside the vestibule has two parts, the utricle(larger) and the saccule(smaller). The exact function of the saccule is not yet known, so static equilibrium can best be explained in terms of the macula within the utricle. The macula is the structure that contains the hair cells, that are receptors for changes in head position. The hairs of the hair cells extend upward when the head is in upright position and downward when the head bends because they terminate in a mass of gelatinous material that is responsive to gravity. The static equilibrium organs function primarily in maintaining the stability of the head and neck when the body is motionless. This is achieved through the tonic labyrinthine reflexes in early infancy and later by the righting reactions. Any movements of the head and neck stimulates the macula within the labyrinths (vestibular input) as well as the kinesthetic receptors within the muscles, tendons, and joints of the neck; thus, it is impossible, for all practical purposes, to separate static equilibrium and kinesthetic input.

Balance is developed progressively by moving a person from the most stable position to the least stable position. Stability and control of the head should be established first as it is vital in all positions.

Approach

As indicated above, positions for retraining of balance are selected on the basis of progression from the easy to the difficult positions.

Example : Forearm Support Prone Lying
Forearm Support Prone Kneeling
Prone Kneeling
Reach Grasp Kneeling
Half Kneeling
Sitting
Walk Standing
Standing

Resistance is applied to all the components needed to maintain a particular position. Selection is made from the following:

- Head
- Shoulder
- Pelvis
- Knees
- Toes for gripping the floor

The direction of the resistance will vary with the point selected, for example-

1. The pelvis
- Forwards and backwards
- Laterally
- Diagonally
- Rotation

2. The knee
- Forwards and backwards

A combination of stabilizing points may be used to an advantage, e.g. the shoulder and the pelvis, the head and the pelvis, the pelvis and the knee.

Dynamic balance

The body is under constant state of adjustment to maintain or regain posture and equilibrium in response to changes in body posture is known as dynamic balance. The minor adjustment requires, either isometric or isotonic type of contraction of muscles. The gross or major adjustment requires isotonic contraction of muscles.

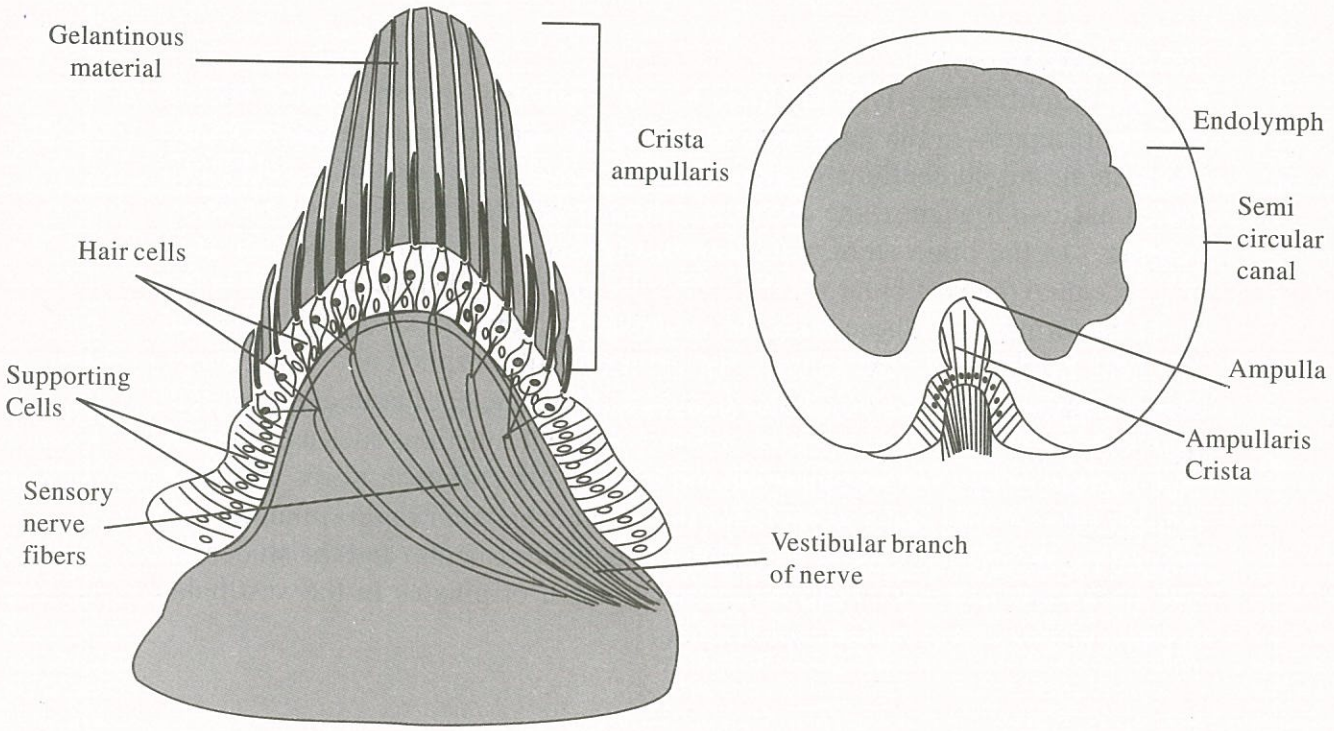


Fig. Organs of Dynamic equilibrium (Balance)

Organs pertaining to dynamic equlibrium include the three bony semi circular canals in the inner ear. At the bottom of each semicircular canal there is a swelling called the ampulla, contains sensory receptors, which is called a crista ampulla. This structure contains hair cells that extend up into a gelatinous mass and remain upright when the head is motionless. In contrast, when the head moves rapidly, as in falling or in spinning, twirling or rolling activities, the gelatinous mass moves in the direction of the head movement, thereby bending and stimulating the hair cells, the dynamic equilibrium organs functions primarily in balancing the head and neck when it is rapidly rotated or moved.

The vestibular system is well developed at birth, as is evidenced by the calming effect of cradling or rocking the infants in arms, crib or rocking chair. Swings, seesaws, merry-go rounds and other playgrounds apparatus owe their popularity to children's natural craving for vestibular stimulation. The use of balance boards, various kinds of balance beams, swing, bridges and trampolines in early childhood helps to stimulate vestibular system.

Balance is acquired

a. By the adjustment of tone to maintain the position and

b. By adjustment of posture to regain balance.

Vestibular system

Balance (equilibrium) is determined by the vestibular system, which has its sensory receptors in the inner ear. Impulses are carried from this point to the brain stem and cerebellum via the eighth cranial nerve.(vestibulo-cochlear), which has two branches: the cochlear, which transmits impulses pertaining to hearing. In the brain stem, equilibrium impulses end up in masses of gray matter, called the vestibular nuclei, which are specialized structures with in the reticular formation. These relay the impulses (which reflexe change the head and neck positions) to the spinal cord via the vestibulospinal and other tracts. Concurrently, they relay vestibular impulses to the nuclei of cranial nerves that innervate the extrinsic eye muscles and such visceral functions such as dizziness and nausea. This anatomical sketch of the interrelation ships between equilibrium, vision, and viscera helps to explain why, after rapid spinning, it is normal for the eyes to exhibit nystagmus (rapid movements) and the student to feel nauseous or dizzy. Motion sickness, which originates in the vestibular system, also involves vision and viscera.

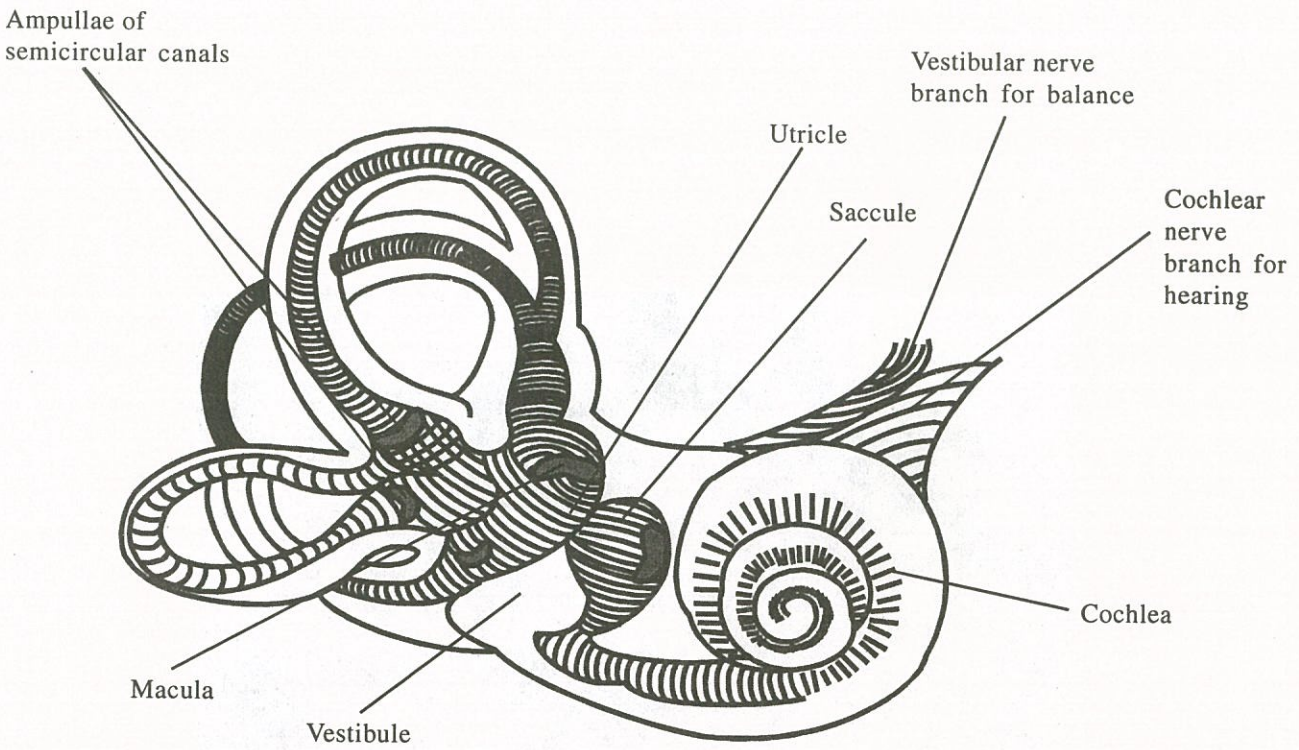


Fig. Vestibular system in the inner ear

Maintenance of balance

This method, allows for little movement. The person is asked to maintain the position against the therapists tapping technique. For example: When a person is standing, a tap on the back, causes the calf muscle to contract and prevents him to fall forwards similarly a tap infront causes the contraction of anterior tibial muscles and prevents him to fall backwards.

Maintaining or regaining balance

Balance reactions are immediate and reliable and are not learned at a voluntary level, so the person is not instructed how to react but is subjected to such a situation that he has to react to maintain balance. Knowledge about normal balance reaction helps the therapist to correct the abnormal reaction.

Balance training in various positions

Lying

This position is used to stimulate trunk movements. Person has to react to remain on the board when it is tilted from side to side.

Fig. Balance training in lying position

Prone kneeling

In training balance reaction, in this position, one of the limbs (lower limbs) is lifted off the support. The normal reactions will be either lifting the contra lateral limb (in case, the passively lifted leg is abducted) or ipsilateral limb(in case passively lifted leg is adducted).

Training balance in prone kneeling

Fig. Lower limb abducted

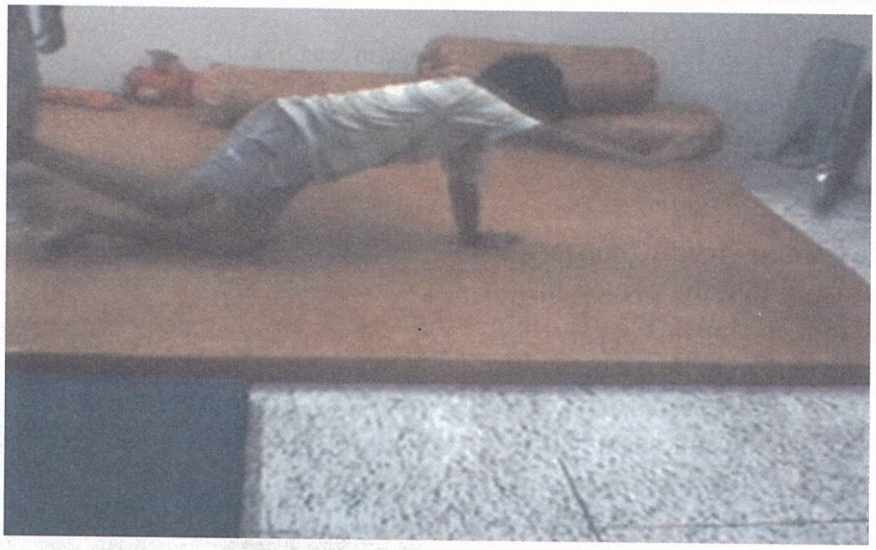


Fig. Lower limb adducted

Kneeling

Child should be trained in kneeling balance, first by transferring the weight forwards so that the person has to reacts by abducting the arms and extending the fingers and thumb, flexing the knees and plantar flexing the ankle. On transferring the weight laterally, the arms should abduct and the fingers extend. The non weight bearing leg is abducted.

Fig. Sideways balance in kneeling

Standing

In standing, balance training first by transferring the weight backwards, in that the person has to react by dorsiflexion at the ankle. Further disturbance causes the person to take a backward step. If the weight is transferred forwards it causes plantar flexion at the ankle and makes him to stand on his toes. Further disturbance causes the person to take a forward step. On transferring the weight on one foot, the person either abducts the non-weight bearing leg or crosses it in front of the weight bearing leg. Standing on one foot with the contra lateral leg flexed at knee and held by the therapist, slight movement will result in considerable activity of the standing foot. Further movement of raised leg by the therapist will cause the person to move either by doing a heel-toe pivot or by hopping.

Fig. Forward balance in standing

Fig. Unilateral stands balance

Fig. Sideways balance in standing

Fig. Backwards balance in standing

Sitting

Child should be trained in sitting on table, first by transferring the weight backwards in which the persons reacts by extending the knees. The person reacts by flexing the knees when the weight is transformed forward. When weight is transferred forwards the person reacts by further flexion of knees. On transferring the weight laterally the persons reacts by moving the limbs into abduction on the contra-lateral side.

Fig. Lateral balance in sitting

Fig. Forward balance in sitting

Fig. Backward balance in sitting

Training balance in cross sitting position

When the child is in a cross sitting position, put a tap at the shoulder in a forward direction, the tap (force) should be strong enough to disturb the child balance but it should not cause the child to fall down. The child will throw his upper limbs in a forward direction to save himself from falling down. Similarly if a tap is given in a backward direction the child will throw his upper limbs in a backward direction to protect himself. If the tap is given laterally the child will throw his upper limbs sideways.

Protective extension reaction of the arms

It is necessary to facilitate this reaction in persons with Central Nervous System damage when balance reactions fails to develop. The following ways to elicit the balance reaction in different positions.

1. The person is placed in the sitting position.

    a. The therapist holds the unaffected arm and transfers the persons weight sideways towards the affected side.

    b. The therapist holds the affected arm, either using one of the hands to keep the persons wrist and fingers extended and by thumb abducted the other hand to control the elbow, or using both hands to maintain the extended wrist, fingers and the abducted thumb. Some of the persons weight is then transferred through the affected arm. The therapist may then use a pull-push technique in the long axis of the limb to facilitate the protective extension reaction.

2. The person is placed in the prone kneeling position. The therapist raises either one or both of the person's arms by grasping at the shoulder and releases the grasp.

3. The person is in standing position. The therapist stands facing the person and grasps the hands, palm-to-palm, keeping the wrists extended and if possible the thumbs abducted. The person's arms are raised into reach position and the therapist gently pulls the person towards himself so transferring his weight forwards. The push-pull technique through the longitudinal axis of the arm may again be used to elicit a response.

The reactions of some person's may be speeded up by pushing them forwards onto a plinth or wall. The therapist may control the person by retaining hold on one arm.

* * *

CHAPTER 14

MASSAGE

Massage is one of the treatment technique used in physiotherapy, rhythmic movements with the help of both hands in a particular manner and directions are given on the persons affected part of body, even pressure executed with palmar surface of hands including fingers by using different techniques. A number of strokes given, differ with every individual. It can be stationary or progressive.

The various massage techniques are given below:

1. Effleurage or stroking

2. Petrissage
   - Kneading
   - Picking up
   - Wringing up
   - Rolling
   - Shaking

3. Percussion
   - Hacking
   - Clapping
   - Vibration
   - Beating
   - Pounding
   - Tapping

4. Shaking
   - Friction
   - Shaking

Effleurage

In this technique, the hands pass over the soft tissue with even pressure, which exerts soothing effect and will assist fluid to flow through the tissue spaces, lymph vessels and veins, distal to proximal.

Fig. Effleurage

Stroking

Stroke the area to be treated with hands and fingers rhythmically, applying even pressure, which produces relaxation.

Fig. Stroking

Kneading

This technique is performed with the pads of the fingers and palmar surface of hands. It is useful to break down the adhesions around the joints.

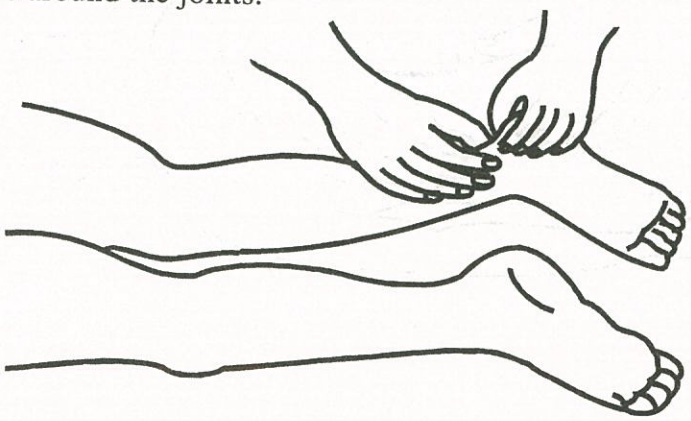


Fig. Kneading

Picking up

This technique involves, lifting the tissues up, at right angles to the underlying bone, squeezing and releasing. Tissue mobility is therefore obtained.

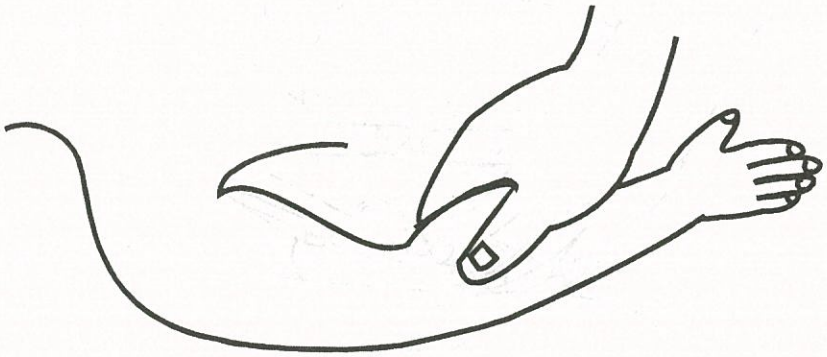


Fig. Picking up

Wringing

This technique involves lifting the tissues, squeezing it and then the muscle are twisted up.

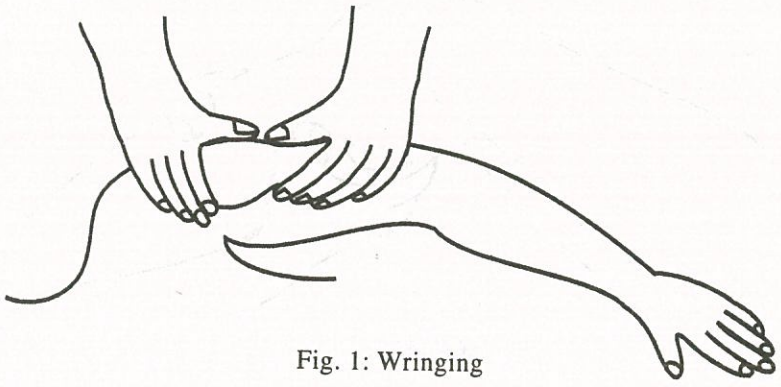


Fig. 1: Wringing

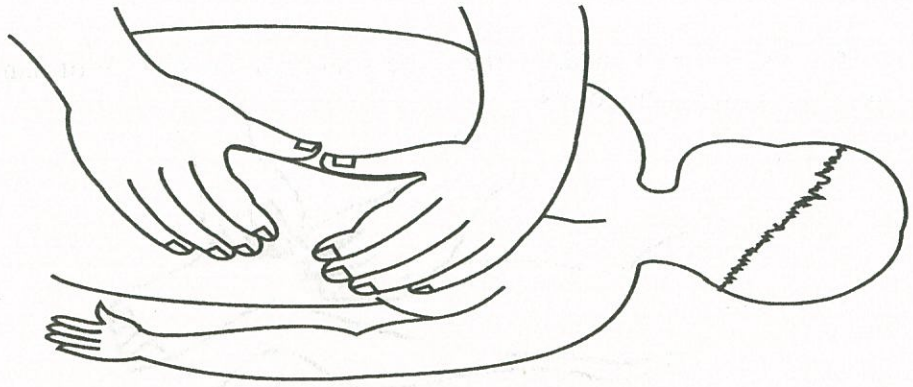


Fig. 2: Wringing

Rolling

With fine movements of the thumb and fingers, soft tissues are lifted, squeezed and then rolled over.

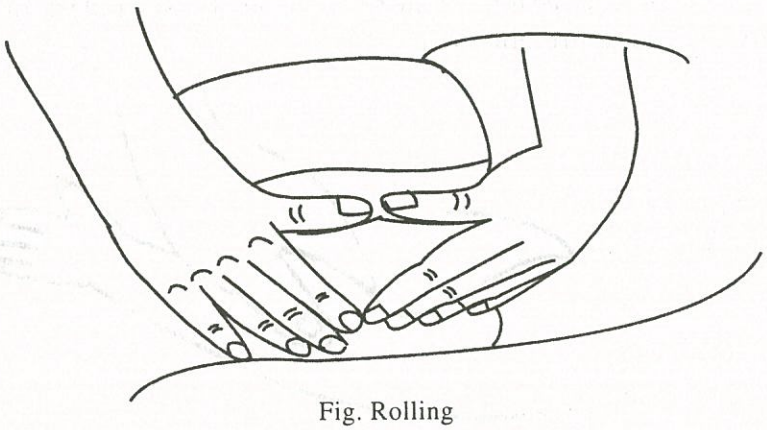


Fig. Rolling

Shaking

Performed with whole hand, moving skin back and front.

