Teaching and Training Material on Physiotherapy
In the field of Mental Retardation

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FOREWORD

There is rapidly increasing evidence that Physiotherapy has remarkable effect on the development of a person with mental retardation. New knowledge is being added continually through research and clinical experience. Out of all these developments arises the need for training the professionals on physiotherapy in the field of mental retardation. This book is intended for this purpose. The book is an outcome of the project titled "Teaching and Training Material on Physiotherapy in the field of Mental Retardation".

In its presentation the authors have taken into cognizance, the difficulties faced during assessment, the adaptations and modifications of techniques to plan an individualized intervention to match the requirements of the clients with mental retardation. Many of the ideas are simple and quite evident, but need a careful study.

Apart from the scientific and therapeutic aspects, the professionals and therapists are to gear themselves with the knowledge of the specific needs of persons with mental retardation and enhancement of their cognitive development through physiotherapy. Working with parents is necessary and important in therapeutic interventions. Incorporating their needs is valuable. Hence, the inclusion of the aspects on parent counseling enhancement of motivation and adoption of safety precautions in this book are appreciable. The book contains appropriate illustrations to make it more comprehensive.

All these features make the book an important training material on physiotherapy in the field of mental retardation. This book should go a long way towards reassuring professionals working with persons with mental retardation and presenting them with appropriate programme suggestions, I am sure it will be a useful guide to undergraduates, therapists and other professionals working in the field of mental retardation at various service centers such as Institutes, Hospitals, Rehabilitation Centers and Community Based Rehabilitation Services.

Dr. L. Govinda Rao

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PREFACE

Physiotherapy as a clinical science is in a process of continual evaluation. It is of utmost importance not only in physical and motor rehabilitation, but also in the field of mental retardation. Realizing the contribution of motor development and activity on the enhancement of cognitive development, the teaching and training of therapeutic interventions has assumed great importance in the field of mental retardation. Advanced scientific research has been continually developing and adding relevant practices which help the overall development of a person with mental retardation.

This book is for all those who intend to use therapeutic exercise protocol in the rehabilitation of persons with mental retardation. The book emphasizes on the areas having practical importance. The contents of this book are dealt under the topics of scope of physiotherapy in the field of mental retardation, relevant basic information on Anatomy and Physiology, Physiotherapy assessments including gait, posture, range of motion, muscle power grading, aids and appliances, equipments, normal motor development, primitive reflexes, balance, hydrotherapy, massage and other associated conditions and their management.

Since the clients are persons with mental retardation who have lesser comprehension of the implications of physiotherapy, attention should be paid by the professionals in the methodology of training. Since the training of the client to a large extent is by the parents and is at home, the training of parents is essential. In order to equip the professionals in the management, notes on parent counseling and parent/caregivers training have been included. More cautious approach is advised while imparting training to persons with mental retardation and hence safety measures to be followed are given in detail. Persons with mental retardation tend to develop abnormal motor patterns, postures, gait and deformities due to cognitive deficit status. The preventive aspects of these are dealt with for the benefit of the professionals. Since there is a high percentage of associated disabilities and health conditions, the need for aids and appliances and the care in planning individualized interventions have been highlighted.

This book would be of great help for physiotherapists working as a guide in management of persons with mental retardation. Since the approach in management is progressing from multidisciplinary to trans disciplinary. This book will help not only the therapists, but other professionals and para professionals working in the field of mental retardation.

R.C. Nitnaware

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CHAPTER 1

PHYSIOTHERAPY

Definition:

It is also called physical therapy. The treatment of physical dysfunction or injury by the use of therapeutic exercise and the application of physical modalities (like heat, light, cold, carrent, water, sound waves). Assistive devices are also used as a part of the treatment programme. They are intended to restore or facilitate normal function or development.

Aims

Physiotherapy in the field of mental retardation is aimed at improving overall motor functions of the child to the maximum extent possible, so as to make the child independent in walking and carrying out activities of daily living. If it is not possible for the person to walk, and carry out activities independently, then aids and appliances are provided and training is given to the person to use it.

Objectives of physiotherapy in general

1. Reduces or relieves pain, muscle spasm, tenderness of muscles.
2. It helps to reduce or relieve swelling.
3. It helps to reduce or relieve inflammation (means the response of the body in the form of pain, swelling, muscle spasm and tenderness of the muscles etc. in the presence of any foreign body).
4. To improve ventilation of lungs, by giving, deep breathing exercises and postural drainage.
5. To encourage correct weight bearing and weight transference on both sides of the body.
6. Re-education of affected or paralysed muscles.
7. It is effective in healing of infected wounds.
8. It helps to check the abnormal growth of bone(bony spurs).
9. Breaking up of adhesion formation (gluing of joint structures by synovial fluid).
10. To keep the person physically fit.
11. To teach relaxation.
12. Stimulation of sensory and motor nerves if sensations are reduced or lost.
13. . Post fracture and dislocation, management.

Objectives of physiotherapy in relation to mental retardation

1. To facilitate the development of child -gross motor and fine motor.
2. To prevent or correct contractures and deformities.
3. Prevent or correct muscle wasting and atrophy of muscles.
4. To normalize muscle tone.
5. To maintain or improve the muscle power.
6. To maintain and improve the joint range of movement.
7. To emphasize the importance of handling and positioning the child.
8. To make the child independent in walking and activities of daily living.
9. Provide aids and appliances and to train the person and parents how to use assistive devices.
10. To improve posture, gait, balance coordination.
11. Inhibition of abnormal reflex activity, abnormal patterns of movement and abnormal muscle tone and facilitation of normal in place of abnormal.
12. To keep the children physically fit.