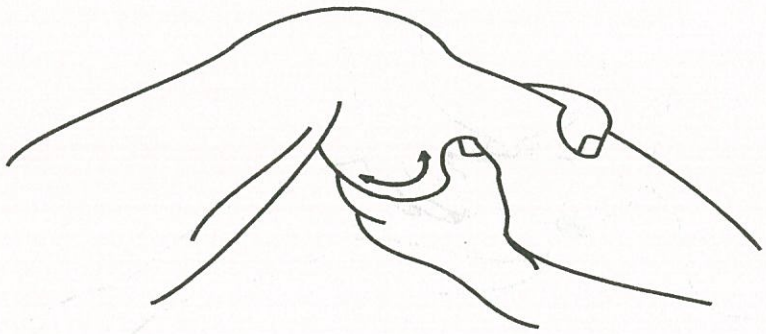


Fig. Shaking

Clapping

It is performed on the larger surfaces with cupping of the palm, by alternate flexion and extension of wrist.

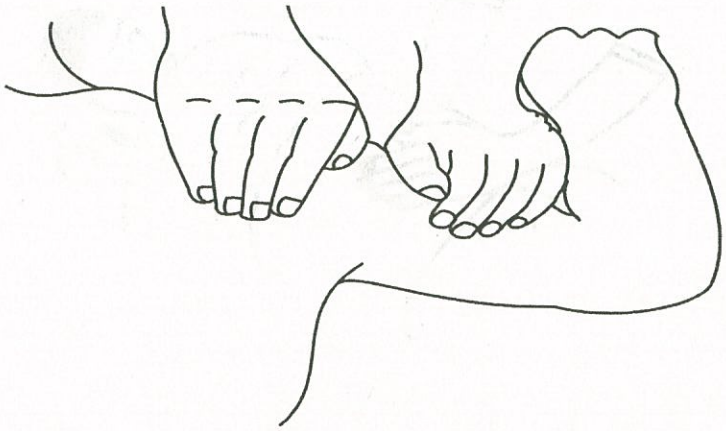


Fig. Clapping

Hacking

This is performed with ulnar border of palm of hand by alternate pronation and supination of the forearm.

Fig. Hacking

Vibration

These are produced by vigorous shaking of the hands placed over the soft tissues and joints.

Fig. Vibration

Pounding

It is performed with the ulnar border of the hand and little finger, by making a fist with alternate flexion and extension at the elbow. Slow, rhythmical movements, are given on soft tissue and joints.

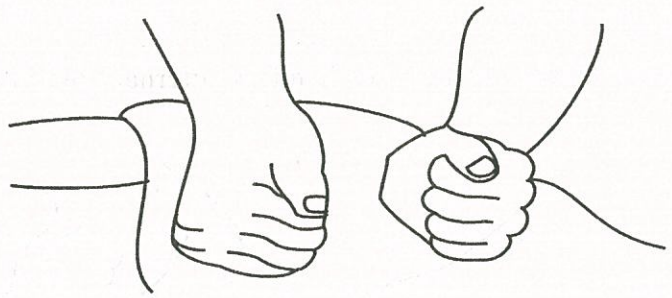


Fig. Pounding

Friction

These are small range of movements applied with the thumb or fingers, superficially over the skin and are applied in transverse and circular fashions. They are used, to mobilize the tight structures or soft tissues.

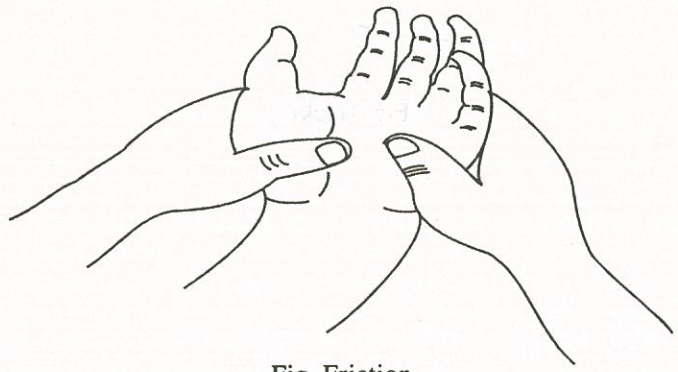


Fig. Friction

The effects of massage are given below:

1. Increases blood circulation in the area.
2. Reduces the tone in the muscles.
3. Stretching of tight fascia and restoration of mobility of soft tissue.
4. Pain relief is obtained by releasing acute or chronic tension in muscles and by the effect of pressure and touch on nerve endings.
5. Waste products are effectively drained.
6. Removal of oedematous fluid.
7. To promote relaxation.
8. To stimulate sensory and motor nerves.

Contra-indications

1. Acute inflammations. Ex. Rheumatoid arthritis.
2. Skin conditions. Ex. Eczema.
3. Infection does not rule out soft tissue manipulation but precautions are necessary to avoid gross infection.
4. Skin disorders which would be irritated either by increase in warmth of the part or the lubricants, which might be used.
5. In the presence of malignant tumors.
6. Early bruising.
7. In the presence of recent unhealed scars or open wounds.
8. Joints or other tissues, which are acutely inflamed, especially joints with tubercular infections.

Indications

1. Scar tissue
2. Muscle spasms
3. Facial tethering
4. Muscle contractures
5. Oedema
6. Pains
7. Slow healing scars or ulcers

General effects of massage

It is described under the following main headings.

1. Mechanical
2. Physiological effects on-
   - Circulatory system
   - The nervous system
   - The musculoskeletal system

Mechanical effects

Massage has number of effects on the skin; the constant movement of hands over the skin will assist in following ways:

1. Removal of dead cells allows the sweat glands and sebaceous glands to be free from obstruction.
2. Helps to retain or promote the mobility of the new skin tissue relative to the underlying tissue layers.
3. The percussive manipulations performed over the lungs, have a mechanical effect of jerking adherent mucous secretion to be free from the bronchial tree.
4. Vibratory movements cause some mixing of respiratory gases.

Physiological effects of massage :

The squeezing, compressive and pushing elements of the massage increase the drainage of venous blood and lymph.

1. Drainage of waste products more efficiently.
2. Increases the blood circulation and in turn increases the general metabolism.
3. Fine stroking stimulate the sensory nerves and proprioceptors.
4. The pressure of massage itself increases the pressure in the tissues.
5. Improves the nutrition of the muscles.
6. Removing metabolites and chemicals from muscles.
7. Reduces the swelling by removing waste products.
8. Massage increases the vasodilatation, following superficial and deep massage.
9. Massage can reduce the incidence of deep vein thrombosis.

General tips before giving massage

1. Massage should not be done too quickly.
2. Dry tissue should be massaged more slowly.
3. Lymphatic drainage can be increased by pumping and pulling effects on the filaments, which open the gaps between cells in the walls of lymphatic vessels.
4. The muscle spindle can be stimulated.

Lymphatic system

Understanding the location of various lymph nodes is of great value before giving massage, the movement of lymph occurs via the following chain of events.

Fig. Lymphatic drainage

The factors increasing the lymphatic drainage are given below:

1. Increased capillary pressure
2. Reduced plasma osmotic pressure
3. Increased capillary permeability

Procedure to give massage

- Place the person in a comfortable position so that the part (to be massaged) is adequately exposed.
- Start with effleurage and end with effleurage.
- Start from distal parts of the body and carry it towards the proximal parts and terminate it into the lymph nodes.

Lymphatic system : It absorbs the waste products formed in the muscles and are drained out of the body in the form of perspiration, or the waste products, are absorbed into the lymph nodes.

Location of the lymph nodes in the body

Face - The lymph nodes are situated below the ear, which are called auricle lymph nodes, so while giving massage to face. Start from middle part of the face and carry it towards the ear and end it below the ear.

In upper limbs - The lymph nodes are situated in axilla and are called as axillary lymph nodes, and on front part of elbow which are called cuboital lymph nodes.

Start massage for upper limb from fingers and carry it towards proximal part of the upper limb and end it either in cuboital lymph nodes or in axillary lymph nodes.

In lower limbs - The lymph nodes are situated at the back of the knee joint and are called as popliteal lymph nodes, and on front of the hip joint which are called as Inguinal lymph nodes.

Start massage for lower limb from toes and carry it upwards and end either in popliteal area or Inguinal area.

In the back - Lymph nodes are situated in lumbo sacral area.

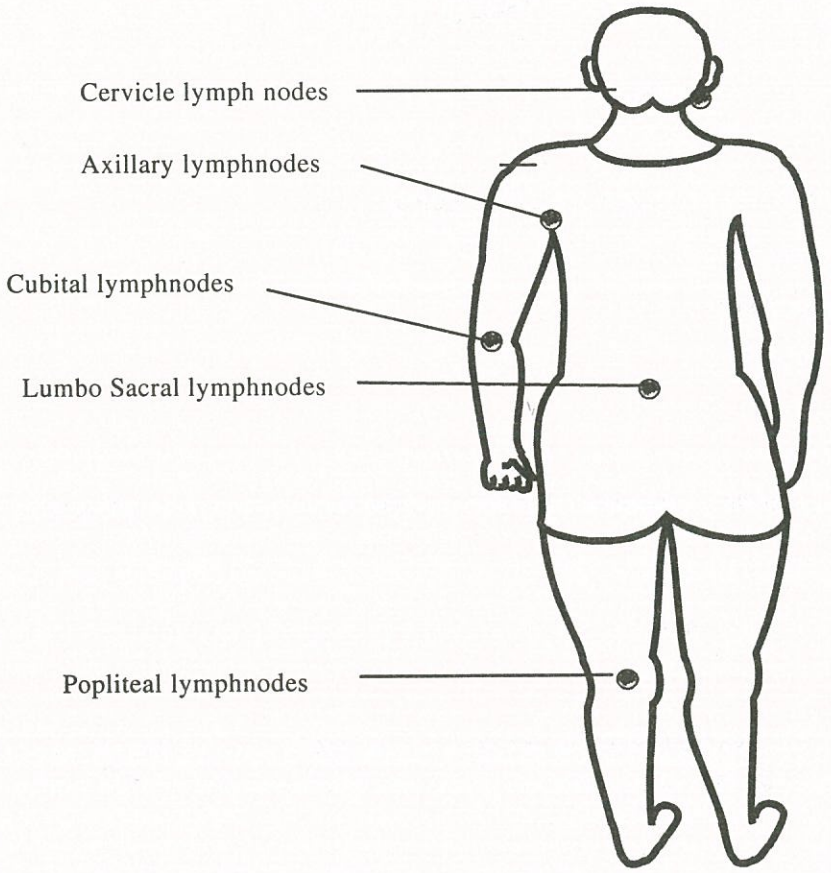


Fig. Location of lymphnodes of the body

While giving massage to back, start from the middle part of vertebral column and end it either in axillary lymph nodes or in lumbo-sacral area.

Type of lubricant used for massage

Grape seed oil, olive oil or sweet almond oil, apricot kernal (for sensitive skin) or coconut oil may be used Check that baby is not allergic to the particular oil- test on a small area of the skin and leave it for 30 minutes. Warm the oil with your hands by rubbing. Don't put it straight on baby.

Baby massage

In babies sensation plays vital role, and the way we touch the baby initiates many responses, so the type of massage we give plays a vital role.

Principles of baby massage

1) The room should be adequately warm.
2) Use regular oil and it should be warmed in the hands first.
3) Fingernails should be short.
4) Ten minutes should be the maximum length of the massage for a baby who is under four months old.
5) The mother should be relaxed.

Points to consider during baby massage

a. A baby's tactile sense is developed at 7.5 months.
b. Touch is important learning tool for a baby.
c. A child's self image and esteem are partly shaped through all forms of touch.
d. Oils, should not cause irritation.
e. Ensure that, the understanding of the developmental sequence and reflex activity to influence your positioning and handling of babies.

Positioning

- Sit on a low stool with legs straight out to the side or lean back against a soft cushion and manage baby on your lap.
- Kneel down on a cushion or sit between your feet.
- Choose the position, which is most comfortable.

How to massage the baby

- Hand should always be with oil, to maintain even contact with the babies body.
- Massage should be done in an outward direction from the midline of babies body.
- Massage should be done in a circular manner.
- Stretching should be done gently.
- Start with gentle and slow touch, when the baby is young, for older babies massage can be done with faster and firmer rhythms.
- Talk and sing to the baby throughout the massage.
- Start with baby on back.
- Place hands as flat as possible on the baby's chest, and do single strokes up and out, towards the shoulders, and down to the elbows.
- Continue strokes down the arms either together or one at a time. Stroke down from the shoulders to the hands. Try to stretch out the arm.
- Do gentle "wringing" movements down the arm.
- Tummy - do single strokes down from the chest to the tummy area.
- Now do circular movements around the tummy area, always in a clockwise direction. This can be done with one or both hands.
- Then gently massage the "soft" side of the baby's tummy.
- Stroke down the legs, either one at a time or both together. Gently straighten them out.
- Then do " wringing" movements down the legs as it is with the arm.
- Now spread out the hands and massage the bottom of the fingers in the palm. Gently stretch out and open the hands.
- Pull each fingers one by one, massage them gently.
- Spread the toes out and then gently massage the base of the toes in the sole of the foot without big toes. Stretch each toe one by one and give a gentle pull.
- Hold baby's ankles, letting knees bend outwards and gently push them up towards the shoulders. Don't force this movement, let the baby be your guide.
- Roll baby onto his or her front. Do singles strokes down from the shoulders to the buttocks using flat hands.
- Continue this down the back of the legs.
- Gently massage the buttocks with the palm of your hand moving in a circular direction.
- Continue strokes down the backs of the legs to the feet.
- Gently stretch the heel of one foot up towards that buttock. Do the same for the other leg.

[Note : Use of massage for babies with hyper tone should be avoided.]

* * *

CHAPTER 15

HYDROTHERAPY

Introduction

Treatment given to musculoskeletal disorder by using water as a medium. It may be warm water or cold water. The value of water as a therapeutic modality lies in its thermal and mechanical properties.

a. Thermal effects.

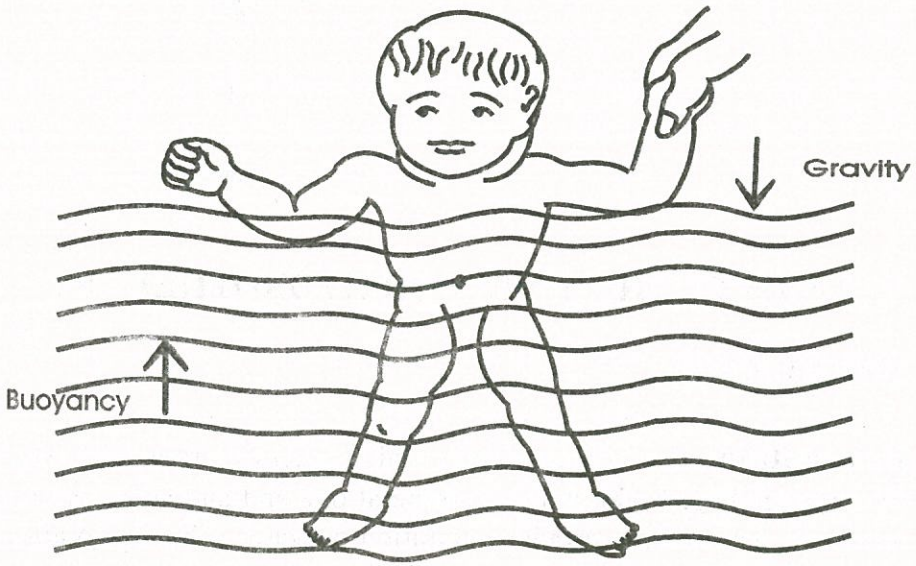
1. It is a good conductor of heat and cold.

2. The application of agitated water dilates the blood vessels and application of cold water on the other hand constricts the blood vessels.

3. The effect of warm water on body, increases blood circulation, nutrition and metabolism into the body.

b. Mechanical effects

1. Buoyancy of water



- It exerts upward thrust.
- It supports the body weight.
- It assists upward movement.
- It resists downward movement.

2. Specific gravity of water

- The specific gravity of any objects is less than that of water (1.00ccm) so it float.
- In human being, specific gravity with inflated lungs is only 0.974 so specific gravity in combination with buoyancy renders the person essentially weightless.
- Gravitational force is less inside the water hence the person doesn't feels exact weight of body and it is less inside the water. So the activities which the person finds difficult on ground and painful, can be done easily inside the water.

3. Viscosity of water

- The cohesive forces between molecules in liquids, tend to resist flow in all direction.
- This viscosity, increases resistance at higher speeds of movement.

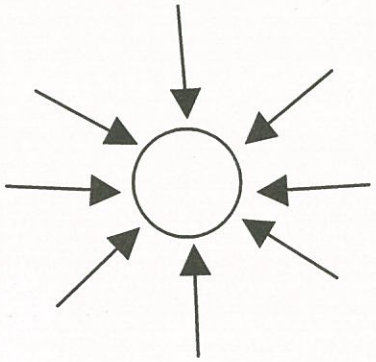


Fig. Hydro static pressure

VARIOUS EQUIPMENTS FOR HYDROTHERAPY

WHIRLPOOL

Description: It is a water tank, which offers thermal and mechanical stimuli to the part. It is rectangular shaped tank with a turbine at one end and small platform to rest the part of body at the other end. The turbine provides agitation of water, which also allows to adjust the speed, depth and direction of agitation. The water can be heated as per the requirements.

1. Water heater is attached to one side, to make the water warm.
2. Arrangement for changing the flow of water according to the requirement of movements and type of exercises.

3. Arrangement to increase or decrease air bubble to get the vibratory effect.
e.g. assisted type of exercises are given by adjusting the water flow towards the direction of movement. If the water flow is against the direction of movement, it is resisted type of exercise.

Physiological effects

1. Increase metabolism
2. Increase perspiration
3. Induce muscle relaxation
4. Mild heat sedates sensory nerve endings.
5. Hydrostatic pressure can increase venous and lymphatic blood flow.
6. Assisted exercises can be performed by moving the limb with turbulence, resistance exercise can be performed against the turbulence.

Advantages

1. The part is visible during treatment.
2. Wounds can be cleansed.
3. Person can move freely and safely during the treatment to elongate the structures while they are warmed.

Indications

1. Traumatic and inflammatory conditions(chronic and sub acute).
2. Peripheral vascular disorders with appropriate water temperature.
3. Peripheral nerve injuries.
4. Conditions that produce muscle weakness.
5. Conditions that produce spasticity, muscles tightness such as in spastic cerebral palsy.

Contra-indications

1. Fever
2. Infections (skin)
3. Acute inflammatory conditions.
4. Persons with cardiac instability, respiratory instability should be treated only for local motor problem.

INSTRUCTIONS

1. Tank should be filled with water at required temperature.
2. Usual temperature ranges are as follows:

Descriptor	^{0}F	^{0}C
Very hot	104.0-110.0	40.0-43.5
Hot	99.0-104.0	37.0-40.0
Warm	96.0-99.0	35.5-37.0
Neutral	92.0-96.0	33.5-35.5
Tupid	80.0-92.0	27.0-33.5

(Common temperature ranges used with hydrotherapy)

3. Persons with open wounds, circulatory disorders, cardiac conditions should receive neutral to warm baths.
4. Chronic problems can be treated with warm water.
5. Local areas can be treated with warm water.
6. Temperatures for full body immersion should not exceed 100^0 F.
7. Painful conditions with no other contraindication can be treated with hot temperatures.

8. Exercises in whirlpool should be performed under tupid temperatures, to eliminate fatigue factor.
9. Disinfectants can be added when open wound are present.
10. For treatment of upper extremities, a chair can be placed by the side of the whirlpool.
11. For treatment of lower extremities, a high seat at the end of the whirlpool can be placed.
12. A chair can be placed inside the whirlpool for general exercises.
13. The treatment time should be about 20 minutes.
14. Frequency of whirlpool treatments may be daily.

HUBBARD TANK

This is a butterfly shape whirlpool, which allows the persons to move his limbs through abduction in the recumbent position. It is provided with two turbines, one at each end.

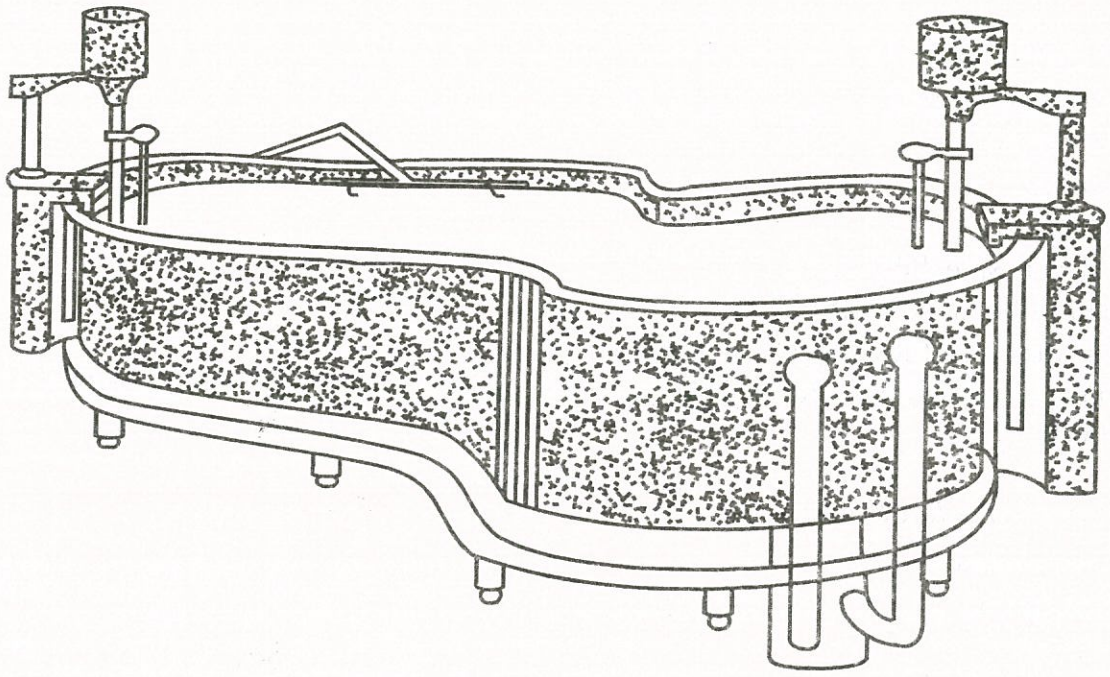


Fig. Hubbard Tank

Purpose and effects

The primary purpose of the Hubbard tank is to deliver heat and cold to large parts of the body.

Advantages

1. It is very useful for the persons who can not assume sitting position.
2. Exercises can be performed in the tank.

Indications

- Generalise painful conditions.
- For general relaxation or sedation.

Precaution

The temperature should not exceed 100^0 F.

WATER POOL

These are water tanks of large size specially made for therapeutic purpose. It is design in such a way that the flooring is non slippery and it is coloured blue. The water can be replaced easily for hygiene maintenance. These pools are available in various sizes and shapes at various depths. They are provided with steps and ramps to get down in the water. Floats such as rings, tubes and supportive system are provided to ensure support and stability for the person in the water. Depth of the pool is very shallow, that does not exceed more than 5 to 6 feet at the center. They are very useful in treating paralysis persons and in gait training, active exercises, assisted exercise and resisted exercises. They are useful for strengthening muscles and to increase endurance.

General conditions that can be treated with hydrotherapy are

1. Rheumatoid arthritis
2. Spondylosis
3. Capsulitis
4. Osteoarthritis
5. Mechanical spinal disorders
6. Juvenile chronic polyarthritis
7. Major fractures of lower limbs or spine
8. Neruological conditions like Hemiplegia, Paraplegia, Tetraplegia, Polyneuropathy M.R, C. P, Down syndrome.

General contraindications

1. Infected wounds
2. Pyrexia (fever)
3. Incontinence
4. Deep vein thrombosis,
5. Pulmonary embolus
6. Gastrointestinal disorders.
7. Epilepsy
8. Vertigo
9. Thyroid deficiency.
10. Acute skin conditions.

* * *

CHAPTER 16

MOBILITY AIDS AND APPLIANCES

Introduction

There are number of Aids and Appliances which assist the persons with neuro musclulo skeletal system disorders. They give support, stability to weak areas of body and helps in walking or carrying out activities of daily living. The mobility devices are classified under broad head of orthotics and prosthetics. Orthotics devices assist the part of the body which is not functioning properly due to muscle weakness or joint problems. Such orthotic devices are named or classified according to the purpose they serve or according to the area they are fitted. Such appliances and their uses are described below.

Classification of orthotic devices : These can be listed under three categories.

1. Splints
2. Calipers
3. Braces

Splints

- Cockup splint
- Knuckle binder splint
- C-splint
- Aeroplane splint
- Short opponens splint
- Foot drop splint
- Hip abduction splint

Calipers

- Ankle foot orthosis
- Knee, ankle, foot orthosis
- Hip, knee, ankle, foot orthosis
- Long leg calipers with or without pelvic belt.

Braces

- Cervical collars
- Head, cervical orthosis
- Head, cervical, thoracic orthosis
- Thoracolumbar and sacral orthosis
- Lumbo sacral orthosis

1. **Splints:** A device to provide support and stability to individual joints. It is made up of polypropelene, PVC, wood, aluminum etc.

Classification of splints : These are Static splints and Dynamic splints.

1. *Static splints :* Prevent abnormal position and support the part in functional position.

Uses

- To align specified joints in proper position and to progressively stretch the joint structures.
- To assist weak muscles.
- To provide stability to unstable joints.
- To maintain corrections.

Disadvantages

- Prolonged immobilization can cause atrophy and stiffness of soft tissues.
- It should be used only to the joints that needs support.

2. *Dynamic splints :* Will permit and control movement in addition to support.

Uses

- Provides prehension function of hand.
- It gives support to joint and assist weak muscles.
- To provide stability to joint.
- To maintain correction.

General functions of splinting

- To reduce pain.
- To diminish muscle spasm.
- To prevent abnormal movement.
- To provide support (stability to unstable joints)

Various types of splints

1. *Cock up splints:* Stabilizes the wrist in extension.

(Fig. Cock up splint)

Indications

1. Wrist drop, due to radial nerve palsy.
2. Deformity of wrist due to spasticity.
3. Fractures around the wrist.

2. *Knuckle binder splint:* Keeps the metacarpophalangeal joints in extension.

Indications

- It helps to maintain hand and finger in neutral position.
- Total claw hand in case of medial and ulnar nerve injury.
- Ulnar claw hand alone.
- Hansen's disease or leprosy.
- Abnormal position of hand, joint stiffness, muscle weakness.

3. *C-Splint:* Keeps the thumb in abduction and partial rotation.

Indications

- Median nerve injury
- First web contracture

4. *Aeroplane splints:* Keeps the shoulder in abduction and external rotation.

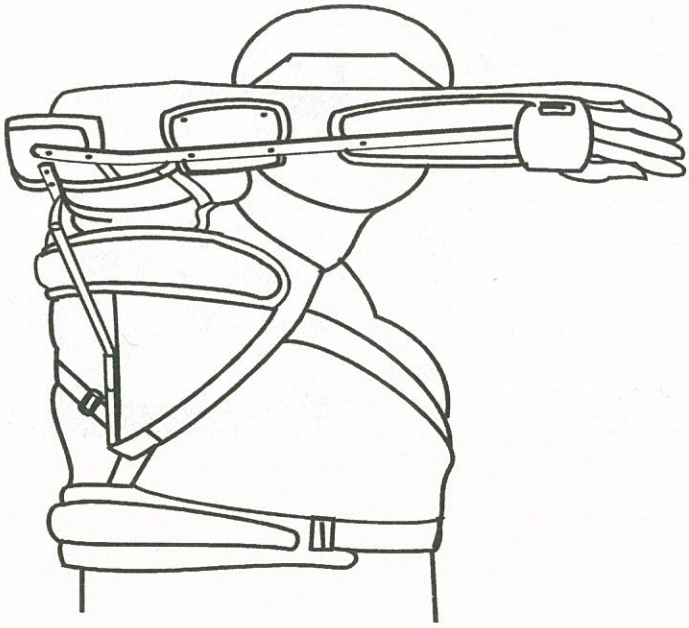


Fig. Aeroplane splint

Indications

- Paralysis of deltoid
- Erbs palsy
- Post surgical immobilization in # of proximal part of humers

5. *Short opponens splint:* Keeps the thumb in abduction and partial rotation.

Indications

- Low median nerve injury paralysis.

6. *Foot drop splint:* To maintain the foot in neutral position and to give stability to ankle joint.

Indications

- Common peroneal nerve injury.
- Equinus deformity due to spasticity.

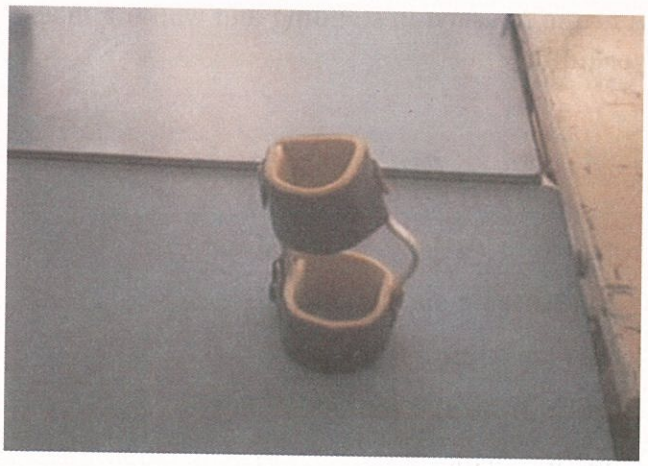
7. *Hip abduction splint:* It is useful to prevent adductors contractures by holding the hips in an abducted position.

(Fig. Hip abductions splint)

Indication

- Scissoring of legs

8. *Knee brace:* It is useful in preventing knee flexion deformity and contracture.



(Fig. Knee braces)

Indications

- Knee flexion deformity and contractures.

9. *Finger splints:* These are useful to keep the fingers in normal alignment.

(Fig. Finger splints)

Indications

- To prevent or correct finger flexion contracture and deformity.
- To maintain correction.

2. CALIPERS: Calipers are orthosis fitted to lower limb to assist in standing and walking incase of muscular weakness or joint instabilities of lower limbs.

Instructions

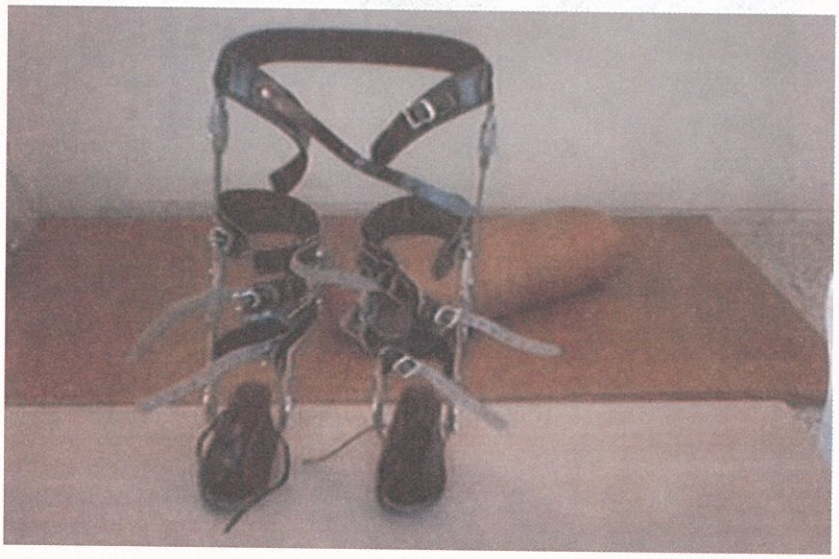
- Prescribed only as long as necessary.
- Movement is allowed wherever possible and appropriate.
- Person compliance will be enhanced if orthosis is comfortable and functional.
- Orthotic hip joint should be in position that allows person to sit upright.
- Orthotic knee joint should be centered over prominence of medial femoral condyle.
- Orthotic ankle joint should be centered over tip of medial malleolus.
- Orthosis should be functional through out all phases of gait.
- Orthotic devices helps to restrict abnormal movement and enhances functional movement in lower limb and assist in walking and locomotion.

Classification of calipers

1. **Long leg calipers or above knee calipers, with or without pelvic belt:** These are indicated for muscle weakness affecting the spinal stability, pelvis, hip, knee and ankle joints stability.

1) Above knee caliper with or without locking and unlocking arrangements at hip, knee and ankle joint.

2) Above hip (long leg or full length caliper with pelvic band -hip joint and knee joint lock).



(Fig. Bilateral hip knee ankle foot orthosis)

Indications

- Weakness of muscles of trunk, pelvis, hip, knee and ankle.
- Instability of joints of lower limb, paralysis of lower limbs.

Uses

- It controls abnormal movement.
- It gives stability to the hip, knee and ankle joint.
- It gives support, stability to weak muscles and unstable joints of lower limb.
- Assist in walking.
- It facilitates locomotion.

2. **Below knee calipers :** These may be unilateral or bilateral. Unilateral calipers are used for single lower limb. Bilateral calipers are used for both lower limbs.

Types of below knee calipers

1. *Ankle foot caliper :* This is indicated for muscle weakness affecting the ankle and subtaloid joints, prevention or correction of deformities of the foot and ankle.

(Fig. Ankle foot orthosis)

Indications

- Dorsiflexor muscle weakness.
- Plantarflexor muscle weakness.
- Ankle and foot muscles weakness.
- Hyper mobility of joints.
- Altered biomechanics due to muscle imbalance.
- Spasticity.
- Limited weight bearing.

2. *Knee Ankle Foot Orthosis (KAFO):* It provides stability to knee, ankle and foot.

(Fig. Knee ankle foot orthosis)

Indications

- Abnormal movement.
- Muscle weakness.
- Upper motor neuron lesions.
- Lower motor neuron disorder.
- Joint instability.
- Loss of structural integrity.
- Enhances the function of lower limb.
- It helps to facilitates locomotion.

3. **BRACES (Spinal Orthosis) :** These are orthosis used for spinal stabilization. Various orthosis which can be fitted to different parts of the spine according to the disorders of spine.

Functions

- Prevention and correction of spinal deformities.
- Reduces axial loading.
- Stabilization of vertebral segments.
- Relief of pain by limiting rotation and weight bearing.
- Enhance spinal function.
- Restricting movement after acute trauma or after a surgical procedure to protect against further injury.

Types of spinal orthosis

1. **Cervical collars:** Also known as cervical orthosis, it is used around cervical spine and allow only functional movement in cervical spine.

(Fig. Cervical collar)

Indications

- Cervical Injuries.
- Sprains and strains.
- Cervical degenerative diseases.
- It gives support and stability to cervical spine.

Head Cervical Orthosis (HCO): It provides support to both head and cervical spine.

Types of head cervical orthosis.

a) *Four-poster cervical orthosis :* This provides greater restriction of flexion, extension, lateral bending and rotation.

b) *Minerva jacket :* This is applied to head and trunk. It provides support and stability.

Head cervical thoracic orthosis (HCTO)

Types of head cervical thoracic orthosis.

a. *Halo orthosis :* Stabilization of cervical spine is facilitated through external fixation of skull with reference to the chest.

Indication

- Paralysis results after fracture of cervical spine.
- Cervical vertebral fracture with dislocation.
- Muscle weakness or joint stiffness.

b. *Somibrace :* It is also known as sterno occipito mandibular immobilization brace. It restricts flexion, extension, rotation and lateral bending.

(Fig. Somibrace)

Indication

- Fracture of cervical vertebrae.
- Immobilization of head, neck and spine.

Thoracolumbar and Sacral Orthosis (TLSO)

Types of thoracolumbar and sacral orthosis.

a. *Jewett Orthosis :* It restricts flexion, extension and lateral flexion.

Indication

- Immobilisation of spine.
- Inter vertebral diseases.

b. *Milwaukee brace :* It is used for correcting scoliosis.

Indication

- Used for correcting spinal deformities.
- Used for correcting scoliosis.

Lumbo Sacral Orthosis (LSO)

Types of lumbo sacral orthosis.

a. *Knight brace or Taylors brace and Boston brace :* These orthosis reminds the wearers to avoid abrupt motion. Movement control is achieved by means of three point force system.

(Fig. Lumbo sacral orthosis)

Indication

- It gives support to weak back muscles.
- Degenerative diseases of spine.
- It gives stability to lumbar spine.
- To prevent or correct the deformities.

Walking Aids

These aids, assist the people in walking, those who have difficulty in walking or who cannot walk independently. Inability to take or transferred body weight on one lower limb or both lower limbs.

TYPES OF WALKING AIDS

1. **Axillary Crutches :** These are made up of wood, aluminium and consists of axillary pad, hand piece and rubber ferrule.

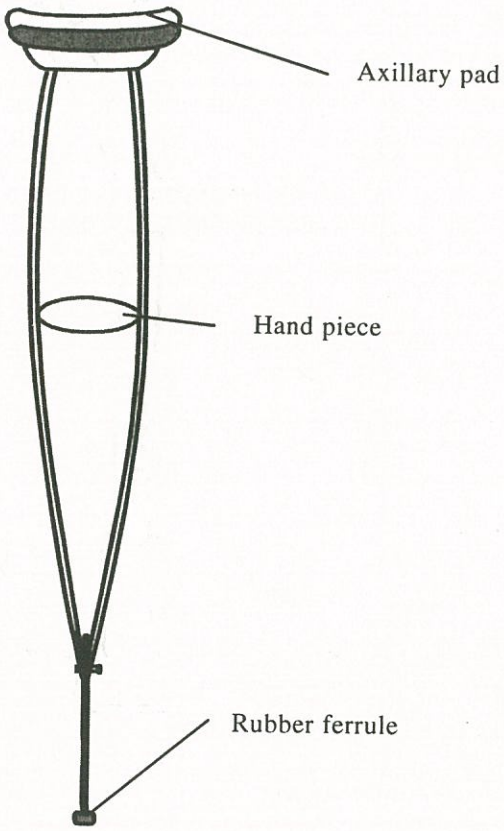


Fig. Axillary crutch

Uses

- These are useful for the persons who have bilateral or unilateral lower limb weakness. The persons, who are using these crutches can move forward either by three point or two point or four point gait patterns. Weight of body is taken on crutches and transferred on crutches through hand piece and the person propels himself forwards. Care should be taken that axillary pad should not be pressed against the axilla because of possibility of axillary nerve injury.
- It reduces or relieves body weight either on one lower limb or both lower limb. It gives support and stability to lower limb joints.
- It gives support to weak lower limb muscles.

Elbow Crutches: These are made up of metal and consists of plastic or metal forearm band, hand piece and at the base rubber ferrule.

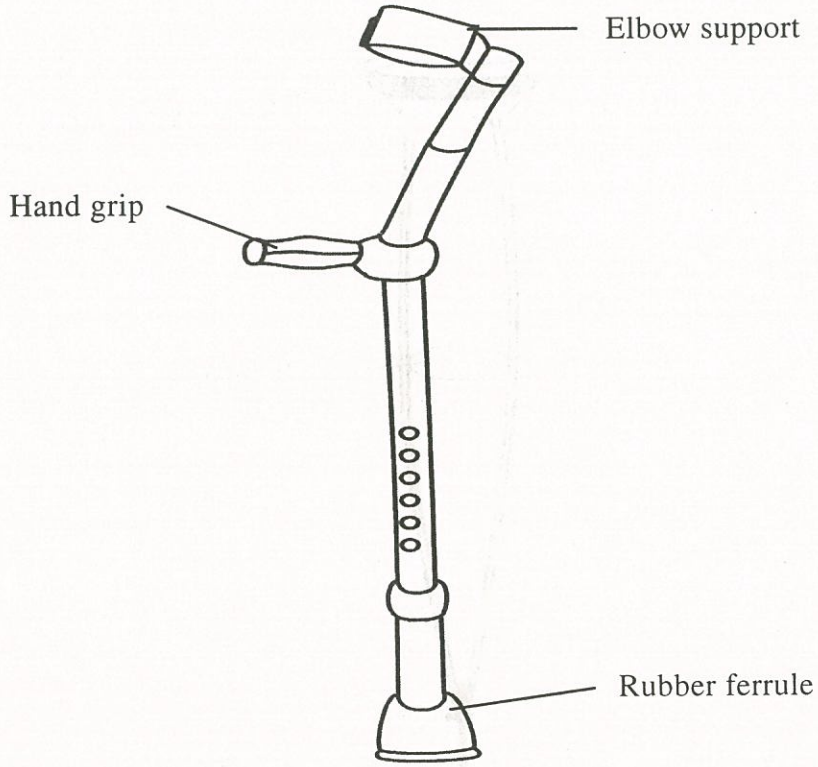


Fig. Elbow crutch

Uses

- These crutches are used by the persons with lower limb weakness or joint stiffness problems and helps the person to move. The crutch assists the affected limb in weight bearing and weight transference(muscle weakness, joint instability, pain in lower limb etc).
- It reduces or relieves weight either on one lower limb on both lower limb.

2. **Gutter Crutches :** These are made up of metal with forearm support pad, strap hand piece and rubber ferrule.

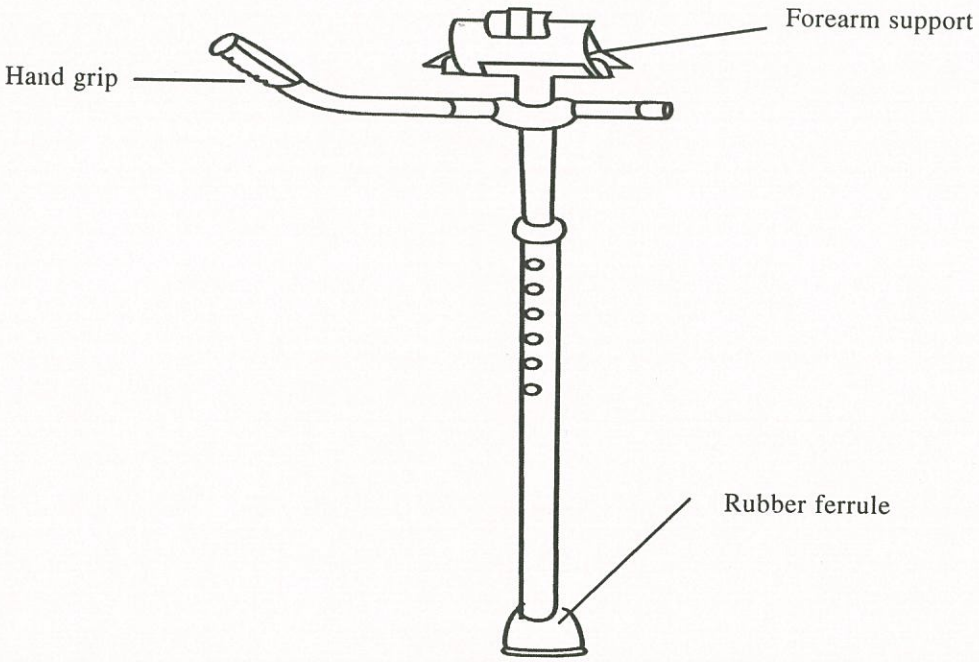


Fig. Forearm crutch

Uses

- These are used by the persons with painful joints. It provides support for the painful limbs and assist in walking. Gutter crutches can also be used by persons with weak grasp.

3. Sticks : Sticks are of various types. It may be simple stick, quadripod or tripod.

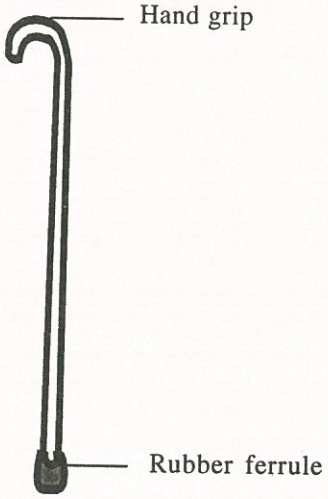


Fig. Simple stick

Uses

- It is useful for the persons who have minor postural or balance problems either due to age factor or due to some musculoskeletal disorder.

- **Quadripod :** These are metal sticks with four small legs at the base.

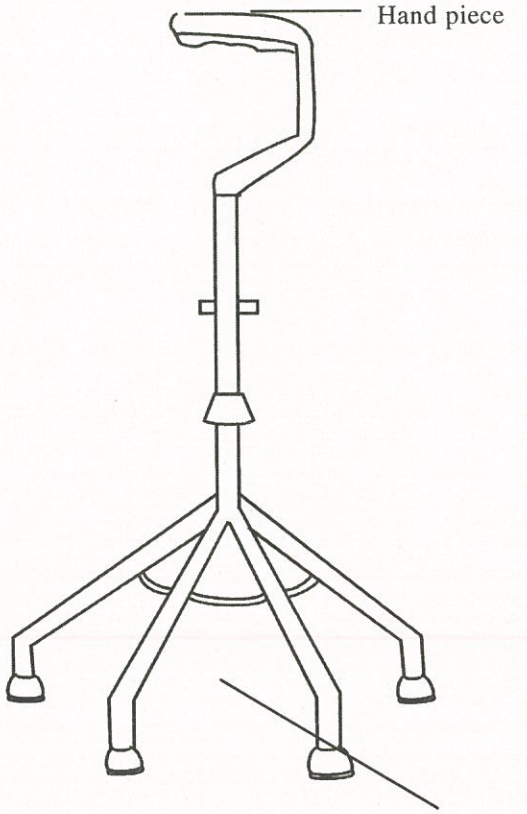


Fig. Quadripod

- **Tripod :** It is made up of metal sticks with three pronged legs at the base. These types of sticks are provided with three small legs at the base of the stick. It gives a wide base of support and stability for walking.