Scope of Physiotherapy

Physiotherapy has scope in treating a wide range of conditions. It play an important role in all the branches of Medical Sciences, especially Orthopaedics, Pediatrics, Neurology, Cardio thoracic, Surgery, Sports Medicine etc. In set ups like leprosy, child guidance clinics, rehabilitation set ups for cerebral palsy, mental retardation, hemiplegic, paraplegic and poliomyelitis after plastic surgery, burns clinics, spinal cord injury centers and in assistive devices manufacturing units etc.

Physiotherapy has *three* major functions in the management of children with mental retardation.

1. To facilitate motor development
2. To prevent and correct contractures and deformities.
3. To make the child as independent as possible and functional(locomotor function and activities of daily living).

Methods of treatment

1. Hydrotherapy
2. Electrotherapy
3. Exercise Therapy
4. Massage or Manipulation
5. Gait

1. **Electrotherapy** means, therapeutic electromagnetic waves, rays, heat, current are used to bring the physiological changes in a body, that helps in relieving pain, and its associated symptoms. The various modalities used in electrotherapy are given below:

a. Low frequency currents

These are currents with frequencies between 1-1000Hz. They are used to stimulate both sensory and motor nerves.

Electrical stimulation

Therapeutic (faradic, galvanic) currents are used. Faradic current is an unevenly alternating current with frequency of 50Hz with pulse duration of 1ms. these currents are used to stimulate denervated (means whose nerve supply is cut off) muscles. Direct current is a unidirectional current with 50-100Hz. It is used to stimulate the innervated muscles(innervated muscles - means whose nerve supply is intact but it is not functioning).

Uses

- These currents are used to train the lost muscles actions. In cases of peripheral nerve injuries.
- To teach new muscle actions in case of tendon transfers.
- Reduction of oedema by increasing venous and lymphatic drainage.
- Prevention and loosening of adhesions.
- Increases the blood supply, nutrition and metabolism into the muscles and prevents muscle wasting and atrophy of muscles.

b. High frequency currents

These are currents with frequencies more than 10,000Hz.

Short wave diathermy

It is the application of electromagnetic radiations with frequencies of 27.12MHz. It produces electromagnetic waves and absorption of these waves into the body will result in the production of heat and it penetrates deep up to the level of bony surfaces.

Uses

- It increases blood circulation, nutrition, and metabolism.
- It helps in reducing pain, inflammation, tenderness of muscles, muscle spasm and swelling.
- It is useful in treating soft tissue injuries, degenerative disorders and inflammatory conditions such as arthritis.
- It is useful in treating sprain, strain of soft tissues and joints.

Ultra Sound

It produces longitudinal, mechanical waves above the audible range (20kHz). The frequencies used in physiotherapy vary from 0.25MHz to 3MHz.

Uses

- It increases blood circulation, cellular activity of phagocytes and microphages to reduce oedema, infection and helps in healing.
- Breaking up of adhesions in the soft tissues.
- It is used for relieving pain.
- It is also useful in soft tissue injuries to accelerate healing process.

Infra Red Rays

Absorption of these rays into the body results in conversion of radiant energy into heat.

Uses

- It causes vasodilatation of blood vessels. Thereby brings nutrition and remove waste products.
- It is used to promote healing of wounds.
- To reduce pain and muscle spasm.

Ultraviolet radiation

These rays are between visible rays and X-rays in electromagnetic spectrum. It is produced by vaporization of mercury in a quartz tube.

Uses

- It is used in the treatment of skin conditions such as psoriasis, alopecia and pressure sores.

Microwave diathermy

It is the application of electromagnetic radiation with the wave length of 12.25cm and frequency of 2450MHz. It is used in the treatment of soft tissue and joint pain.

Uses

- To relieve pain, spasm and induce relaxation.

c. Medium frequency currents

These are currents with frequencies between 1000 - 10,000Hz.

Interferential therapy

Interferential therapy is the use of two medium frequency currents having frequency 4000 Hz & 4010 Hz, to produce low frequency effect within the body without much skin resistance.

Uses

- It is used to relieve pain by blocking pain gate mechanism.
- It reduces pain, swelling.
- It can be used in the treatment of arthritic conditions.

Trans cutaneous electrical nerve stimulation (TENS)

It produces pain relief by phasic rectangular wave form through the electrodes on the skin.

Uses

- It is used to relieve pain by blocking the pain pathway.

2. Thermal modalities

Paraffin wax bath

Application of liquid paraffin-wax, directly on the soft tissues to produce heat. Mixture of paraffin-wax is heated upto 44°c in a equipment, which has thermostatic control. It is applied at the temperature of 44°c or the temperature of paraffin wax should be slightly above the body temperature.

Uses

- To reduce pain,
- To loosen the adhesions.
- To improve the condition of skin(soft, supple and healthy).
- To increase blood circulation in that area and remove metabolic waste products.

Cryotherapy

It is used to cool the body tissues by desensitizing the nerves and nerve receptors. It is applied in the form of ice cubes, crushed ice or icebags directly on the soft tissues.

Uses

- It is used to prevent swelling after injuries.
- To reduce pain.

Contrast bath

This is the combination of cold and heat therapy. It is used in treating soft tissue injuries.

Uses

- To relieve pain.
- To accelerate healing.
- To prevent swelling.

3. **Hydrotherapy :** Use of water for therapeutic purposes and performing exercises in water. Exercises which are not possible and difficult on ground due to pain and other problems, it can be get it done inside the water as properties of water assist in therapy.

Uses

- Provides weight bears.
- To reduce or relieve pain.
- To mobilise joint.
- To improve endurance.
- Warm water, increases blood circulation.
- Increases stability

4. **Manipulations:** Application of even pressure on soft tissues and joints by using various techniques with both hands and fingers.

Uses

- To increase blood circulation.
- Massage or manipulation gives relaxation.
- Relieves pain.

5. **Exercise therapy :** In this, graded and specific therapeutic exercises are used to improve soft tissues and joint condition (e.g. passive and active movements, free exercises, assisted exercises, assisted-resisted exercises, and resisted exercises).

Uses

- To maintain or improve muscles strength.
- To improve power and endurance.
- To achieve fitness.
- To prevent or correct contractures and deformities.

Children with mental retardation having associated motor problems are handled and managed by using the principles of neurodevelopmental techniques, explained by various authors(Rood, Bobath etc.) which are based on neurophysiological and neurodevelopmental patterns.

* * *

CHAPTER 2

MENTAL RETARDATION

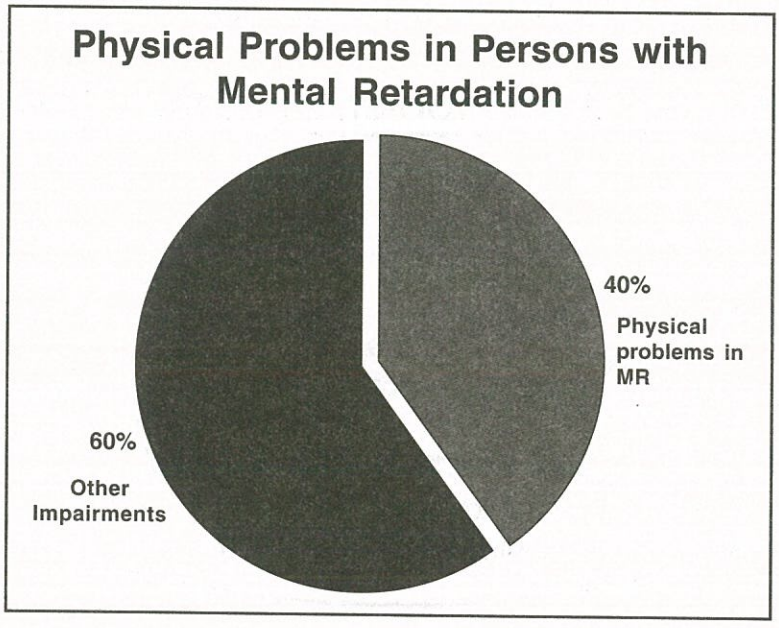
Introduction

"Mental Retardation refers to substantial limitations in present functioning. It is characterized by significant sub average intellectual functioning existing concurrently and with related limitation in two or more of the following applicable adaptive areas; communication, self care, home living, social skills, community use, self-direction, health and safety, functional academics, leisure and work, mental retardation manifests before age 18(American Association on Mental Retardation, 1992).

'Significantly subaverage' is defined as IQ of 70 or below on standardized measures of intelligence. The upper limit is intended as a guideline; it could be extended to 75 or more, depending upon the reliability of intelligence test used.

'Adaptive behaviour' is defined as the degree with which the individual meets the standards of personal independence and social responsibility expected of his age and cultural group. The expectations of adaptive behaviour vary with the chronological age.

As per the NSSO(National Sample Survey Organization) report December 2002, the incidence of mental retardation associated with physical disability is about 40%. As the incidence of physical disability in Mental Retardation is high, it is important to consider the physical problems and physiotherapist plays an important role in the field of mental retardation.



Children with mental retardation often have delay in motor development. Also have problems with motor learning and motor control. As motor and cognitive developments are interrelated, both display equally protected developmental timetables. When cognitive development is delayed or deficient motor development is often adversely affected. The severity of motor dysfunction depends on the extent of involvement of brain.

In general, children with severe mental retardation are likely to have motor delays, as they have relatively poor motor performance, which is the result of their limited capacity to process information. Such cognitive deficits impede motor learning, leading to the slow movements that children with mental retardation often have, even when they do not have any other associated problem like cerebral palsy and sensory impairments.

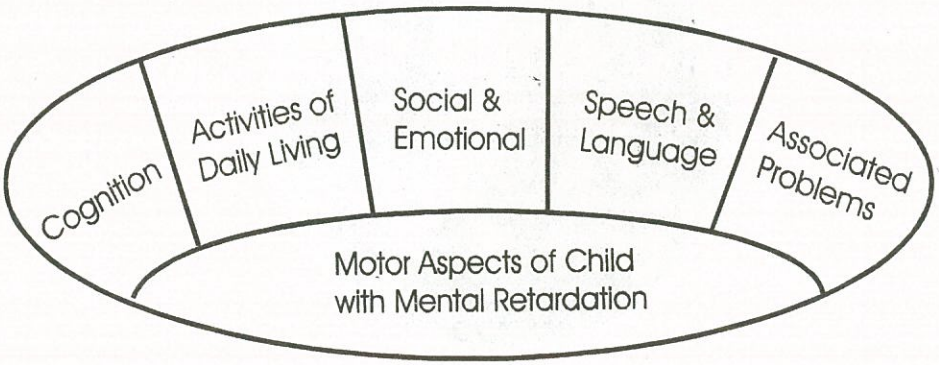
In conditions like mental retardation with cerebral palsy, they show predominant motor problems by which they get noticed. Because of these motor problems the mental retarded persons physical activity and mobility will be restricted to a great extent. They will have limited opportunity to explore the environment and communication aspects are also limited. As these motor problems are going to affect the other areas like cognition and communication, which further worsen the condition and the level of retardation.

Many of the physical therapy assessments and intervention strategies used for persons with Mental Retardation differ to a great extent from that of the normal child who is having physical problems only. These persons different from normal in the following aspects:

- They may be deficient in comprehending / understanding and following instructions.
- Slow and poor in responding
- Inability to perform.
- Progression / achievement may be delayed and poor.

As these persons are different from normal regular activities of intervention, evaluation and adaptation are absolutely necessary. These aspects of intervention are focused in chapter.