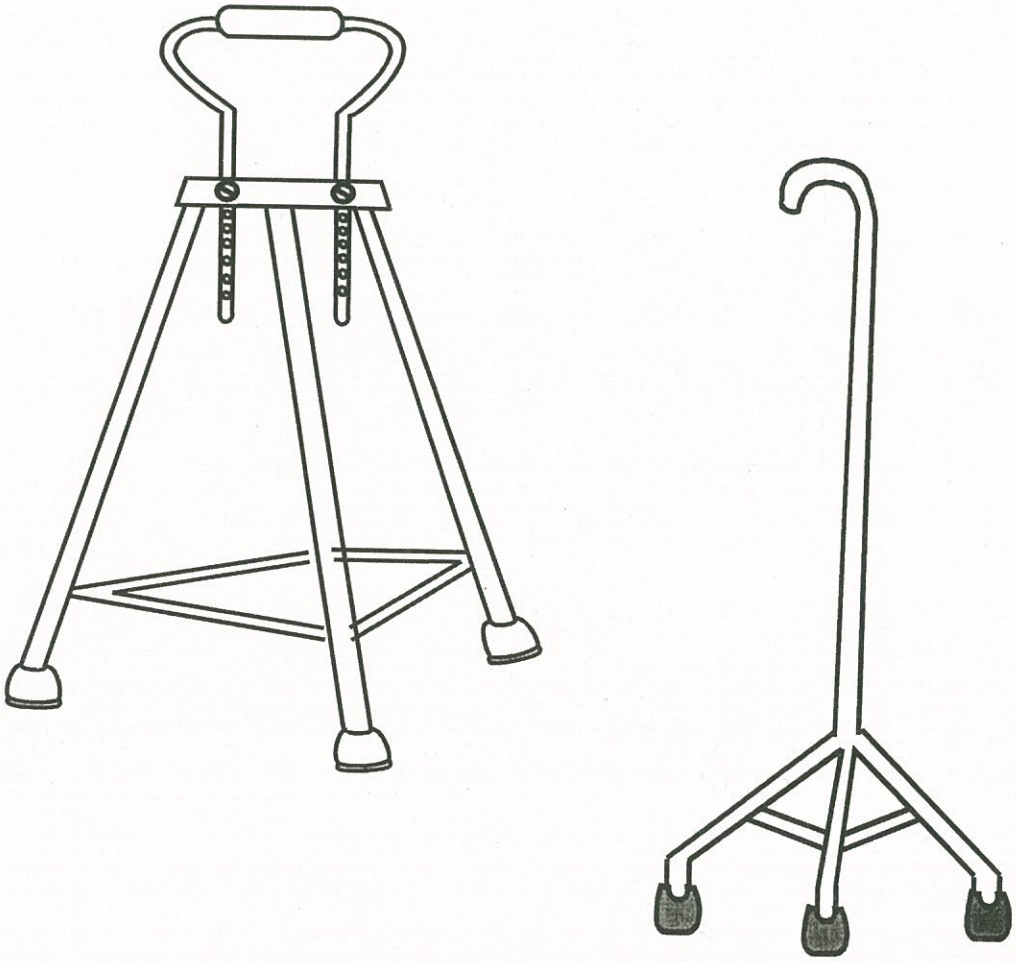


Fig. Tripod

4. **Walker :** The walker has broad base of support adjustable in height and width. The person lifts the frame and put it forward and leans on it and takes steps. It helps to take and transfer body weight on walking frame. It has wide four point stable base, which gives support and stability while walking and helps in locomotion.

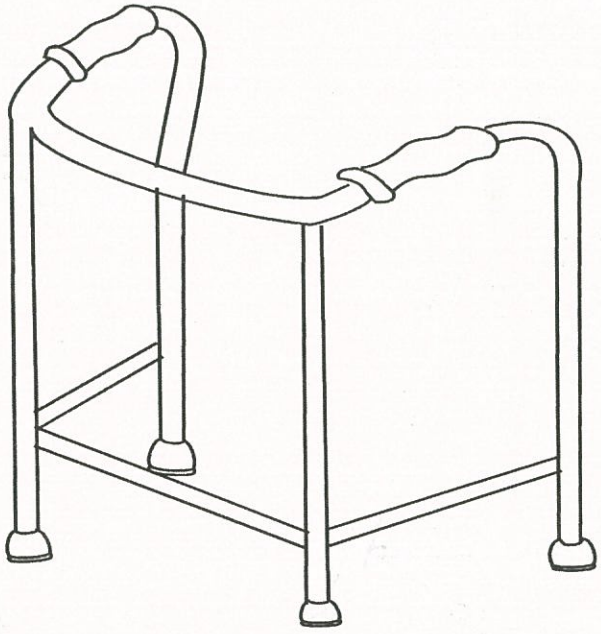


Fig. Walker

Rollator : It is useful for ataxic person who are too unsteady to lift the frame and put it forward. It is provided with wheels at base for frictionless and easy movement. It is adjustable in height. It provide support, stability and assist in walking.

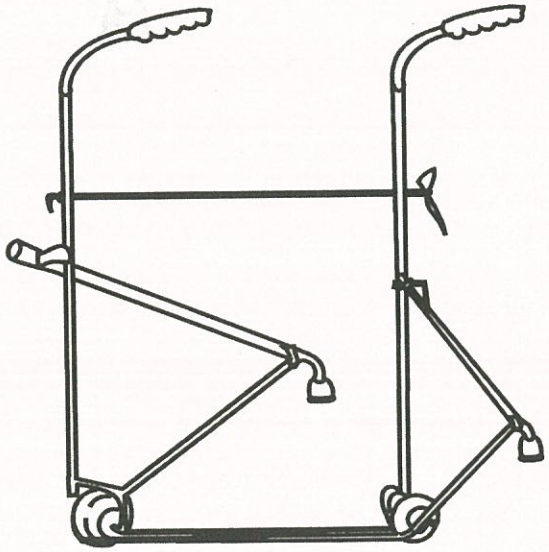


Fig. Rollator

CP Walker : It is designed for children, who have difficulty to start walking due to delayed development and motor problem. The child can be stabilized in the CP walker with Velcro straps to prevent falling. While using CP walker special care should be taken that it should not encourage hip and knee flexion. Bar in front for grip wheels at the base helps in frictionless movement of walker leg separator. Adjustable in height and width. Sitting arrangement for child. Child is more secure and stable. On front adjustable handle for hand support is provided so that the child can hold handle and push it forward Velcro strapping at hip and knee level to keep pelvis, knee in functional position.

(Fig. CP Walker)

Prostheses

The prosthesis are artificial limbs made up of either plastic material or moulded. It is used as a substitute for a missing limb or who lost limbs due to accidents. Their are of different types of prostheses like - elbow prostheses, above knee prostheses and below knee prostheses. It is not necessary in the field of mental retardation. (See Fig. below knee prostheses)

Fig. Below knee prothesis

* * *

CHAPTER 17

EQUIPMENTS USED IN PHYSIOTHERAPY

Various types of apparatus or equipments are used in the management of children with developmental delay. The common equipments used during early intervention and phycal therapy are given below.

Freedom Stander

Standing Frame : It is adjustable in height. Support system is provided at foot, knee and pelvic level. Child is put in standing position with the help of support at pelvic level, knee and foot. Velcro strapping belts are tightened, once the child is put in standing position. Height is adjustable and legs in mild abduction. Cut out table is also provided to facilitate activities.

Uses

- Facilitates standing position.
- It helps to develop supporting reaction in lower limb.
- Develops stability at pelvis, knees and helps the child to maintain standing position with support.
- Tone up of the child for standing.
- It helps to encourage early standing position.

Therapy Mattress

It is available in different sizes. They are made up of foam and covered with Rexene. Size of mattress varies from 8 to 10 feet long and 1 to 2 inches of height(thickness), width 6 to 7 feet.

Fig. Therapy mattress

Uses

- Therapy mattresses are used to give therapy to the child safely. Child will feel comfortable on the mattress and perform activities. It is also minimizes height apprehension and fear of falling down.
- Sensory motor stimulation.
- Balance reactions can be facilitated through balance training.
- Therapy training can be given on the mattress.
- Bouncing exercises for the child can be given.
- It is safe, comfortable, spacious for the child's play and therapy.

Bolster

This can be of various sizes.

Height - 20 inches to 26 inches.
Length- 3 feet to 4 feet.

Fig. Bolster

Uses

- To develop head control in prone.
- Early prone lying positions can be taught and encouraged.
- Weight bearing on hands and knees can be taught.
- It helps to develop shoulder, pelvis girdle and trunk stability.
- Extension of trunk and neck can be facilitated.
- Postural reflex activities, muscle tone, pattern of movement and equilibrium reactions are facilitated.

- It helps to develop head extension and head control.
- Standing and walking on bolster helps to develop balance reaction.
- It helps to stimulate crawling activity.

Soft Rolls

Rolls are available in different lengths and diameters.
They are made up of variety of materials, some with rigid foam with brightly coloured and covered with washable plastic covers.

Uses

- Person can sit in squat position.
- Person can be put in prone position .
- To develop head control and trunk extension.
- It helps to inhibit spasticity.
- Rocking movements can be initiated to reeducate balance, co-ordination and body awareness as the roll moves backward and forwards.

BALANCE BOARD / TILT BOARD

Balance boards are rectangular boards with an uneven or unstable base. They are available from small size to very large size. It is made up of either wood or iron and covered with soft material and Rexene.

Bottom of the board should be inclined or should have tilting effect, bottom surface of board should be unstable.

Fig. Balance board

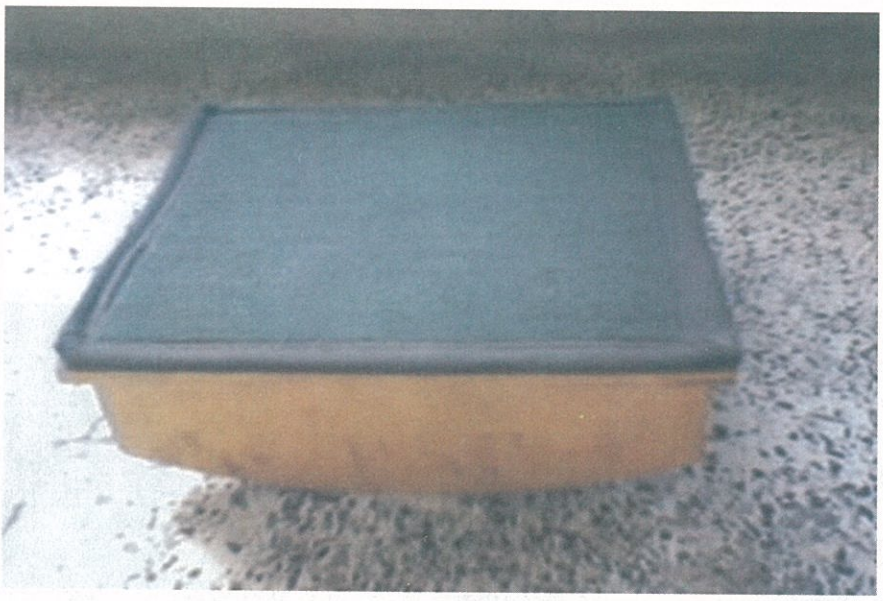


Fig. Tilt board

Uses

- To facilitate righting, balance and equilibrium reaction.
- Training the person to maintain or regain balance reactions, which helps in standing and walking.
- Protective extension reaction of the arms can be gained.
- It is used to elicit or develop balance reaction(in lying, sitting and standing position).
- Proprioception at ankle joint in standing position.
- It helps to strengthen muscles of lower limbs.

Balance Beam

It is a wooden plank having width of 4 to 5 inches and length 6 to 8 feet.
Fixed to the supporting area and covered with Foam or Rexene.

Fig. Balance beam

Uses

- It helps the person to learn the maintenance or regaining of balance reaction.
- Walking on top of the balance beam first in the forward direction then side ways helps to strengthen the lower limb muscles not advisable in adductor spasticity.
- Prevents and corrects contractures and deformities of foot.
- If balance beam is attached at the middle of the parallel bar then it helps to prevents scissoring of legs.
- Helps to develop the normal walking pattern.

Prone wedges

These are inclined blocks made in various sizes and covered with Rexene. The height of the wedges varies from 8 inches to 24 inches.

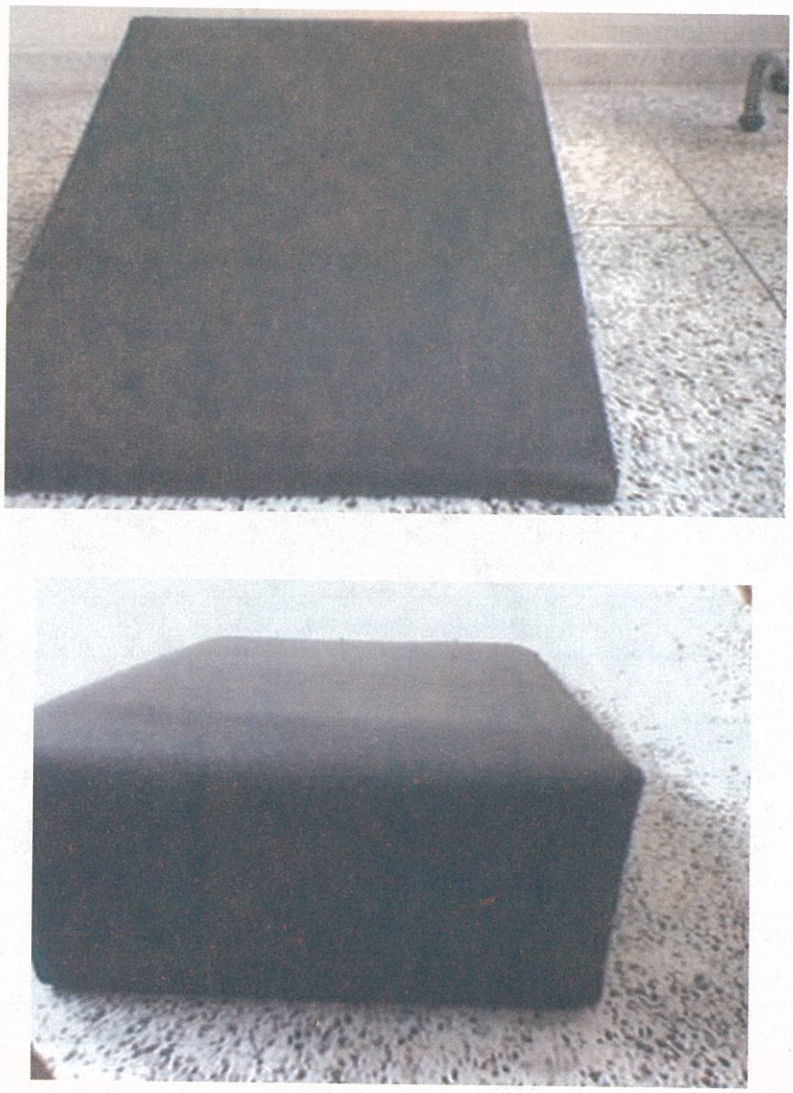


Fig. Prone wedges

Uses

- Wedges are useful in walking on it.
- Strengthening of plantar flexors and dorsiflexor's of the ankle by walking up and down on the incline and also training the person how to climb up and down.
- Proprioceptive stimulation can be facilitated.
- To teach early prone lying position and antigravity position.

- Activities against gravity can be learnt.
- Antigravity posture can be facilitated.
- Helps to develop head, neck, and trunk extension and thereby head control.
- Helps to develop shoulder girdle stability.
- Extension of upper limb can be gained.
- Supportive reaction of upper limb can be facilitated.

Different size and shapes rings

These are different sizes and shapes. (Triangle, square, round, rectangular etc.) It is made up of plastic or iron material.

Fig. Different size and shapes rings

Uses

- These are useful for developing coordination. e.g. these can be arranged in the serial manner and child is asked to go through it when he passes through it he has to adjust his body parts according to the size and shapes of the rings.
- It helps to develop eye hand coordination.
- It helps to develop body awareness.
- It helps to develop flexibility.
- It can be use for fun and play.

Side Lying Board

It is 4 to 5 feet long and 2 to 3 feet broad with adjustable side lying plank. One side is provided with wooden pad which is adjustable in height and it helps to prevent falling, it is covered with Rexene or foam. Velcro straps at hip, knee and chest level are provided to keep child in side lying position

Fig. Side lying board

Uses

- It is difficult to put some children either in prone or supine position for these children side lying board is useful.
- Children can be made to lie in the side lying position, and this helps to prevent abnormalities, contractures and deformities.
- Inhibit abnormal reflex activity and tone and facilitates normal tone and gives relaxation effect.

Steps and Stairs Case

It is of 6 feet in height with 6 to 7 steps and provided with railing, adjustable in height for support on both the sides of the stairs. One steps size is 4 to 8 inches.

Fig. Steps and stair case

Uses

- It helps the child to learn climbing steps and stairs.
- Locomotion can be facilitated(alternate, rhythmical, reciprocal movements of upper limb and lower limb can be trained).

Crawler

Height is 1 - 3 feet.
Width is 2 x 2 feet in length and breadth.
It is provided with small wheels at the base.

Fig. Crawler

Uses

- It helps the child to learn weight bearing on knees and hands. And later crawling.
- It helps to develop shoulder girdle stability, trunk extension, head and neck control.
- Early prone lying position can be encouraged.

Swing

It is revolving chair hanged with the slings. Swinging on horse or floor mounted swing.

Fig. Swing

Uses

- It helps to stimulate vestibule or labyrinth present inside the inner ear and there by helps to integrate the system concern for the development of righting, equilibrium and balance reaction.
- Swinging in clockwise and anticlockwise direction gives the child calming and relaxation effect.
- Protective extension reaction of arm can be developed.

Parallel Bar

The whole unit is made of iron or wood.

Height and width of the parallel bar is adjustable according to the persons size.

An adjustable divider can be placed, in the middle of parallel bar, which divides walking base and keep legs in abduction and separated .

Adjustable height and width according to child's physique.

Fig. Parallel bar

Uses

- Train the person in normal pattern of walking.
- In early stages of walking it helps to reeducate or trained the child in walking.
- It gives support, stability and confidence.
- Gait training is generally started in parallel bar.
- Balance training
- Postural re-education

Baby Walker or CP Walker

This is available in various sizes.

Fig. Baby walker or CP walker

Uses

- Putting the child in a baby walker can encourage early standing and walking.
- Supportive reaction of arms and legs can be facilitated.
- To initiate weight bearing on legs.
- To prepare the child for walking.
- CP walker or adapted walker according to the needs of cerebral palsy child. Like - cotton-belt to separate legs or prevent scissoring of legs, prevents crossing of legs, Height is also adjustable, put the child's hands in front on handle.
- Wheels are provided at the base.
- Child pushes the walker and takes steps.
- Scissoring can be prevented while walking.

Floor mounted walking ladder

It is usually made up of iron or wood with connection between the segments. The whole unit divided into many squares horizontally with small bars to longitudinal divider is kept. Steps size can be adjusted according to the physique of the child.

Fig. Floor mounted walking ladder

Uses

- Gait training.
- To develop walking pattern.
- Eye foot coordination can be improved.
- Coordination training can also be given.
- Involuntary gait pattern can be prevented and normal gait pattern facilitated.
- Walking in a straight line can be taught specially for those person who has lesion in sensory tracts cerebellum and basal ganglion.

Special chairs

Chairs are available in different sizes to match the individual requirement. It is made up of different material such as wood and iron and also provided with Velcro straps to fix the person in proper sitting position. This can be adjusted or adopted according to the child's deformities. Velcro strapping is provided to keep the child in proper position and head rest in neutral position.

Fig. Special chairs

Uses

- To put the child in proper sitting position and thereby facilitate activities.
- To prevent postural deformities.
- To introduce child to a sitting position.
- To prevent any abnormal positioning of limbs or body parts.
- Handling the child is made easy.
- Head approximation and exercises can be performed on the chair.
- Strapping for head, neck, trunk, shoulder girdle, pelvic girdle, thighs and small bar to inhibit scissoring of legs and keeps the thighs separate, straps to keep the legs in place, foot are rested on foot rest. Wheels at the base of chair helps for easy ambulation.
- Potty under the seat, which can be taken off for emergency.

Corner seat with adjustable cut out table and cut out board to facilitate activities.

This is made up of wood and available in different sizes. The whole unit consists of cover seat and a table. It is adjustable in height. It supports the child by using Velcro straps and also corner of seat helps the child to sit in it. Cut out table in front of seat helps to facilitate activities. It is useful for those children who cannot sit independently.

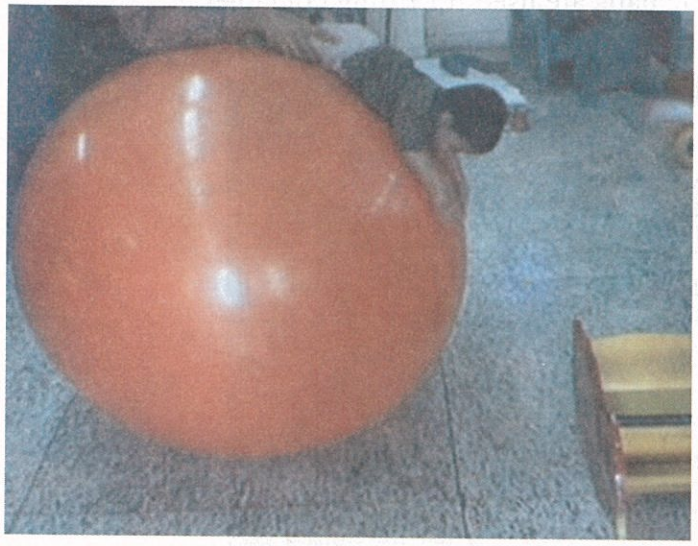
Fig. Cut out table

Uses

- To put the child in proper sitting position and facilitate activities for those children who are unable to seat independently.
- It is useful in positioning the child in proper sitting position.
- Objects can be placed on the cutout table to allow the child to play with toys and objects.
- To put the child in a proper sitting position.