Effect of Motor Problems in Other Areas



Classification of Mental Retardation

Comparison of 1983 American Association on Mental Deficiency(AAMD) levels of retardation and traditional special education categories.

AAMD level of retardation	Intelligence test score	Educational category
Mild	50 to 70	Educable
Moderate	35 to 49	Trainable
Severe	20 to 34	Custodial
Profound	Below 20	

Motor Problems seen in Mental Retardation

Motor delay and disabilities are common problems in mental retardation. The severity of delay and disabilities depends on the extent of CNS insult and also the intellectual capacities of the child. Following motor problems may be commonly associated in persons with Mental Retardation.

- Gross and fine motor developmental delay
- Persistence of abnormal reflexes
- Abnormal muscle tone(Spastic, floppy, ataxic & athetoid)
- Weakness / paralysis of the muscles
- Wasting & atrophy of muscle
- Restricted range of movements
- Abnormal postural patterns
- Tightness, contractures and deformities
- Gait abnormalities
- Oro-motor dysfunctions
- Respiratory dysfunctions.

POINTS TO BE NOTED WHILE DEALING WITH PERSONS HAVING MENTAL RETARDATION

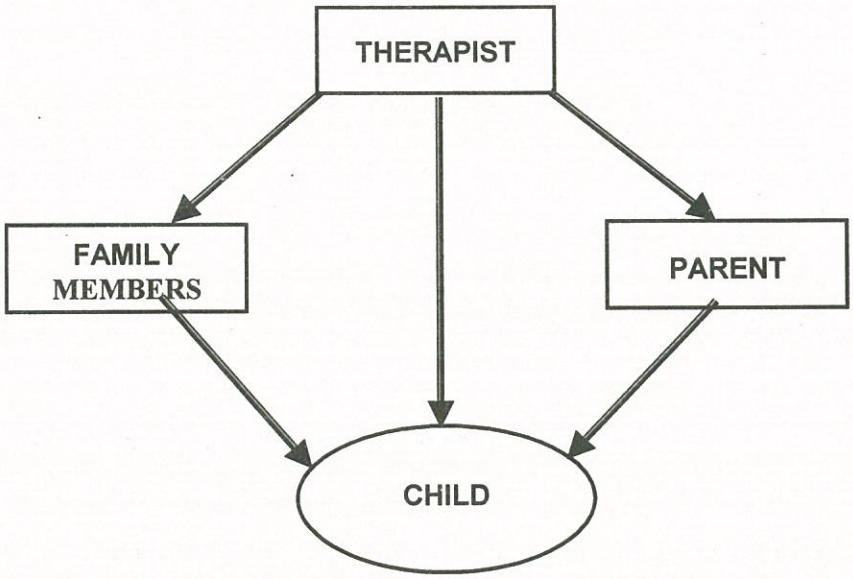
During assessment and implementation of intervention for children with Mental Retardation, it is important to keep in mind certain basic principles.

Some of the practices to be followed are:

- During the assessment suitable adaptations are made to get the exact picture of the childs condition and abilities.
- The therapy should be planed according to the needs and abilities of the clients and their level of retardation.

- Due to various reasons(like hunger, sleep, unconsolable cry, restlessness, fits, health problems and behaviour problems) it may be difficult to assess and intervene with the clients it may be difficult to adhere the schedule. The session may require postponement and dates to be given for further assessment and intervention.
- An emphasis to be late more on active participation of the client for better results and outcome.
- Therapy should be integrated into daily activities for better results and improvement.
- Activities should be made simple and easy to perform for the client to achieve success, improves motivation and participation.
- The activities should gradually grow in complexity and in simple steps.
- Mental retardation persons are having poor learning so activities should be repeated more often for better performance and learning.
- Mental retarded persons will have poor generalization so the intervention must be given in different settings to enhance generalization.
- Including parents and family members in intervention programme helps the parents to understand the child's intervention and monitor progress.
- Therapist should have patience, as the outcome of the results will take longer time then usual.

THERAPY SCENARIO



While handling children with mental retardation the therapist may kindly take note of the following:

- **Level of understanding of parents:** Therapist should give activities in a way that parents can understand and perform at home. Therapist must give a clear picture of that activity.

- **Behaviour problems:** Most the client will have behaviour problem so the therapist should be able to handle the behavioural problem of the client to make the therapy programme more successful.
- **Slow progression of the condition:** The progression of the condition in person with mental retardation will be slow. So therapist should have patience in giving intervention.
- **Rapport building:** While giving therapy therapist should develop good rapport with client by which he can involve the client in therapy programme for better results.
- **Motivation:** Active participation of the client in therapy programme is very important, so the therapist should enhance the motivation of clients in participating therapy.
- **Play way method:** The therapy is plan in a play method and it should be simple, easy and understandable to the client and their parents by which the therapist get the active participation of the child.
- **Associated conditions:** Associated conditions are more frequent with the mental retardation. These conditions may further worsen the condition of the client, so during assessment and planning intervention associated conditions are taken into consideration.
- **Counseling:** Therapist should know basic counseling skills, when ever he needed he can implement.

ROLE OF A PHYSIOTHERAPIST IN THE FIELD OF MENTAL RETARDATION

As an incidence of physical disability in mental retardation is high, the physiotherapist plays a major and important role in the field of mental retardation. Here the physiotherapist dons different roles and responsibilities as per the need. They are as follows:

- **Diagnostician:** Here the physiotherapist assess the client and order for the necessary investigation, on the basis of this therapist arises at diagnosis. According to the diagnosis therapy will be planned.

- **Interventionist:** Therapist plays a role as a interventionist in setting intervention goals, planning and implementation of therapy programme, giving follow-ups and regular evaluation of the client, modifying programme as per the clients need.

- **Team member:** Therapist treated as a team member as the team member in multidisciplinary approach, this is the most commonly seen approach in field of mental retardation. In trans disciplinary approach therapist play a role as a team member by gathering information and helps in planning intervention along with other experts of the team. In certain condition therapist become a case manager and give input.

- **Proving Information and guidance:** As the parents need information guidance regarding the condition of the child and therapy, the therapist gives proper information to parents and also to other professional when ever needed.

- **Counselor:** Physiotherapist play a counselor role in the field of mental retardation. Parent counseling is in important aspect, which should be included in intervention programme. The parents of the clients may not be aware of the condition of the child and the facilities available for their child. They will come to you in a state of confusion and anxiety to know what happening with their child.

  Before as part of planning an intervention programme therapist should give proper counseling to the parents regarding the following things:
  - Condition of the child.
  - Child's needs and abilities.
  - How the therapy is going to help the child in improving his functional abilities.
  - Proper instructions given to the parents.
  - Training is given to the parents how to give therapy at home.
  - What are the facilities and services available for the persons with mental retardation.

- **Trainer:** Therapist plays a role of trainer, as the therapist will train the parents how to give therapy at home and conducts classes and work shops for parents and other professional, to make them aware of disability and affects of intervention on the clients.

- **Researcher:** Research is an important aspect in the field of mental retardation. Therapist also plays a role as a researcher by doing research on different aspects and population study. To innovate new techniques and equipment for making the intervention better and to get better out come results.

- **Leader:** Therapist plays a role of leader of the team by voicing on behalf of the clients and by giving guidelines to the former self-help groups by the parents.

- **As an administrative officer:** Therapist plays a role of administrative officer by heading an organization and establishing a institution or center to serve the people better.

- Provider of referral: Therapist will give referrals to the concern professionals to obtain information of the clients and to related services out side the institute for investigations or for expert opinion.

Unique features of assessment in persons with mental retardation

Assessment of a person with mental retardation will differ in many aspects to great extends from that of the normal.

Assessment should include the following:

- Assessment is done in natural environment and necessary adaptations are made according to the need.
- Flexibility must be maintained in order to get the complete picture of the childs condition and abilities.

- Therapist should take in to consideration other areas like cognition, communication, sensory impairments and associated problems during assessment. These things are interrelated with motor development.
- Assessment of the client may need many sessions as it is not possible to get complete picture of the clients condition in one session.
- Therapist also involve parents in the session to get the complete information of the child(activity of the child at home).

Determining Intervention Goal

Goals of intervention to reduce child's disability needs to represent specific functional skills. As these children are slow in learning, tendency to forget easily and generalize poorly, goals should be specific to a particular isolated activity. The goals are prioritized according to the needs and the abilities of the client.

Guidelines to the parents for home based programme

Therapist should give proper guidelines and instructions to parents to follow the therapy at home. Guidelines are given on the following aspects:

- All the family members should have regular interaction with the client.
- The home environment should be stimulating and barrier free.
- Guidelines are given on proper handling, positioning and carrying techniques during ADLs.
- Frequent change in position of the client.
- Activities are made interesting, enjoyable and play way method may be employed.
- Regular follow-ups should be maintained.
- Regular report to therapist regarding clients condition and progression.
- Maintenance of all records at home, which will guide further plan of intervention.
- Parents or family members participation in activities to achieve target goal.
- Importance of nutrition and diet.
- Proper hygiene conditions

Planning therapy programme

The therapy programme for persons with mental retardation planned according to there needs and abilities. While planning therapy programme emphasis laid more on the following aspects:

- Different therapeutic techniques are employed to facilitate the development.
  - NDT
  - PNF
  - ROODS
  - SI
  - VOJTA

- Graded exercises to maintain and improve the joint range of motion and muscle power.
- Therapy should be given to inhibit the abnormal reflex patterns.
- Intervention to limit impairments and functional limitation.
- Intervention to limit the cognitive and communication impairment.
- Postural training is giving to correct the abnormal postures.
- Activities to improve balance and coordination.
- Gait training is given to improve and correct the gait pattern.
- Therapy programme is planned to prevent the secondary complications and also the associated problems.
- Assistive devices prescribed according to the persons need to prevent and correct the deformities.
- Training self-help, social and practical skills.
- Other therapeutic methods also used to treat the persons with mental retardation. Ex. Hydrotherapy, Massage, EMG Bio-feedback.
- Oro-motor exercises / activities are given to reduce the drooling problem.
- Proper feeding techniques or advised.
- Activities to improve the general fitness of the persons with mental retardation. Ex. Aerobics, Yoga, Jogging, Walking and Treadmill etc.
- Breathing exercises and proper positioning is advised to prevent the respiratory complications.
- Referrals are given to the concern person.

Here in this chapter we have discussed about the role of physiotherapy in the field of mental retardation and how the assessment and intervention strategies are different from that of the normal. These aspects of physiotherapy assessment and intervention are further elaborated in detail in the following chapters.

* * *

CHAPTER 3

BASIC HUMAN ANATOMY AND PHYSIOLOGY

ANATOMY

Definition :

Anatomy is a science that deals with the structures of the body and the relationship of various parts of body with each other. A knowledge of these structures is necessary to understand its functions.

Descriptive terms used in Anatomy are given below:

1. *Symmetric* e.g. limbs, eyes, ears and lungs. Their arrangement on the right side and left side are similar.

2. *Asymmetric* e.g. heart and liver. The heart lies in the left side. Major part of the liver lies on the right side.

The study of human body is done in anatomical position. In this position, the body is erect, the head faces forwards, arms at the sides of body and palms of hand faces forward. The following are the few important terms, which are used to describe the human body:

1. Midline (mid saggittal plane): A line divides the body into two equal halves i.e. right and left is called midline(normally midline falls at the centre of base of support).
2. Medial : Towards the midline.
3. Lateral : Away from the midline.
4. Superior : Nearer to the head(above).
5. Inferior : Nearer to the foot(below).
6. Anterior : Front surface of body.
7. Posterior : Back surface of body.
8. Proximal : Towards the head.
9. Distal : Towards the foot.
10. Superficial : Nearer to the skin surface.
11. Deep : Deeper from the skin surface.