THERAPY BALL

These are available in different sizes and colours.



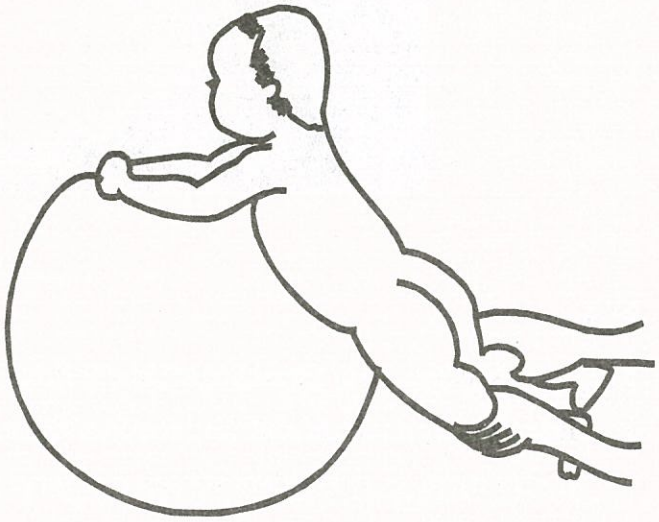


Fig. Therapy ball

Uses

- Tactile stimulation.
- Sensory motor stimulation.
- Bouncing exercises.
- Therapy is given on ball.
- Inhibit abnormal reflex activities and facilitate normal in its place.
- Righting, balance, equilibrium and supporting reaction can be facilitated.
- To develop supporting reactions of arms and legs.
- To develop antigravity posture.

Ball baths

A ball pool is a container for small balls. The container walls are of semi rigid and covered in plastic or rexene. Brightly, multicoloured air filled plastic balls are used for filling container.

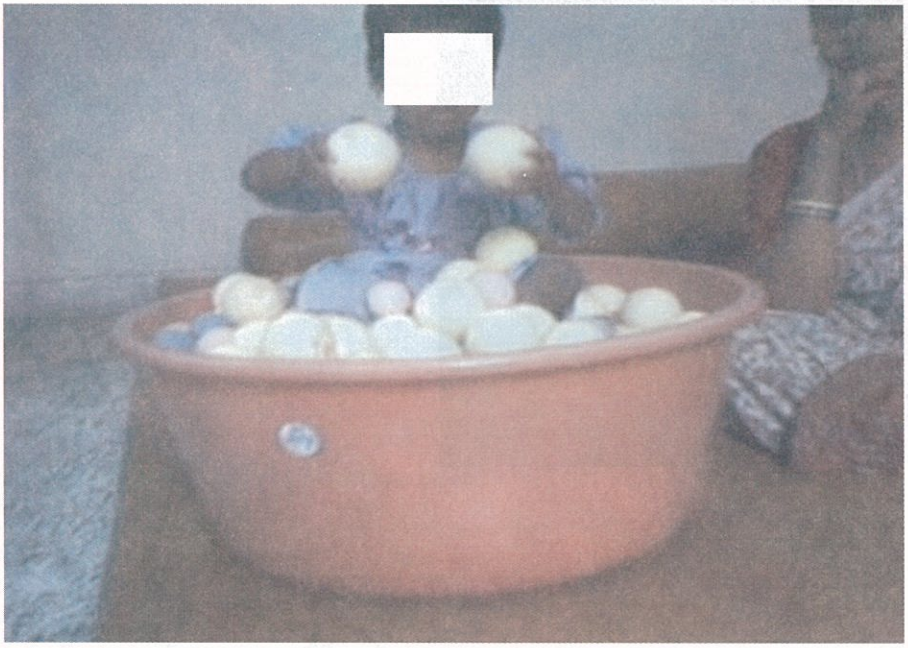


Fig. Ball baths

Uses

- It is used as a play facility for the children.
- It is used as a tactile and visual stimulation.
- It also helps to strengthen muscles of hand and improves joint mobility.

Springs

Three types of elasticity is available for exercise purpose.

1. Extensibility.
2. Compressibility.
3. Torsion.

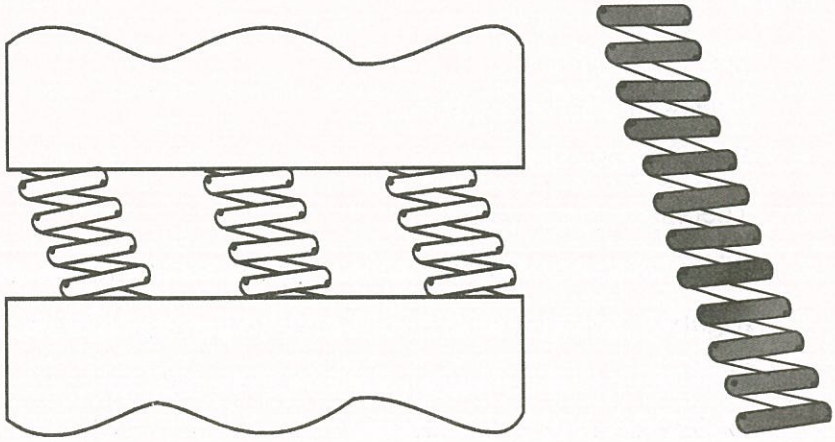


Fig. Springs

Uses

- Extensible springs offer resistance to muscle work as they are stretched, recoil and offers resistance to movement.
- Compressible springs are used for exercising.
- Resisted type of exercises are given to improve muscle power and Bulk of the muscle.

Pulley

Pulley circuits may be used to change the angle, to give mechanical advantage. It consists of a grooved wheel, fixed to the wall and a rope, which passes through the groove. The rope is provided with two hand bars on either ends.

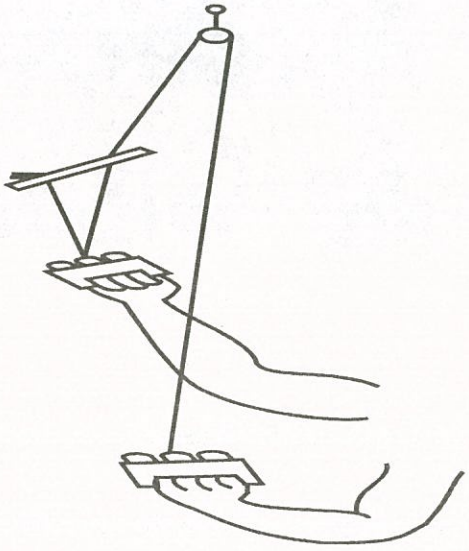


Fig. Pulley

Uses

- Assisted type of exercises.
- It helps to move the weak part of body.
- To mobilize joints.
- For stretching.

Sand bags

These are made up of sand stuffed inside a bag of cloth. These are available in different weights ranging from 1/2 kg to 5 kg. It is used to put the joint in proper position and stabilized to the limbs for stabilization. Sand bags can be used to strengthen the specific group of muscles.

Fig. Sandbag

Uses

- For developing the arches of the foot(intrinsic muscles) ask the person stand on inner edges, outer edges of sand bags.
- Used for simple resistance exercises to strengthen the specific group of muscles.
- It can be used for positioning of the body parts.

Dumbbells

These are used for muscle training(resisted exercises). These are made either steel or by molding iron two weights of equal amount are attached to the ends of the steel bar.

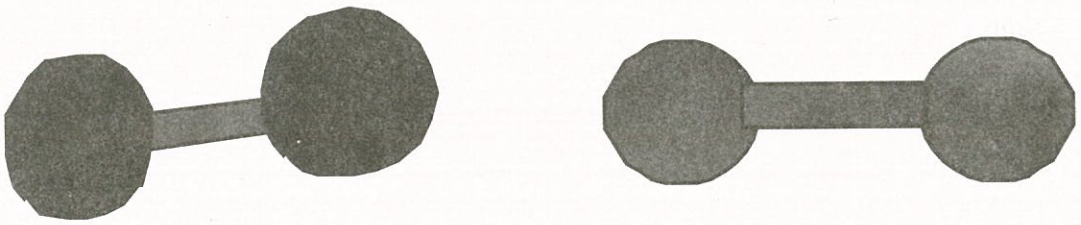


Fig. Dumbbells

Uses

- Used for strengthening the muscle groups.
- To increase the muscle Bulk.
- To improve the tone and bulk of the muscle.

Postural mirror

It is a long length common mirror, which reflects the image of a person standing in front of it, used for feedback purpose in physiotherapy.

Fig. Postural mirror

Uses

- The person can be trained, in proper alignment of his body, posture and gait.
- Postural correction.
- Voluntary correction of gait.
- Voluntary correction of posture.
- Self-correction of postural deformities.

Bouncers or trampoline

Trampolines are used for fun and exercises of all age groups and small enough to store in home. Children can make safe walk, jog, bounce or jump on. A child should be trained in bouncing on trampoline.

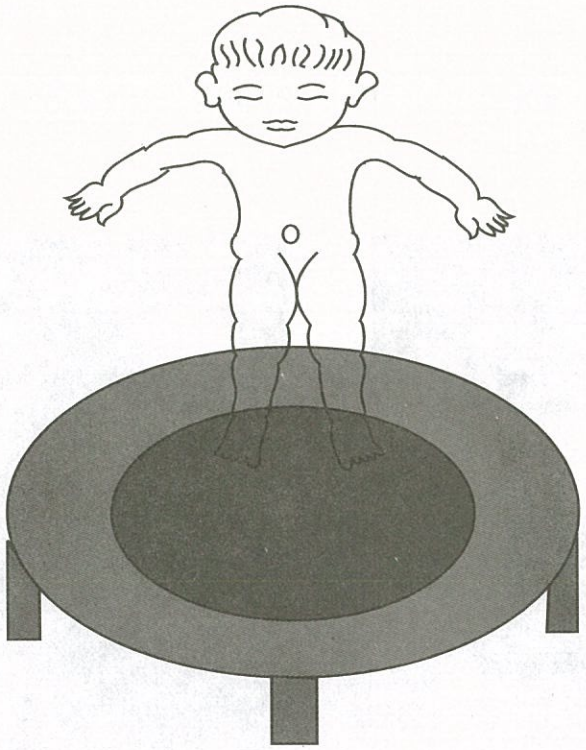


Fig. Trampoline

Uses

- Helps to develop lower limb muscles on bouncing.
- Muscles can be strengthen safely without the fear of joint trauma.
- They are useful in retraining balance, rhythm, speed, agility, proprioception and Neuro muscular coordination.
- Helps to maintain or regain balance.
- Improves balance while walking.
- Stimulates vestibular system for coordination.

Balls

They are of different sizes, shapes and textures. It is made up of materials like sponge, leather, plastic etc. It may be hard or soft according to the material used.

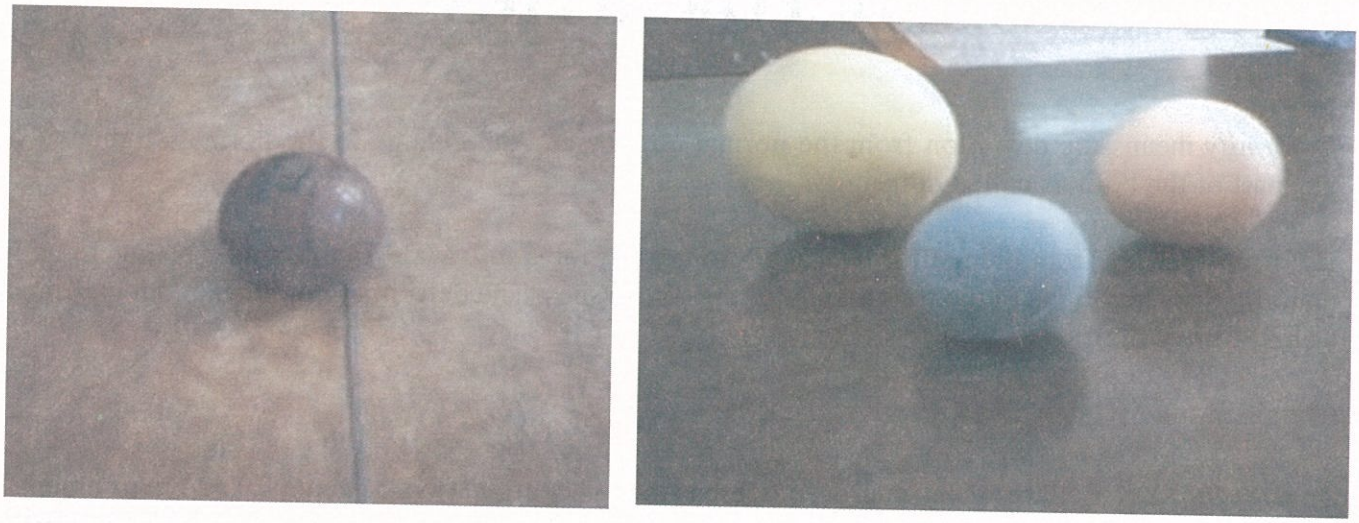


Fig. Balls

Uses

- It can be used for hand exercises.
- To develop muscle strength in the hands and mobility in the joints.
- As a part of play activity.

Soft apparatus for resistance

Rubber tubes, therabands, chest expanders, skipping rope, power grips, silicone putty, plastacin or some of the soft apparatus. These are made up of the soft material with foam and elastic material.

Uses

- These are mainly useful for the upper limb and lower limb resistance exercises.
- It is also useful for improving mobility, flexibility and muscle power.

* * *

CHAPTER 18

DEFORMITIES

Deformity means the deviation from the normal alignment. Any change in the normal alignment of any part of the body is called deformity.

Deformity results from the malformation of any part of the body. Malformation may be due to body distortion or alterations in the topography of the soft tissues. The deformity could lead to impairment or loss of function.

Classification of deformities are given below:

1. *Congenital:* Failure of normal development due to continuation of genetic and environmental factors and due to improper position in the uterus, congenital deformities may or may not be hereditary.

1. *Acquired deformities:* These are developed after birth. Due to various causes.

   i) Bone diseases: e.g. Bone tuberculosis
   Carcinoma
   Rickets etc

   ii) Joint diseases: e.g. Arthritis
   Gout

   iii) Muscular causes: a. Muscle paralysis
   b. Muscle spasticity
   c. Muscular diseases - muscular dystrophy
   d. Contractures

   iv) Nerve lesions: e.g. Hensen's diseases.

   v) Postural causes: Faulty postural habits, can lead to deformity. (mainly spinal deformity).

   vi) Continuous abnormal position, contractures or tightness of soft tissue.

   vii) If present for longer period then it may lead to deformity.

Grading of deformities

Deformities are classified into three grades.

1. First degree: Mild, it can be corrected by manipulation of soft tissue contractures.

2. Second degree: Bony changes may be present, attempt to correct the deformity causes pain and prevent passive correction of the deformity.

Management

First and second degrees of deformities can be corrected by using following strategies.

a. Gradual passive stretching.
b. Correcting muscular imbalance by exercises.
c. Strapping of deformity in an over corrected position with suitable supportive device.
d. Maintenance of correction by adequate immobilization.
e. Re-education exercises.
f. Splinting to maintain the correction.

3. *Third degree:* Deformities are corrected by a series of corrective manipulations and surgical procedure on the soft tissues and bones.

Congenital Talipes Equino Varus (clubfoot, CTEV)

It is characterized with a foot plantar flexed at the ankle, inverted at the subtalar joint and adducted at the forefoot.

The talus is plantar flexed and superior articular surface is exposed. The calcaneus is inverted so that its medial malleolus and its posterior aspect is elevated. The navicular is rotated on its axis and its tubercle may almost come in contact with the medial malleolus. The soft tissue on the posterior aspect of the ankle and medial, aspect of foot are shortened.

Causes

1. A defect in fetal development.
2. Abnormal intrautrine position of fetus.
3. Ischemia of calf muscles during intrautirain life.
4. Secondary to polio, AMC, spina bifida etc.

Deformities of clubfoot

Fig. Equinus deformity at ankle

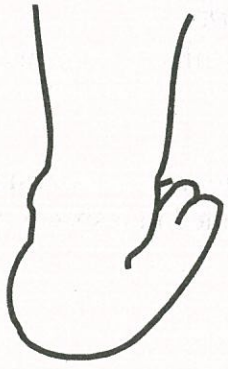


Fig. Inversion at subtalar joint

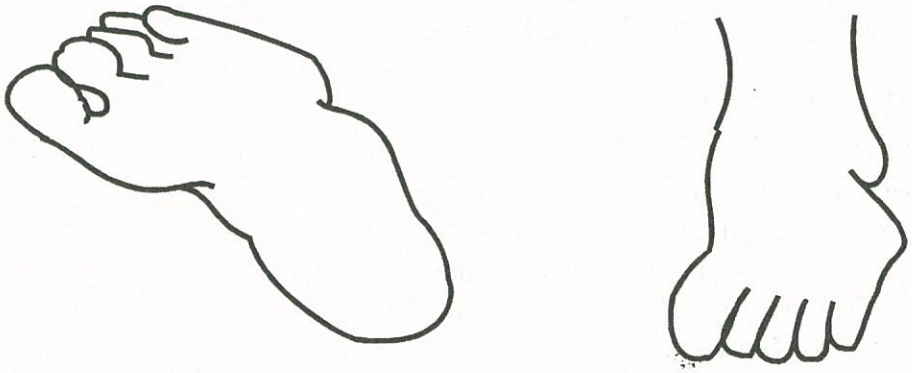


Fig. Adduction of forefoot

Management

Following techniques are used in the management of clubfoot deformity.

1. Early gentle stretching and strapping.
2. Manipulative correction and plaster casting.
3. Surgery - If it is too tight, cannot be corrected by passive stretching.
4. Supportive devices to maintain correction and put the foot in corrected position as long as possible.

Conservative management

In the first 3 weeks

Initially, either child or parent is taught to move the infant's foot twice a day.

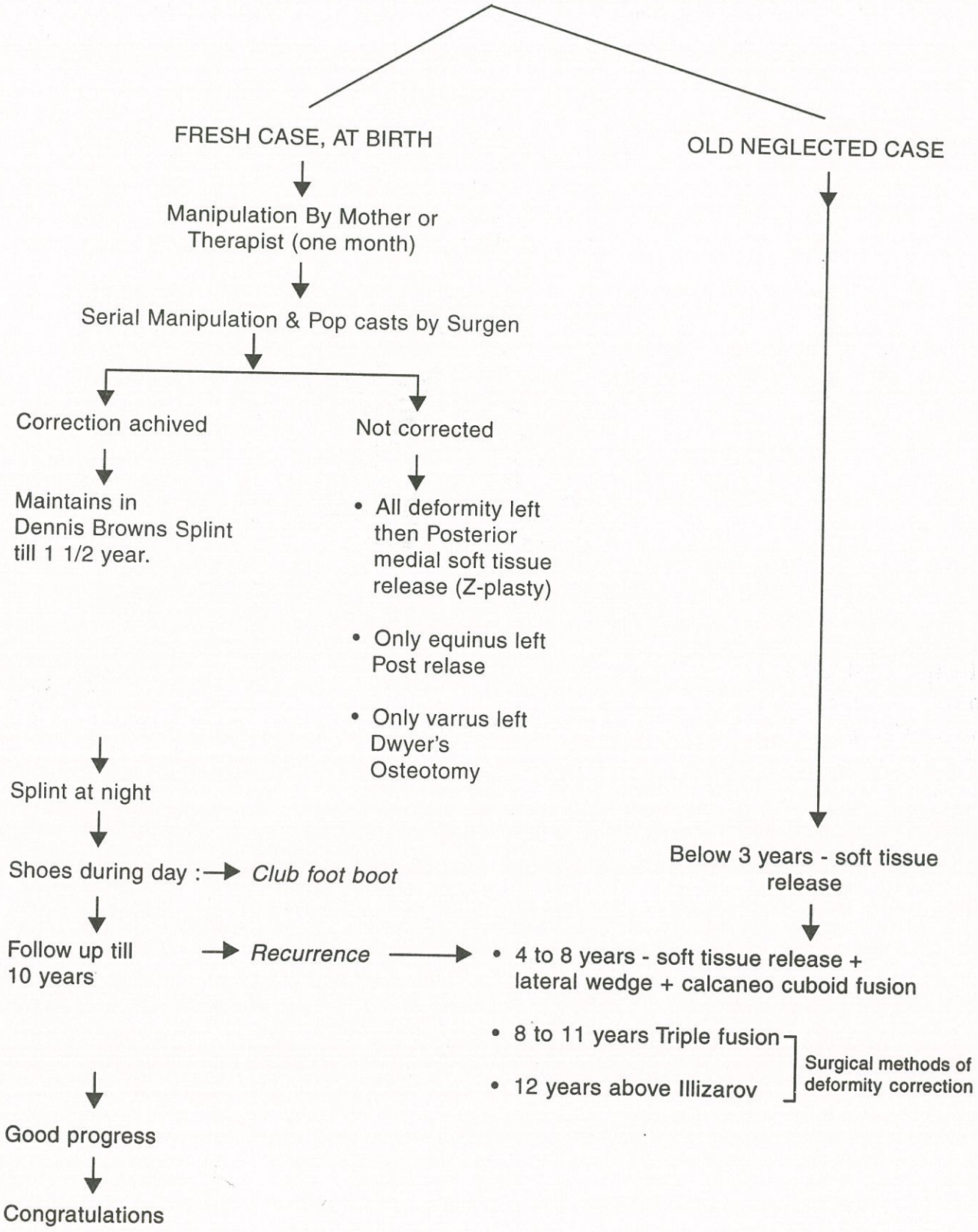
Three weeks to three months

Manipulation and strapping (with adhesive plaster) in position.

Three months to one year

Manipulation is done under general anesthesia and plaster of paris cast is applied with the knee in flexion. Correction, is maintained in a special clubfoot boot after the removal of cast.

CLUB FOOT MANAGEMENT



Surgical Treatment

Surgical treatment is required in the delayed chronic cases. It includes lengthening of tendoachiles tendon, bony corrections around foot. Denis Browne special night splints are worn after correction of deformity.

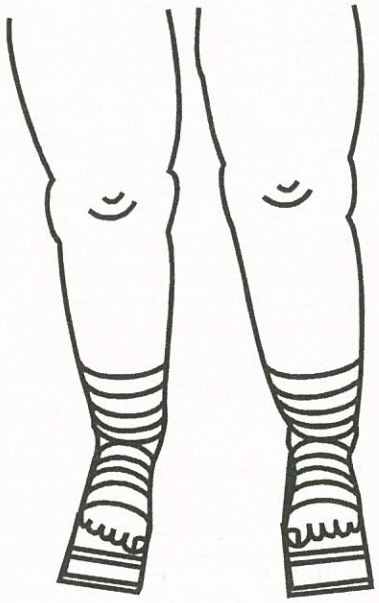


Fig. Dennis browne's splint

Talipes Calcaneovalgus (CTCV)

It is a rare deformity. This deformity is characterized by the dorsiflexion at the ankle joint and eversion at the subtalar joint, which cannot be moved into full inversion or plantarflexion. The soft tissues on the anterior surface of the ankle are contracted. Congenital talipes calcaneovalgus is commonly associated with congenital hip dislocation.

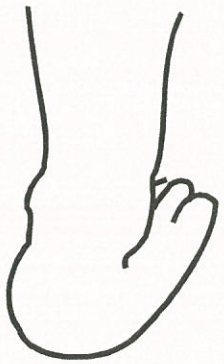


Fig. CTCV

Management

- Passive movements
- Active plantar flexion exercises.
- Suitable supportive device(special shoe) to maintain correction and also to correct the deformity.

Coxa vara

1. This condition is characterised by decrease in the angle between the neck of femur and the shaft of femur (90^0 or less). (normal angle-115^0).
2. Subluxation of the head of femur may occur.
3. Limitation of the passive range of hip abduction, flexion, with excessive extension.
4. External rotation is limited but internal rotation is more.
5. The person stands with hips in adduction, external rotation and the foot in eversion.
6. In bilateral coxa vara, there is a waddling of gait with occasional scissoring.
7. In unilateral deformity, there is a marked limp.

Management

- This is treated by applying traction, isometric exercise to the abductors, relaxed passive full range hip, knee exercises.
- Standing with equal weight on both the hip joints. Progressed to weight bearing on affected leg and gait training. Full range of abduction is initiated, progress to a relaxed passive movement, finally resisted movements.

Genu valgum (knock knee)

It is characterised by outward deviation of the legs at the knee joint. It can be unilateral or bilateral. The degree of genu valgum is measured by the distance between the medial malleoli at the ankle(when the child stands or lies down with the knees touching each other). It may be due to rickets, growth imbalance, muscular and ligaments weakness.

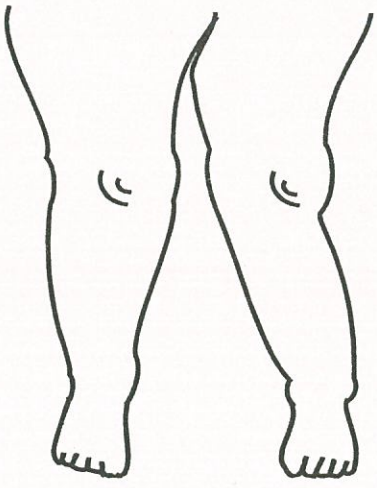


Fig. Genu valgum

In this deformity the line of weight bearing passes outside the knee joint(normally passes through the middle of the joint).

Causes

1. Hypotonia
2. Hypertonia
3. Muscle weakness
4. Joint instability

Management

Mild case of genu valgum(intermalleolar distance less than 5 cms) can be corrected with boots with the inner side of the heel raised by 3/8 inch and elongated forward(Robert Jones Heel). Moderate deformity(intermalleolar distance being 5-10cm) can be corrected by an Orthosis consisting of boots with long outside bar upto the level of the greater trochanter and knee straps. Surgery is required for severe deformity.

Genu varum (bow legs)

It is a deformity, with lateral bowing of the legs at the knee. The degree of the deformity is measured by the distance between the two medial femoral condyles. (intercondylar distance) when the person stands or lying position with the ankles together.

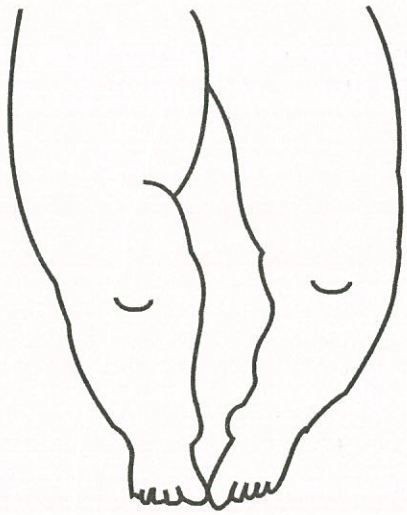


Fig. Genu varum

Causes

1. Rickets
2. Hypotonia
3. Hypertonia
4. Muscle in balance
5. Joint instability

Management

- Passive stretching exercises and voluntary correction.
- Mild degree cases, can be corrected by wearing an orthotic appliance consisting of boots with a long inner rod extending to the groin and leather straps across the tibia and the knee, to correct the bowing of legs.
- Surgical correction is required for severe deformity.

Genu recurvatum: It is characterised by hyper extension of the knee joint. It is mainly due to the weakness of the quadriceps muscle or lengthening of hamstring muscles rather than shortening.

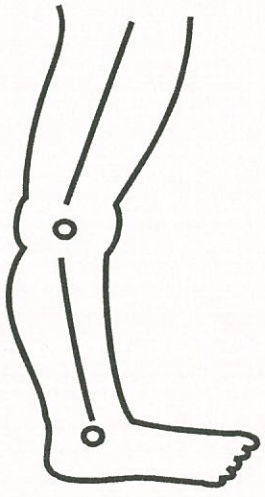


Fig. Genu recurvatum

Causes

1. Hypotonia
2. Hypertonia
3. Muscular imbalance
4. Joint instability

Management

- It can be controlled or restricted by splinting.
- Stretching of hamstrings and strengthening of quadriceps.

Torticollis: It is characterized by titling head to one side and rotation to the opposite side due the Contracture of the sternocleidomastoid muscle on one side.

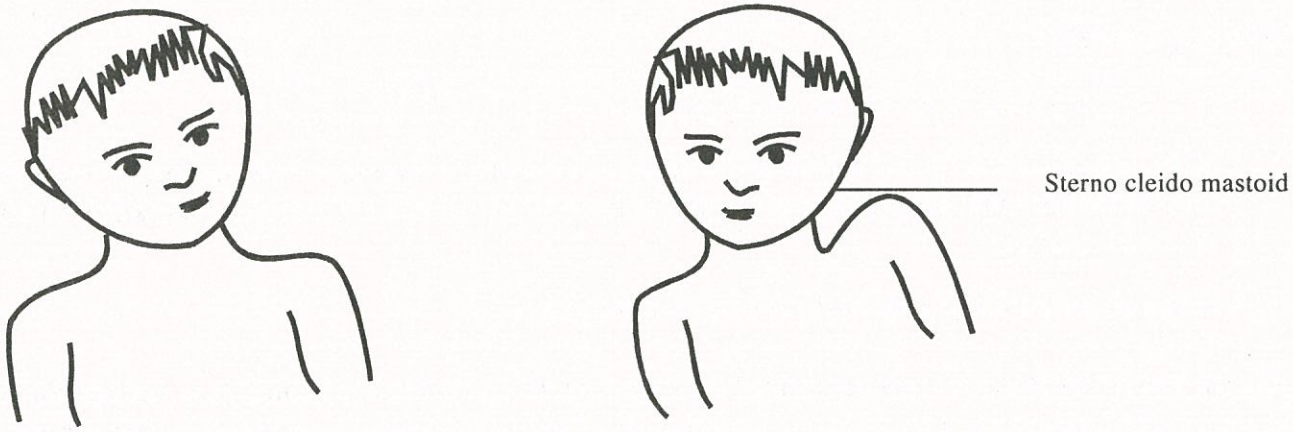


Fig. Torticollis

Causes

1. Muscular dystrophy.
2. Idiopathic.

Management

- Active voluntary correction.
- Stretching of the sternocleidomastoid in new born and surgery during childhood.
- Cervical collar.

Scoliosis : It is defined as a lateral curvature of the spine with or without rotation of the spinal segments. It is classified as follows.

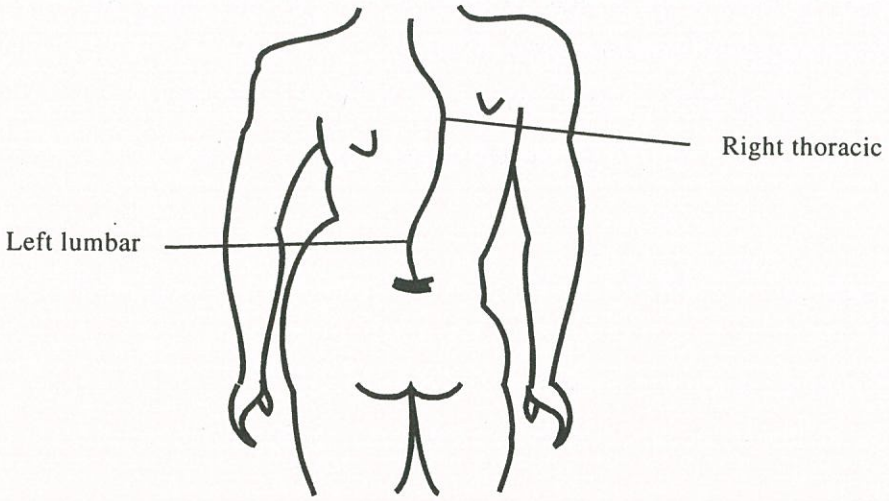


Fig. Scoliosis

Postural scoliosis: It is common in children and corrects completely in lying down position. It does not progress and correction can be possible with spinal exercises.
Structural scoliosis: It may be due to the diseases affecting neuromusculoskeletal systems which progress rapidly if neglected, it can also be caused by a bony abnormalities.

Curves : In scoliosis, main curvature is called as the primary curve. Scoliosis is named according to the level and side in which the main convexity of the curve is directed. e.g. The term left dorsal scoliosis denotes that the convexity of the main curve is towards the left side and it is at the dorsal level. The primary curves has the compensatory curves above and below, it is called the secondary curves.

Causes

1. Hypotonia
2. Hypertonia
3. Muscular weakness
4. Muscular imbalance
5. Vertebral disease

Management

- The person is asked to sleep on the side of the concavity.
- Postural correction is done by giving the heel raise on the convex side of the deformity.
- Spinal and breathing exercises are prescribed.
- Milwaukee brace or modified plastic braces are applied in moderate deformity.
- Surgical intervention is required for severe deformity.

Kyphosis

1. Kyphosis is anterior curvature of the spine. At thoracic level, it exaggerates the normal curve and in lumbar and cervical level it obliterates the normal lordosis.
2. A rounded Kyphosis occurs in adolescence or in elderly.
3. Acute angular Kyphosis occurs due to tuberculosis of spine or traumatic fusion of two vertebrae.

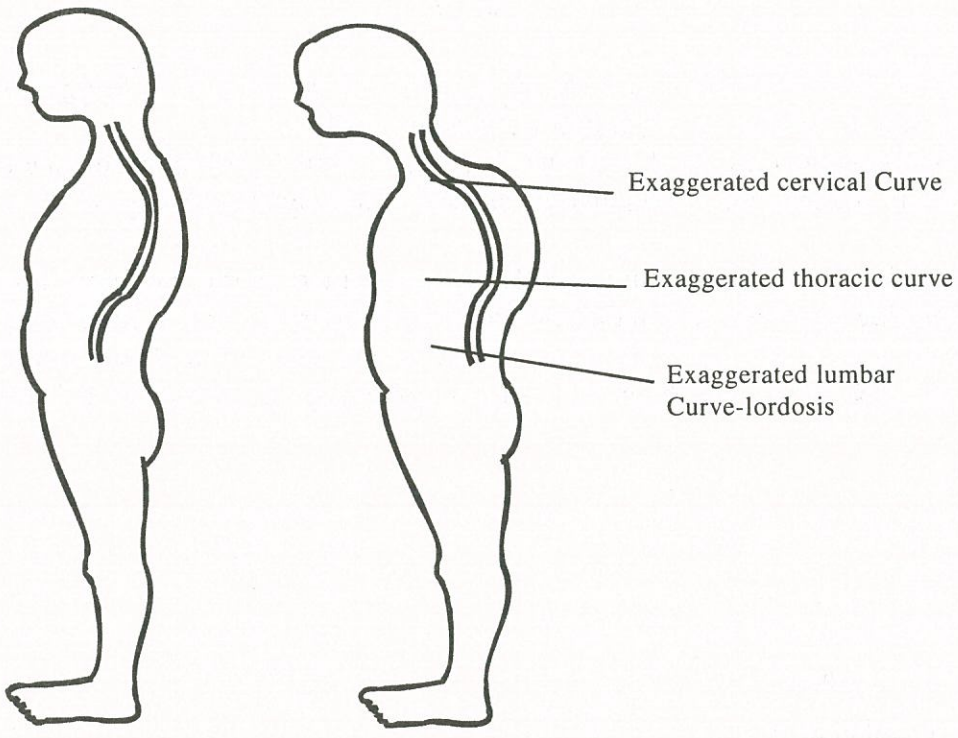


Fig. Kyphosis and lordosis

Causes

1. Senile osteoporosis
2. Tuberculosis of spine
3. Traumatic fusion of vertebrae

Management

- Postural re-education
- Spinal extension exercises
- Breathing exercises
- Spinal jacket (supportive devices)

Lordosis

Normal curvature present in lumbar spine area is called lordotic curve. Lordosis is a posterior curvature of the spine. It occurs commonly in the lumbar spine. Most often as a compensation for a kyphosis above or a flexion deformity of the hip joint. Below diminished normal lumbar lordotic curve is called flat back.

Causes

1. Weakness of abdominal muscles.
2. Tightness of back extensors.
3. Tightness of hamstrings muscles.

Management

- Spinal extension and flexion exercises.
- Abdominal strengthening.
- Stretching of hamstring and back extensors muscles.

Congenital dislocation of hip (developmental dysplasia of hip)

- This includes various degrees of displacement of the head of femur from the acetabulum.

Clinical features

1. The child is presented with obvious shortening of the leg.
2. Additional crease in the posterior and medial aspects of the upper thigh.
3. On examination, there is a limitation of abduction of the flexed hip.
4. The dislocated head of the femur can be palpated in the gluteal region.

Treatment

The therapy depends on the age at which the child comes. The aim of the therapy is to reduce the hip and maintain it in the reduced position till it becomes stable.

In infants below 3 months

The position of the head in the acetabulum is maintained by splinting.

Children from 3 to 6 months

manipulation and immobilization, with hip in 90^0 flexion and 45^0 abduction.

Children from 6 to 12 months

A preliminary traction and gradual abduction is done for 2-3 weeks before reduction under general anesthesia. Then plaster cast applied.

Children from 1 to 3 years

Surgery is a final line of management.

Children 3 to 6 years

After open reduction of the hip and femoral osteotomy, an osteotomy of the innominate bone is also done.

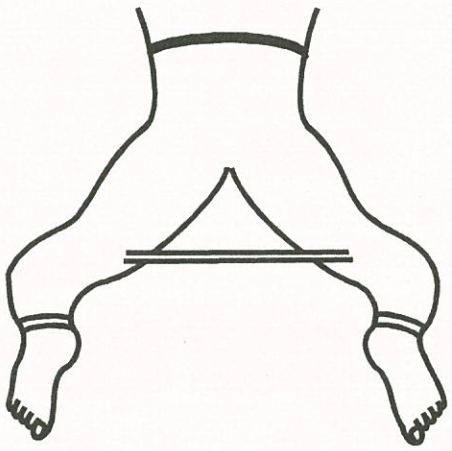


Fig. Pop hip spica

Neglected Congenital Dislocation of Hip (CDH): It may present after the age of 10 years with pain and unstable gait.

Complications

Forceful reduction of the hip in childhood may cause avascular necrosis of the head of the femur.

* * *

CHAPTER 19

GAIT

Definition :

Gait discribed as a translatory progression of the body as a whole produced by coordinated, rotatory movements of body segments.

Description :

Human locomotion or gait may be described as a translatory progression of the body as a whole produced by coordinated, rotatory movement of various body segments. Normal gait is characterized by rhythmic, alternating, propulsive and retropulsive motion of lower extremities. It involves lifting of leg and swinging it in the air and putting it on ground, heel part of the foot first touches the ground and then toes off the ground. Before toes off the other leg initiates movements.

NORMAL GAIT

Figure: Normal gait pattern.

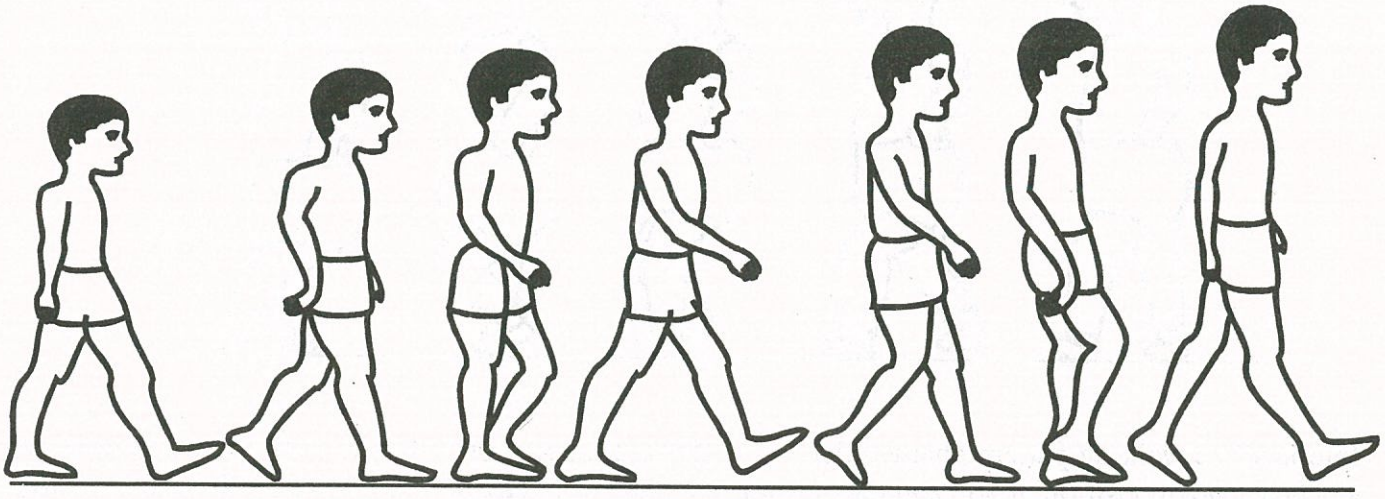
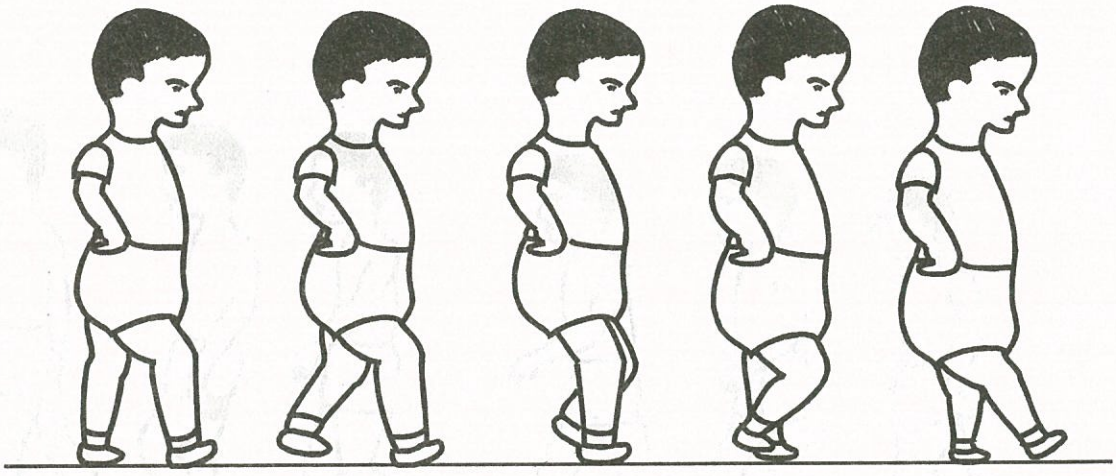


Fig. Gait cycle

The characteristic features of children from ages 4-5 years and older. A gait cycle begins with the heel strike of a leg and ends when the heel of the same leg strikes again. Step length and stride length relate to height.

First walking pattern showing high guard position of arms, rigid torso, excessive flexion of hip, knee joints and flat-footed steps.



Intermediate walking pattern characteristic of children till age 4 or 5. There is still no trunk rotation and hence no opposition of arm and leg movements. Hip and knee action is still excessive, but heel-toe transfer of weight is beginning to appear.

Kinematics

Gait Cycle: A gait cycle consists of the events that occur between initial contact of the reference extremity (right) and successive contact of the same extremity.

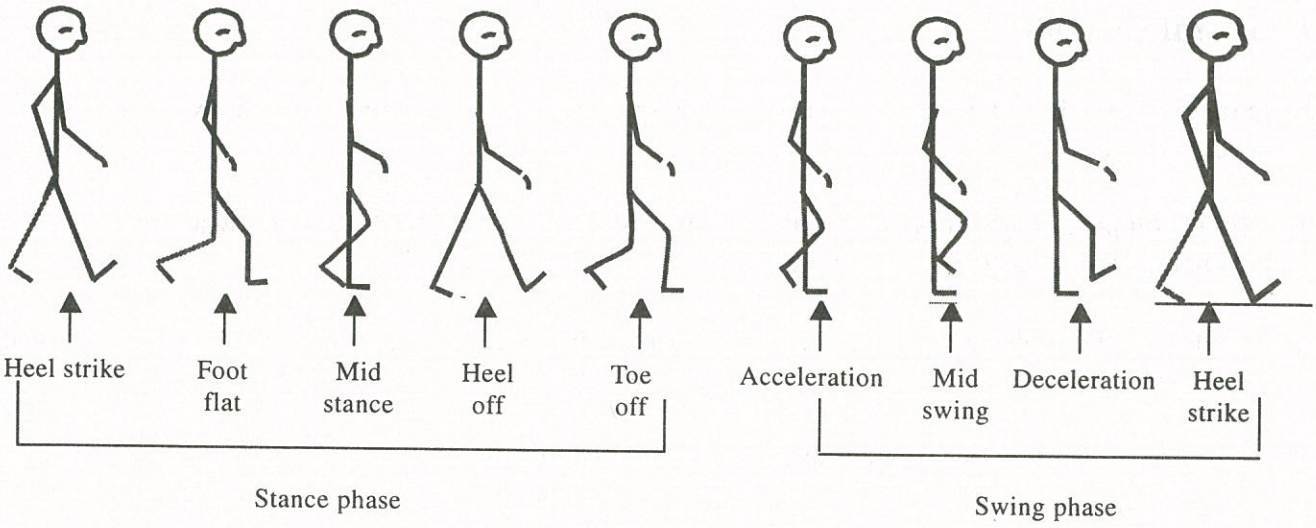


Fig . Events occurring in a gait cycle (black leg)

The gait cycle is divided into two phases.