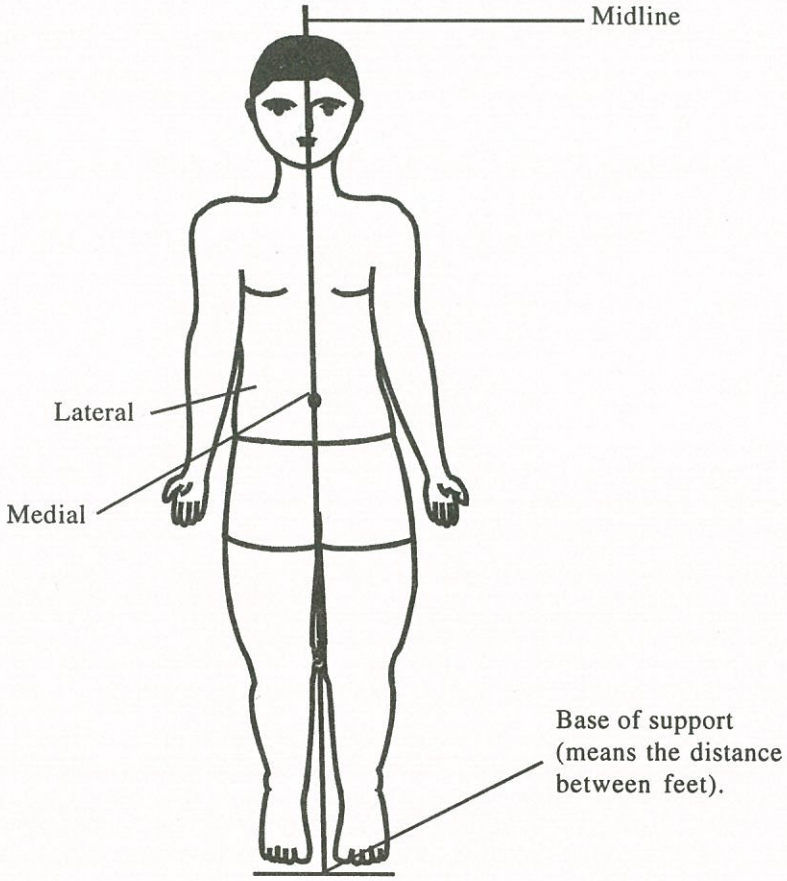


Fig. Anatomical position

Skeletal system

The skeletal system of human body comprises of as many as 206 bones. They are connected to each other to form the skeleton. Union between two or more bones is called a joint and it is discussed separately. The functions of bones of the skeletal system are as follows.

- Gives support to the human body.
- It gives attachment to the muscles.
- Produces red blood corpuscles in the bone marrow.
- It stores mineral and salts (like calcium and phosphorus).

The bones of human skeletal system are mentioned below.

Bones of skull & face

The skull is formed by bones and protects the brain within it. Skull bones comprise a pair of temporal bones, pair of parietal bones, a frontal bone and occipital bone. It gives attachment to the scalp muscles. The face consists of a pair of zygomatic bone, maxilla, mandible and nasal bones.

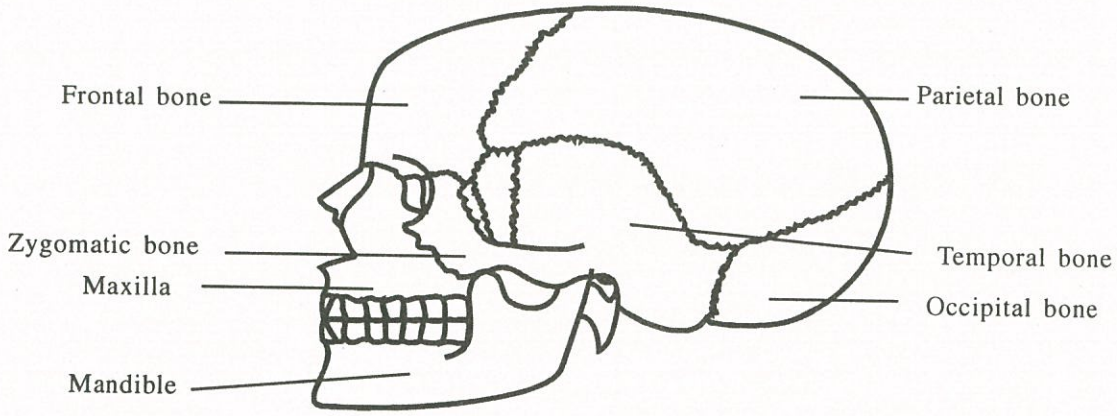


Fig. Bones of skull & face

BONES OF UPPER LIMB

The bones of upper limb are *clavicle, scapula, humerus, radius, ulna, carpal bones, metacarpal bones and phalanges.*

Scapula is a triangular flat bone which is present in the upper back (left and right) and lodges the head of Humerus within glenoid cavity to form the shoulder joint. It has the following landmarks, the spine, the acromion process, coracoid process. The area above the spine of scapula is called supraspinous fossa, the area below spine is called infra spinous fossa. The fossa on the ventral side is called subscapular fossa. It gives attachment to the muscles which act on the shoulder.