(a) Stance phase : (supporting phase or weight bearing phase): It extents from heel strike to toe-off of the reference foot. It constitutes 60% part of gait cycle. During this phase the weight is supported on one leg. So it is called weight bearing phase of gait cycle. It consists of five sub-phases as follows.

i) Heel strike

ii) Foot flat

iii) Mid stance

iv) Heel off

v) Toe off

(b) Swing phase : It extends from acceleration of leg to heel contact of the same foot. It constitute 40% of the gait cycle. The leg in swing phase is balancing leg and it performs the balancing of body. It consists of the following sub phases.

(i) Acceleration

(ii) Mid swing

(iii) Deceleration

PARAMETERS OF GAIT

TIME and DISTANCE are two basic parameters of motion, and measurements of these variables provide a basic description of gait. These parameters will vary according to the age, weight and physique of the person.

Temporal variables:

(a) Stance phase: It is the amount of time that elapses during stance phase of one extremity in a gait cycle.

(b) Single support phase: It is the amount of time that elapses during the period, when one extremity is on support surface in a gait cycle.

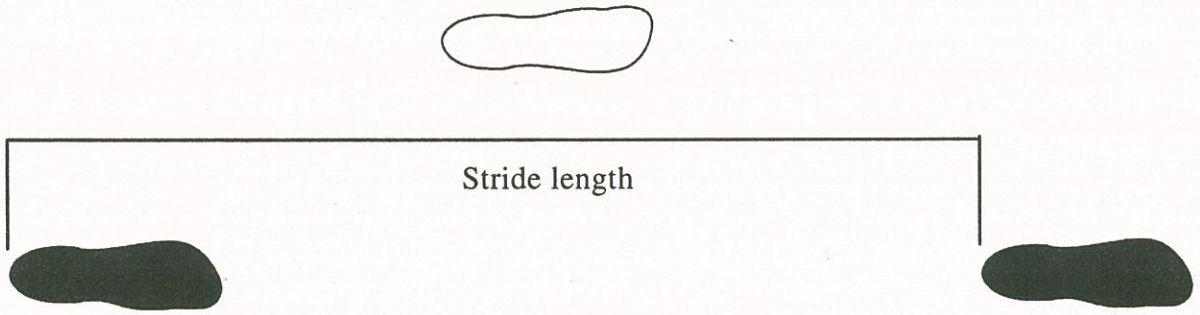
(c) Double support phase: It is the amount of time, that a person spends, both feet on the ground during one gait cycle.

(d) Cadence: Is the number of step taken by person per minute.

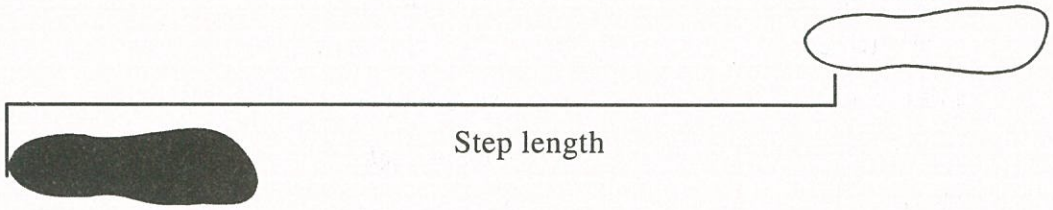
Cadence = No. of steps / time

DISTANCE VARIABLES

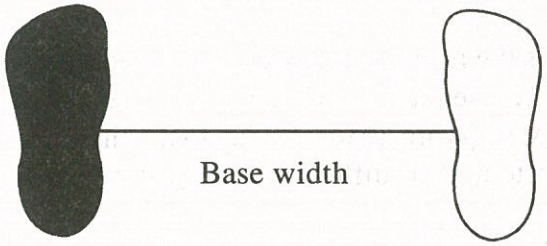
1. Stride length : It is a distance between heel strike of one extremity to the successive heel strike of the same extremity.



2. Step length : It is the distance between heel strike of one extremity and the heel strike of contra lateral extremity.



3. Base width : It is the linear distance between the midpoints of the two feet.



RANGES OF MOTION AT EACH JOINT IN THE LOWER LIMB DURING WALKING.

STANCE PHASE

Joint	Heel strike	Foot flat	Mid stance	Heel off	Toe off
Hip	30^0 flexion	25^0 flexion	Neutral	$10\text{-}20^0$	0^0
Knee	full extension	15^0 flexion	5^0 flexion	0^0 flexion	$35\text{-}40^0$ of flexion
Ankle	Neutral	15^0 flexion	$5\text{-}10^0$ dorsiflexion	0^0 of dorsiflexion	20^0 of plantar flexion
Toes	Neutral	Neutral	Neutral	30^0 of extension	$50\text{-}60^0$ of extension
Movement of pelvis	Same side moves forward	Same side is forward	Neutral	Same side moves forward	Same side moves forward

SWING PHASE

Joint	Acceleration	Mid swing	Deceleration
Hip	20^0 flexion	30^0 flexion	30^0 flexion
Knee	60^0 flexion	30^0 flexion	extended
Ankle	10^0 plantar flexion	Neutral	Neutral
Movement of pelvis	Same side moves forward	Neutral	Same side moves forward

Position of contralateral leg in comparison with the reference leg at various stages of gait cycle.

Right leg	Left leg
Heel strike	Toe off
Foot flat	Acceleration
Mid stance	Mid swing
Heel off	Deceleration
Toe off	Heel strike

ABNORMAL GAIT

Abnormal pattern of walking is the result of diseases or disorders affecting the neuro musculo skeletal system during or after birth. The sequences of gait cycle, the parameters of gait cycle such as step length, stride length, number of steps are disturbed due to the interference of abnormalities or diseases of neuro musculo skeletal system. The different abnormal gait patterns are characteristic of their respective disorders.

Abnormal gaits associated with spasticity and ataxia.

Scissors Gait Characteristic of spastic quadriplegic or diplegic cerebral palsy. The legs are flexed and adducted at the hip joint, causing them to cross alternately in front of each other with the knees scraping together. The knees may be flexed to a greater degree than normal, and the weight of the body may be taken primarily on the toes. The gait is characterized by a narrow walking base.

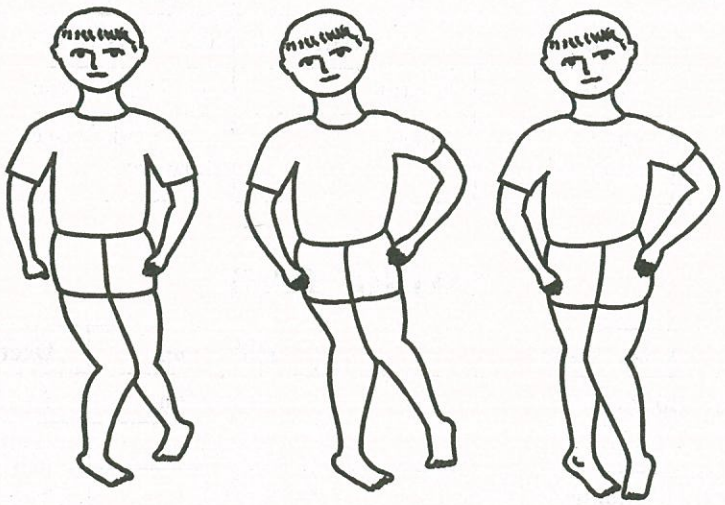


Fig. Scissoring gait

Hemiplegic gait Characteristic of cerebral palsy with spastic hemiplegic. Arm, leg, trunk, pelvic and shoulder girdles on the same side are involved. Affected leg is rigid and swung from the hip joint in a semicircle, by muscle action of the trunk. Individual leans on the affected side, and arm on that side is held in a rigid, semi flexed position. It is also called circumductory gait.

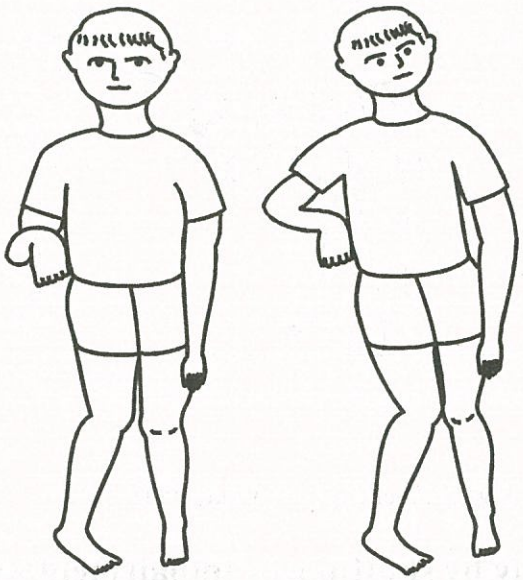


Fig. Hemiplegic gait

Cerebellar gait Characteristic of cerebral palsy with ataxia. Irregularity of steps unsteadiness, incoordination, generalized hypotonia. Problems are increased when the ground is uneven. Note the similarity between this and the immature walk of early childhood before CNS has matured. There are tremours during performing any activity.

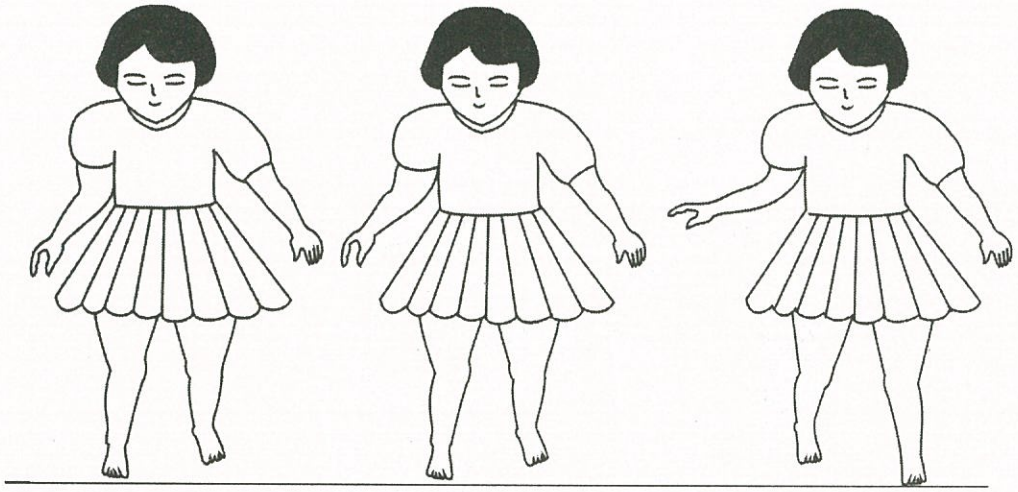


Fig. Cerebellar gaits (Atakic gait)

Gaits characterized, primarily by shuffling or impairment in the heel-toe transfer of weight.

Shuffling gait Associated with severe mental retardation. Inadequate muscle tone to lift the foot off the ground during the normal swinging phase of walking. There is excessive flexion at hip, knee, and ankle joints, and the trunk is usually inclined forward. Contact with floor is flat-footed. Usually, there is no opposition of arms and legs.

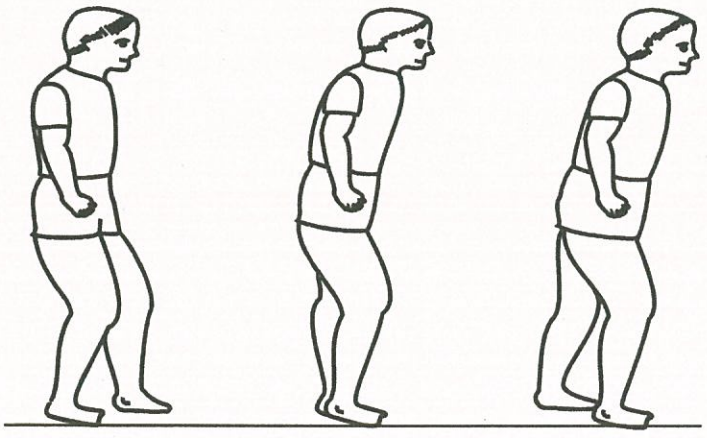


Fig. Shuffling gait

Propulsion or Festinant's gait Characteristic of Parkinson's disease. Individual walks with a forward leaning posture and short shuffling steps which begin slowly and become progressively more rapid. This gait also characterizes very old persons with low fitness.

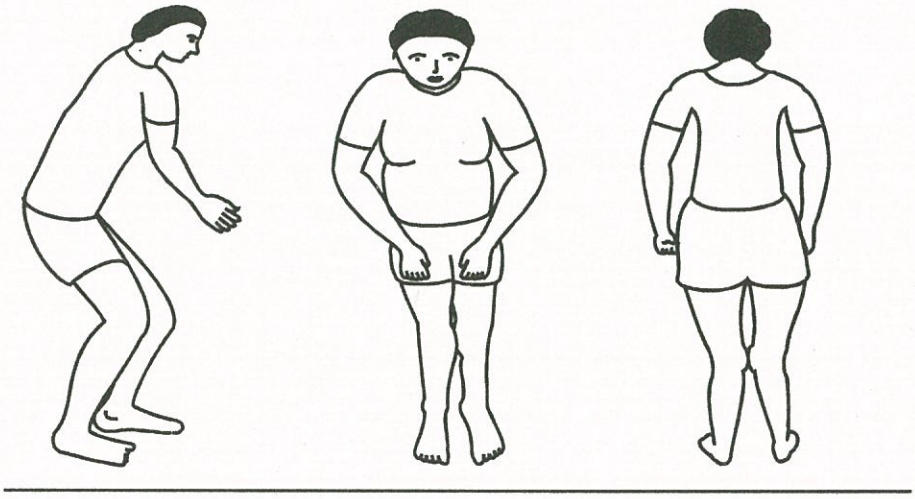


Fig. Festinant's gait

Initiation of walking is a problem, when initiate the child takes fast and short steps as he is trying to catch his line of gravity and cessation of walking is a problem, he never stops unless and until others intervene.

High Steppage gait Also called foot-drop gait and characterized by dropping foot on the floor. Knee action is higher than normal, but toes still tend to drag on floor. Caused by paralysis or weakness in the anterior tibial and peroneal muscles(leg muscles). Results in excessive hip and knee flexor work. There will be hiking in the hip in order to clear the foot forword.

Gaits characterized by waddling, lurching, or abnormal lateral movement.

Waddling gait Main deviation from normal is a rocking movement from side to side. This is usually caused by structural problems like bowlegs (genu varum), hip problems and dislocations or one leg longer than the other, deformities in lower limb, postural deviation. It seen in children with muscular dystrophy.

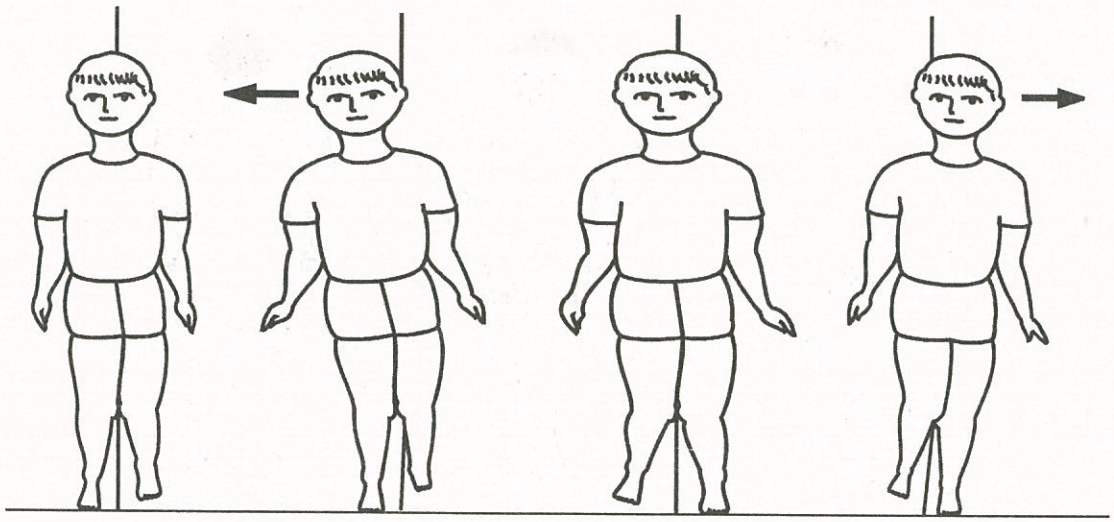


Fig. Waddling gait

Muscular dystrophy gait Characterized by awkward side-to-side waddle, sway back arms held in backward position, and frequent falling. Shoulder girdle muscles are often badly atrophied.

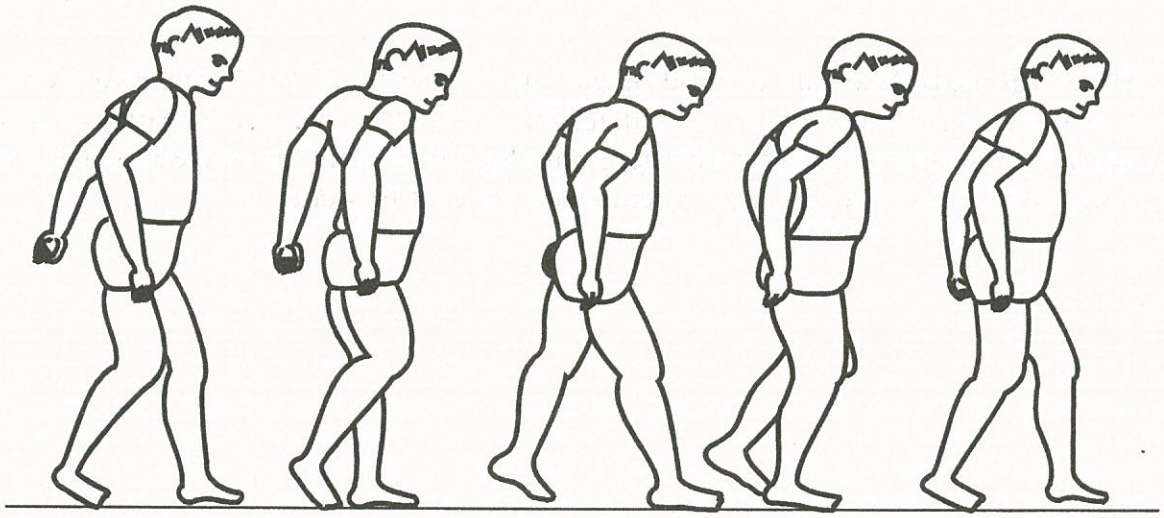


Fig. Muscular dystrophy gait

Gluteus maximus lurch Characterizes by with polio and the spinal paralysis conditions or gluteus muscle in which the paralyzed limb cannot shift the body weight forward onto the normal limb. To compensate this, the trunk is thrust forward. Once the paralyzed limb is thrown forward in this way, the trunk movement cannot be stopped by the normal braking action of the gluteus. A backward movement of the shoulders is therefore initiated to stop trunk movement. The gait, is thus characterized by alternate sticking out of chest and pulling back of shoulders.

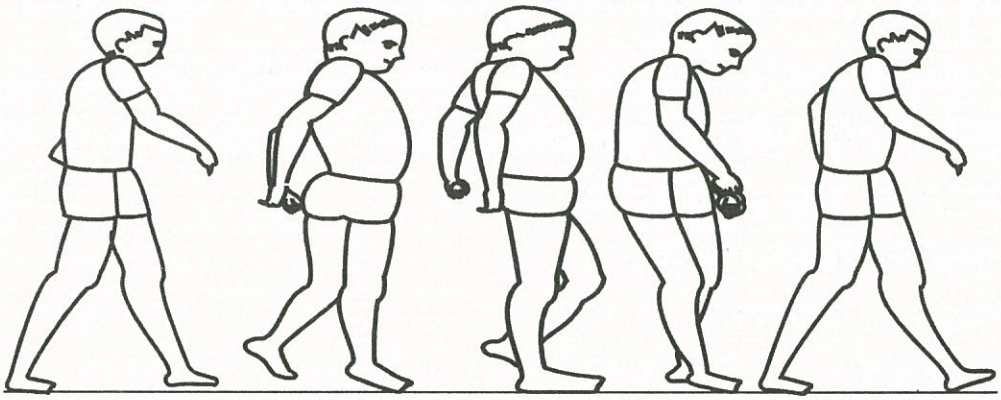


Fig. Gluteus maximus lurch gait

Gait characterized by uneven hip height caused by weakness of hip abductor muscles.

Trendelenburg gait Limp caused by paralysis or weakness of gluteus medius tremdelenburg sign. Pelvis is lower on non affected side (i.e., if right gluteus is affected, left hip is lower when standing with weight of body on right leg). In walking, each time the weight is transferred to right foot, the body leans slightly to the left (the affected side).

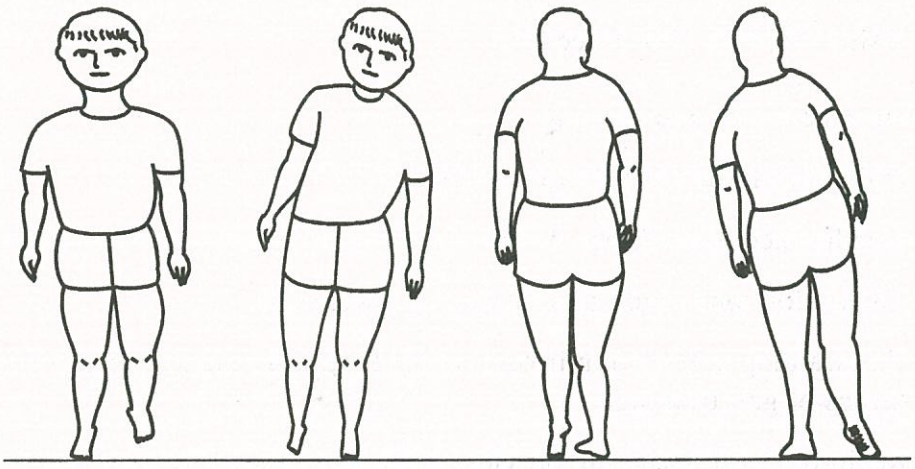


Fig. Trendelenburg gait

Hand to Knee gait : This is characteristic gait of polio or quadriceps muscle weekness, the person passively locks his knee joint with hand and passively moves the limb forword.

Antalgic gait or painful gait : It is usualy seen in painful conditions of the leg. In this the stance phase is shortened on the affected limb. The body weight is shifted quickly to the normal leg. Limping present in this gait.