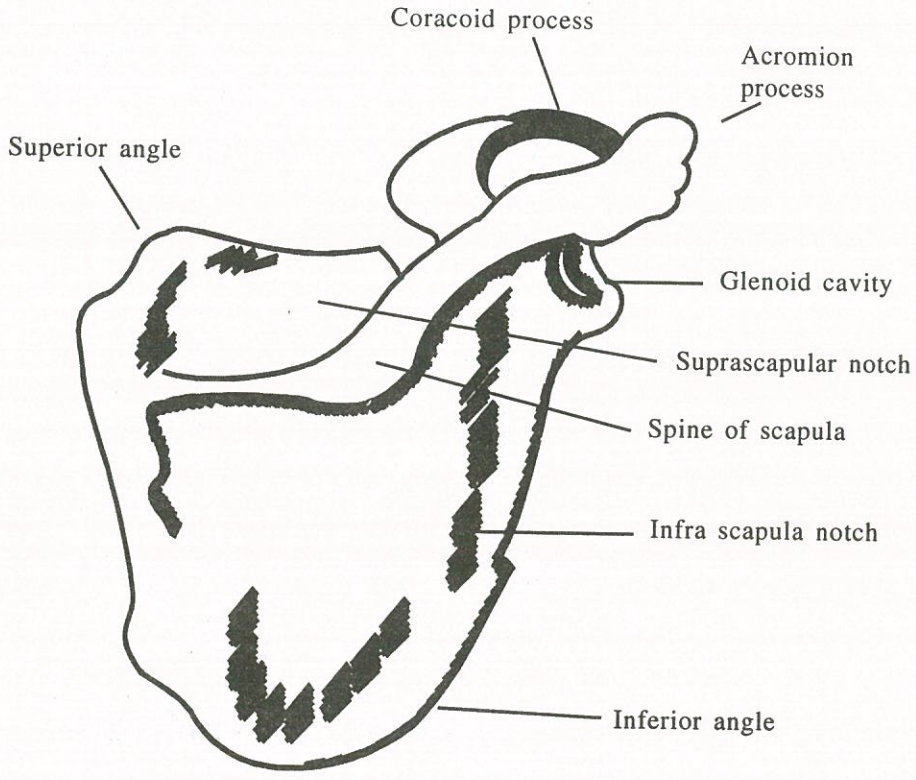


Fig. Scapula(Posterior side)

Clavicle (left and right) is a horizontal bone, which connects upper limb to trunk. The medial 2/3rd is anteriorly convex and lateral 2/3rd anteriorly concave in shape. The medial part is rounded in shape whereas lateral part is flat. It forms Sterno clavicular joint with the sternum medially, which is a part of shoulder girdle and forms acromioclavicular joint laterally.

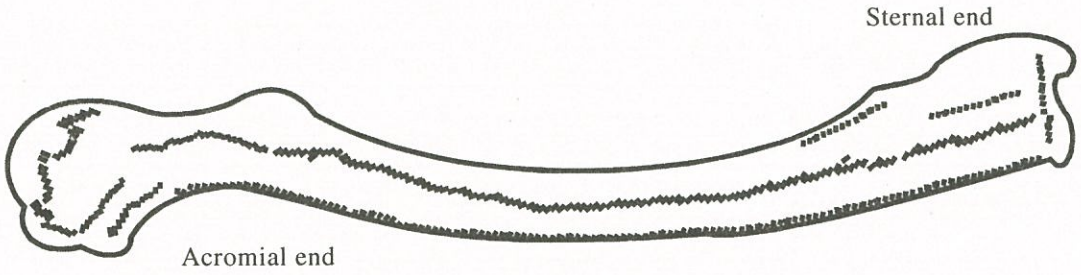


Fig. Clavical

Humerus is the bone of arm. The head of Humerus articulates with the glenoid cavity of the scapula to form a shoulder joint. It articulates with the olecranon process and head of radius below to form the elbow joint. It gives attachment to the biceps in front and triceps behind. It has the following landmarks, *spherical head* with a groove called *anatomical neck,* greater tubercle, a lesser tubercle, a surgical neck. Then a shaft which is in tripod shape. The lower end of humerus have two prominences medially and laterally called the *lateral and medial epicondyles.* It also has two projections in the middle, the *trochlear and capitulum.*