PRINCIPLES OF GAIT TRAINING

Gait training should be started after evaluation of the person. It consist of five phases.

1. Pre gait training evaluation : It requires examination of the following points-
   a. Joints, active range of motion required in walking.
   b. Muscle power, strength and endurance.
   c. Coordination status of the limbs.
   d. Sensory status of the limb.
   e. Balance status.
   f. Age, body built, functional abilities, cooperation and attitude of persons towards walking.
   g. Types of physical activities involve at work and at home.
2. Identification of limiting factors.
3. Therapeutic measures :
   - Correction of the limiting factors such as deformities and soft tissue contractures.
   - Improvement in muscle power, balance and coordination of the upper limb to facilitate the use of walking aids.
   - Using assistive aids if needed.
4. Commencement of gait training
   - Child should be exposed to sensation.
   - Conditioned lower limb.
   - To develop tone / bulk particularly in lower limb.
   - Gait training in front of mirror, over the footmarks marked on the floors provides an excellent means of gait training.
   - Reciprocal arm swinging provides opposite reaction forces.
   - Techniques that provide static and dynamic balance to the gait should be practiced.
   - Gait training is generally initiated in parallel bar.

- Before that the child is exposed to weight bearing and sensation on ground by using baby walker, wooden cart, CP walker, rollator, on the side of cot, bed, chair, wall etc.
- Weight bearing on lower limb by putting the child in standing position.
- Bouncing on mattress, use of gaiter to knee joints(which provides stability to knee joints) and helps in early walking.
- Long sessions of standing balance on the affected leg alone are very effective to give confidence in improving stability and the pattern of gait.
- It is the idea to provide a description of normal pattern of gait to the child.

5. Independence in other activities of walking: The gait training can not be considered complete unless the person learns other walking activities:
   - Walking backwards
   - Turning
   - Walking sideways
   - Managing steps
   - Walking on rough uneven surfaces and slopes.
   - Falling on the floor and rising
   - Bouncing on mattress
   - Walking on narrow surfaces
   - Walking on balance beam

Gait training with crutches

Gait training with crutches progressed from non weight bearing pattern of walking to weight bearing normal pattern of walking. Before gait training is commenced various factor should be considered. Like grip power of the hands, arms, shoulders strength, power, should be increased if necessary. The different type of crutch walking are described as follows.

Step to gait This is used by severely handicapped persons who have little or no control of legs. It is a staccato gait with no follow through in front of the crutches. All the weight is taken by the arms while the legs are lifted and swung or dragged forward.

Special instructions should be given before using crutch that, it should rest on the thorax approximate 5-6 cm from axilla to avoid crutch nerve palsy.

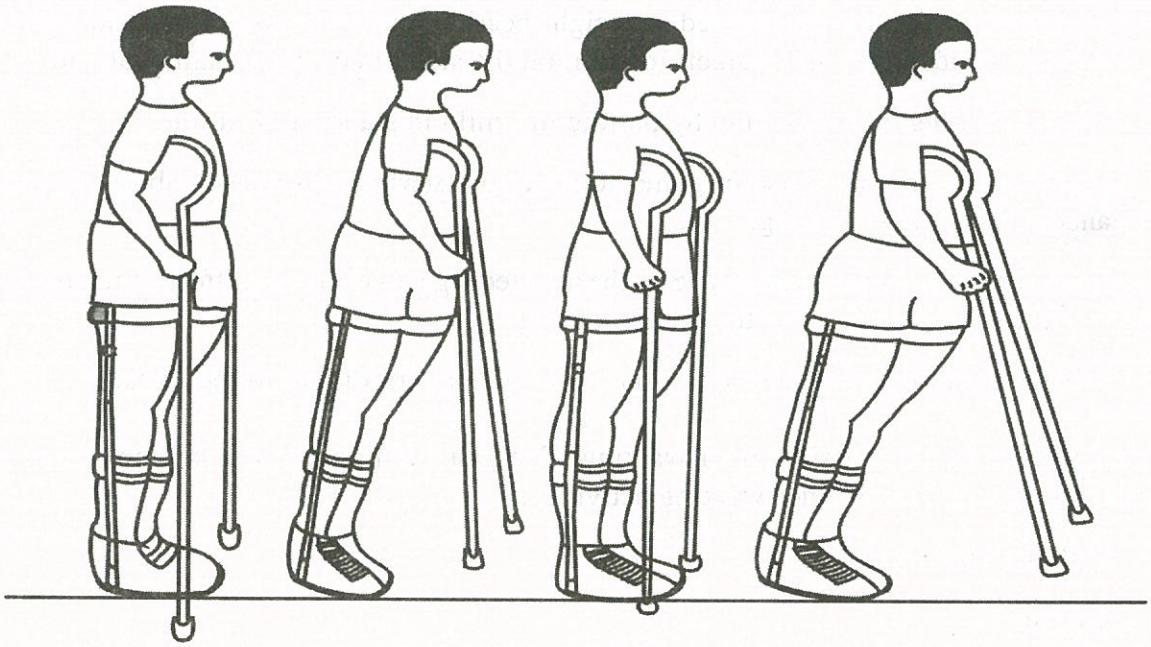


Fig. Step to gait

Swing through gait As a progression, person from swing to swing through. The person leans onto the crutches, lifting the body off the ground by extending the elbows. The body is swung through the crutches so that the normal foot lands in front of the crutches. Then the crutches are brought forward and the sequence is repeated.

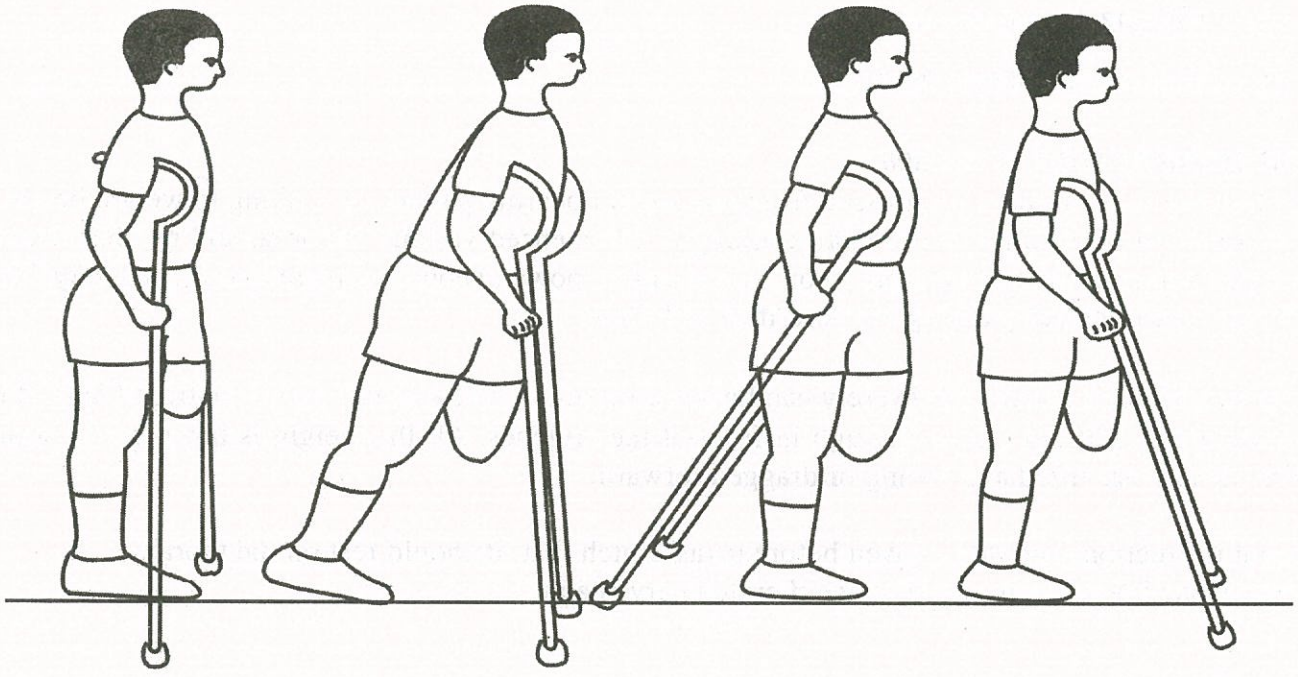


Fig. Swing through gait

Four-point gait This gait is used by persons who can move each leg independently. The pattern is (1) advance left crutch, (2) advance right foot, (3) advance right crutch, and (4) advance left foot.

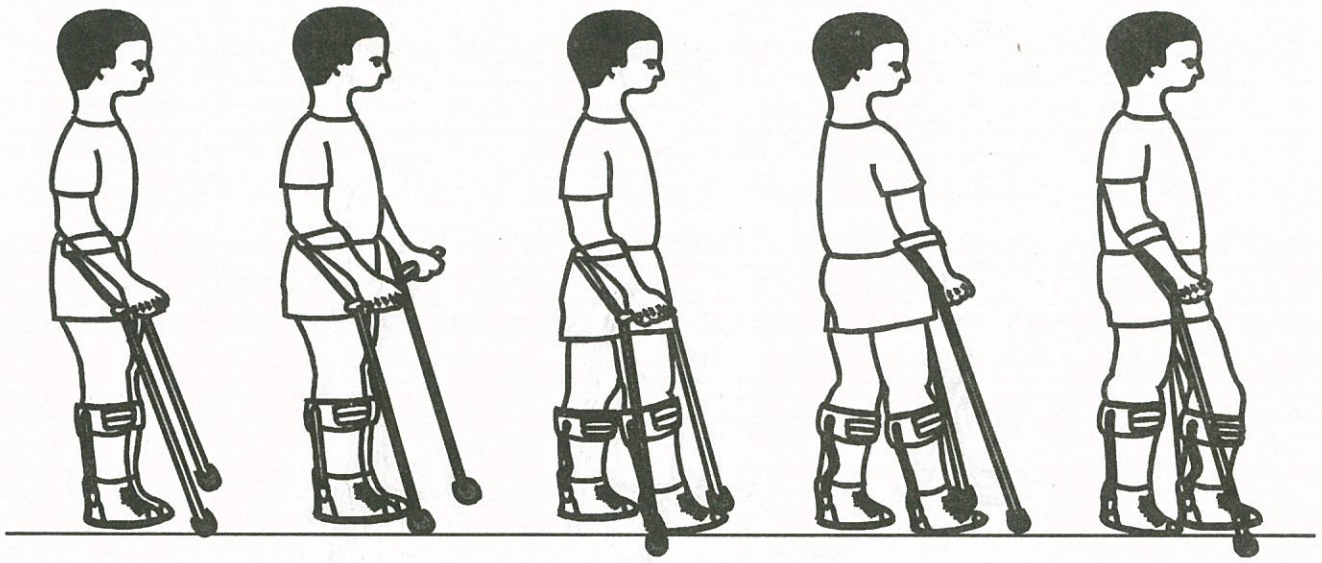


Fig. Four-point gait

Three-point gait In this gait, both crutches move forward in unison as in the step to and swing through gaits, but the feet move separately. Unlike most gaits, the affected, or weaker limb, takes the first step up to and in line with the crutches so it bears only partial body weight, as the good leg then steps out in front of the crutches. The patterns is (1) advance both crutches, (2) advance weak leg, and (3) advance strong leg.

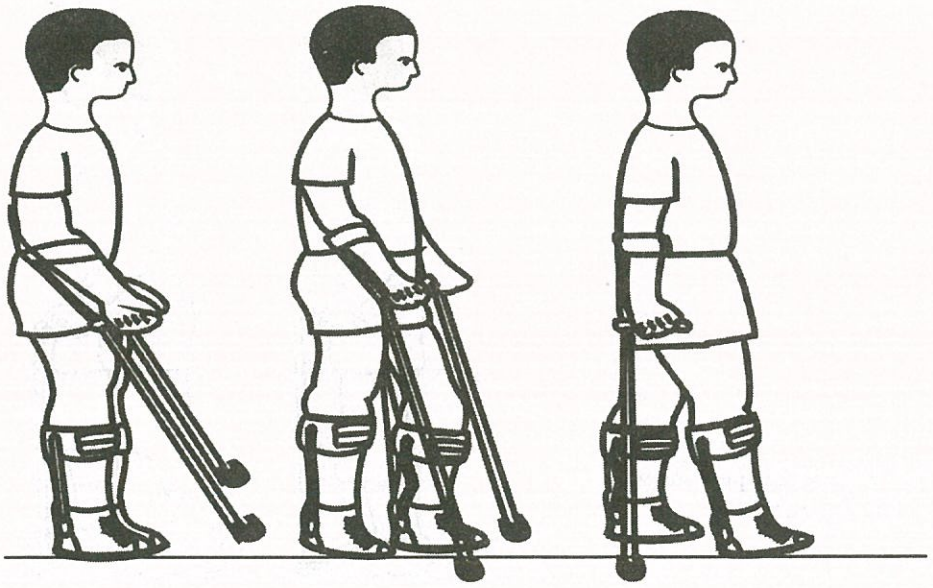


Fig. Three-point gait

Two-point gait This gait is most like normal walking and running. It is the fastest of the gaits, but requires balance because there are only two points of contact with the ground at any time. Whenever the crutch moves, the opposite leg moves in unison. The pattern is (1) advance left crutch and right leg simultaneously and (2) advance right crutch and left leg simultaneously.

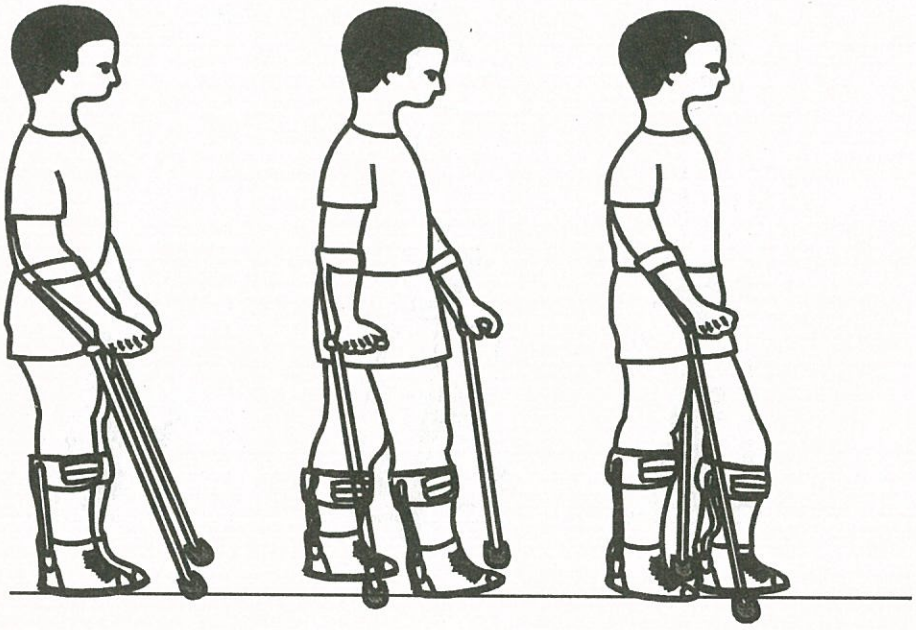


Fig. Two-point gait

Hemiplegic gait This gait is similar to the three-point except that one cane is use instead of two crutches. The cane moves first, then the weak leg opposite the cane, then the strong leg. The steps taken with each leg should be equal in length, with emphasis placed on establishing a rhythmic gait. Although used by persons of all ages, but this gait is most common in older persons who have had strokes.

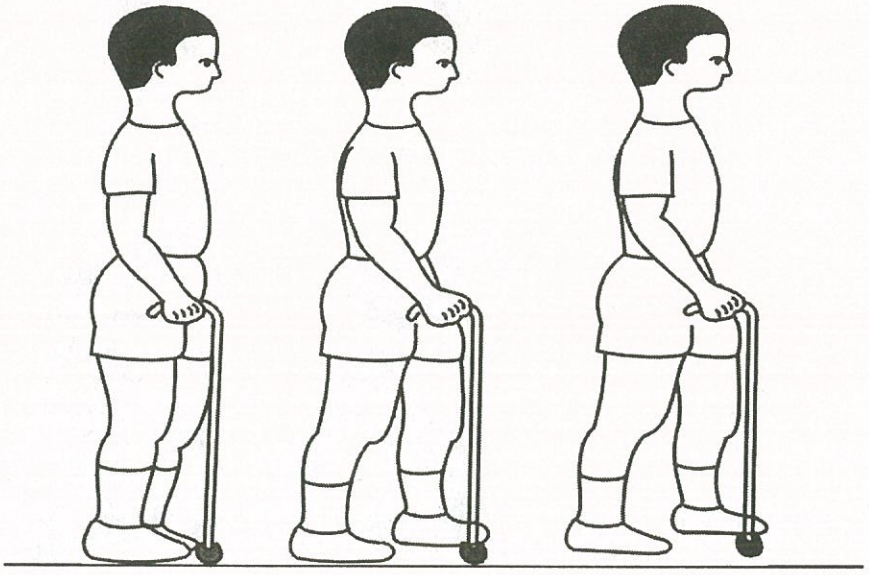


Fig. Hemiplegic persons walking by using cane

The position for walking like a bear is evident around the 12th month in a prone position supported by the hands and feet by this time he will develop strong supportive reaction of legs and this reactions enable the infant to pull himself into an upright kneeling position.

They also enable him to stand holding on to a support when he is placed in a standing position.

Between 15 and 18 months Independent walking is first observed. Early walking tends to be in a forward direction and then the child learns postural control over his centre of gravity and which result in that, he walks in other directions.

GAIT TRAINING

Modify abnormal pattern of walking and train him in the normal pattern of walking while giving gait training or in supported standing.

Support should be given on the key parts of the body (i.e. shoulder girdle and pelvic girdle) leaving the arms free to propel body forward.

Hold pelvic girdle, rhythmic stabilization techniques is used or stabilize diagonally. Depends on instability of parts of body. Hold left knee and Right shoulder or reverse or both shoulder girdles.

Right shoulder and left pelvis or reverse or both pelvic girdles are used. Rhythmic stabilization techniques helps to keep the child in a erect standing position. Once the child is able to maintain standing position then progress him to walk.

Hold pelvic girdles and transfer weight on opposite side so that the child will stand on one limb and other limb will be free, then push free lower limb from backward to forward. This will be a step then repeat the sequence on opposite limb(standing limb). In this way, train the child in walking.

Walking on the footprints drawn on floor.

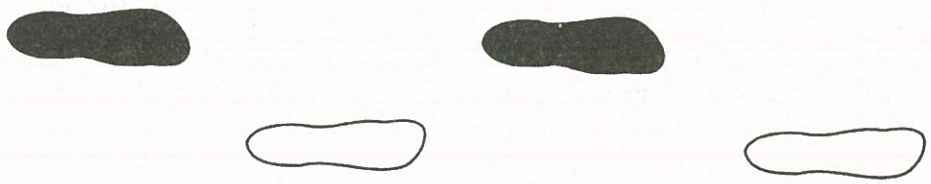


Fig. Foot prints on the floor

Turning on the footprints drawn on floor clockwise and anticlockwise direction.

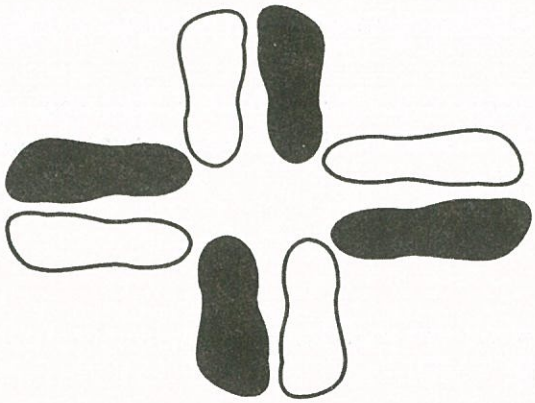


Fig. Footprints for rotation

Walking on the floor-mounted ladder.

Walking with the support of table or chair.

Walking with chair or plastic chair easy to push and walk.

Walking with walker (CP walker, Rollator etc).

Gait training generally begin in parallel bar because it gives support, balance and helps the person to develop walking pattern. So that the child will learn normal pattern of walking (alternate upper and lower limb movements).

Right upper limb	-	Forward and then
Left lower limb	-	Forward and then
Left upper limb	-	Forward and then
Right lower limb	-	Forward and then progress the child from parallel bar to walker progress child from support walking to without support(independent walking).

To support walking, aids and appliances like Crutches, Walker, Tripod, Quadripod, Stick etc. can be used. Walking in children can be facilitated by using Rollator, Baby walker, CP walker and various orthosis (like- gaiter, knee back support splint, "L" shaped splint, AFO, Special shoe, Caliper, etc.)

[Note : Gait training is not effective for persons with neuro motor problems those who are having lack of trunk and girdles stability, specific training should be given improves trunk, hip girdle, this will improve stability of gait].

Checklist for Evaluation of Walking in Normal Persons of Different Ages

Directions : Observe the walking on several different terrains or surfaces (even or uneven), uphill, downhill, and on a level surface. Consider the 11 sets of alternate descriptions and check the one of each set that represents the student's level of performance. Until the child is about age 4 years, most checks will be in the left-hand column. After age 4, the normal child exhibits mature walking. Use findings to write specific motor behavioral objectives.

Check One	Development or Immature Walking	Check One	Mature Walking
	1. Forward lean a. From ground. b. From waist and hips.		1. Good body alignment.
	2. Wide base of support with heels 5-8" from line of progression.		2. Narrower base of support with heels 2-3" from line of progression.
	3. Toes and knees pointed outward.		3. Toes and knees pointed straight ahead.
	4. Flat-footed gait.		4. Heel-ball-toe transfer of weight.
	5. Excessive flexion at knee and hip joints.		5. Strong push-off from toes.
	6. Uneven, jerky steps.		6. Smooth and rhythmical shift of body weight with minimal up-and-down movement of body.
	7. Little or no pelvic rotation until second or third year. Body sways from side to side.		7. Minimal rotatory action of pelvis (short persons will have more than tall ones).
	8. Rigidity of upper limbs.		8. Compensatory rotatory action of torso and shoulders inversely related to pelvic rotation.
	9. Outstretched arms, also called high guard position.		9. Arms swing freely and in opposition wit legs.
	10. Relatively short stride. In preschool children, the distance from heel to heel is 11-18".		10. Greater length of stride dependent upon length of leg. In the average adult man, the distance from heel to heel is 25-26".
	11. Rate of walking stabilizes at about 170 steps per minute.		11. Rate of walking decreases to about 115 to 145 steps per minute.

Jerkiness may be caused by a flat-footed or shuffle gait or by excessive stride length.

* * *

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