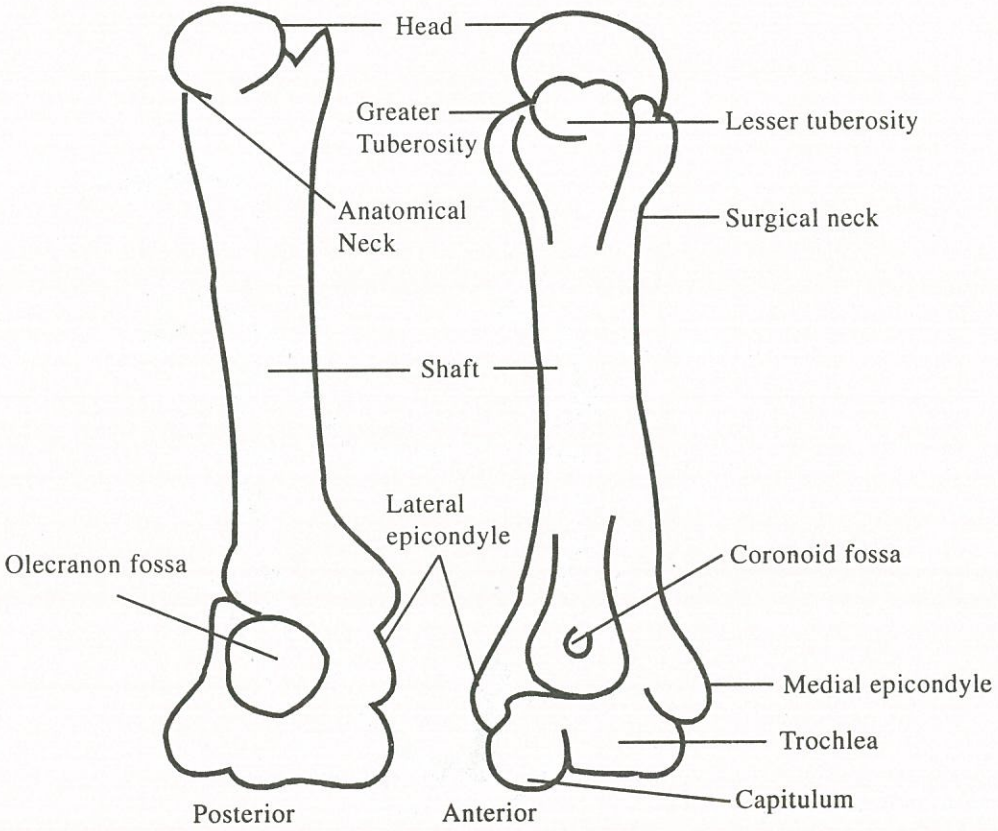


Fig. humerus

Radius is the lateral bone of forearm and ulna is the medial bone of forearm. The upper end of ulna have *olecranon process,* and *coronoid process.* The shaft is tripod in shape, and the lower end has a process called stylus. The radius in the upper end has rounded head. This is also having tripod shape shaft. The lower end has process called stylus. The stylus process of both ulna and radius are called *medial and lateral styloid processes* respectively. They are held together by interosseous membrane. It provides attachment to the muscles, both on anterior and posterior side, which act on wrist and fingers.

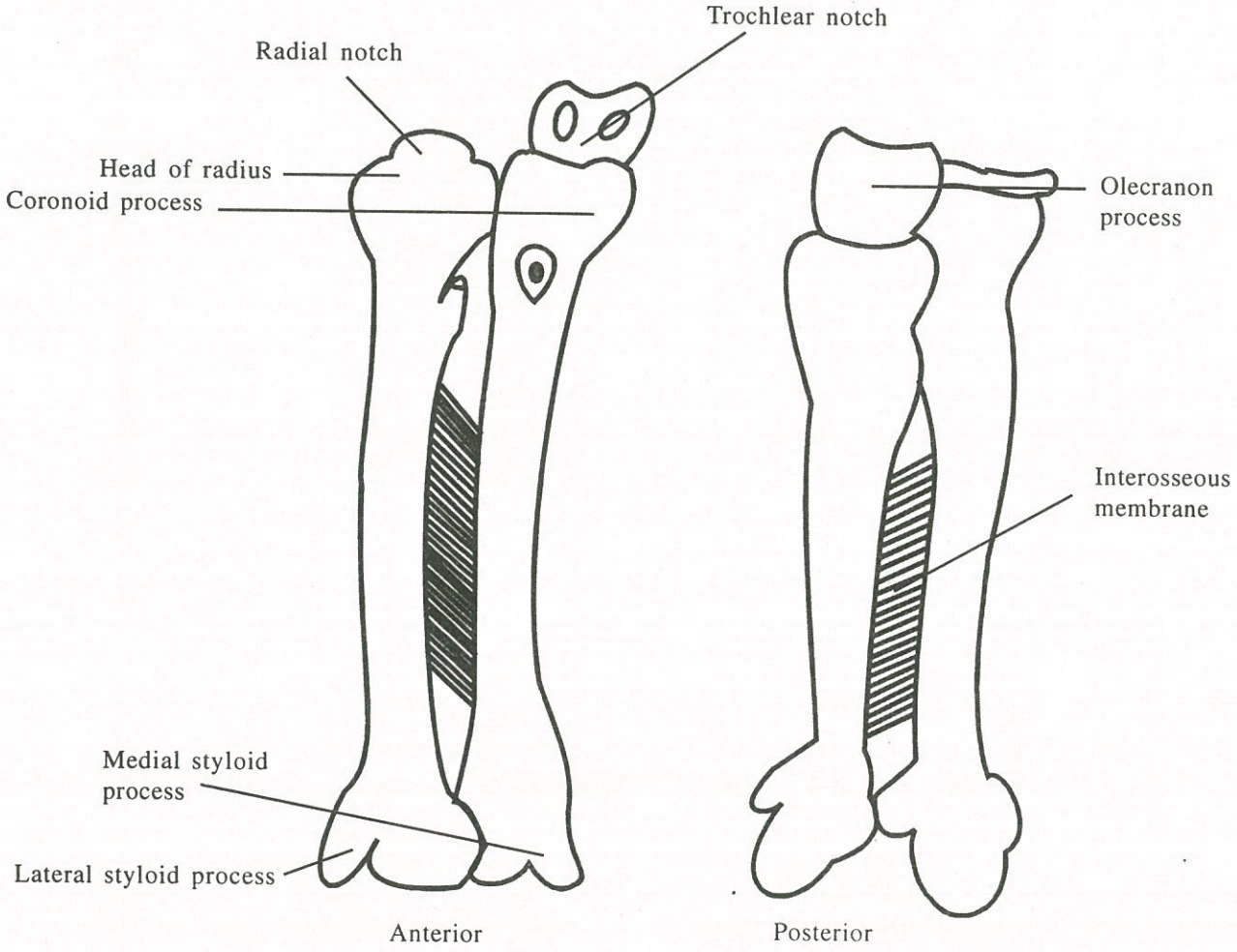


Fig. Radius and ulna

The bony structure of hand comprises with carpal bones, metacarpals and phalanges. There are eight carpal bones namely *scaphoid, lunate, triquetral, pisiform, trapezius, trapezoid, capitate* and *hamate* from lateral to medial. The metacarpal bones are five in number and are named from lateral to medial as first, second, third, fourth and fifth. There are fourteen phalanges for five fingers. The medial four finger have three phalanges each namely, the proximal, middle and distal phalanges and thumb has only two phalanges proximal and distal.

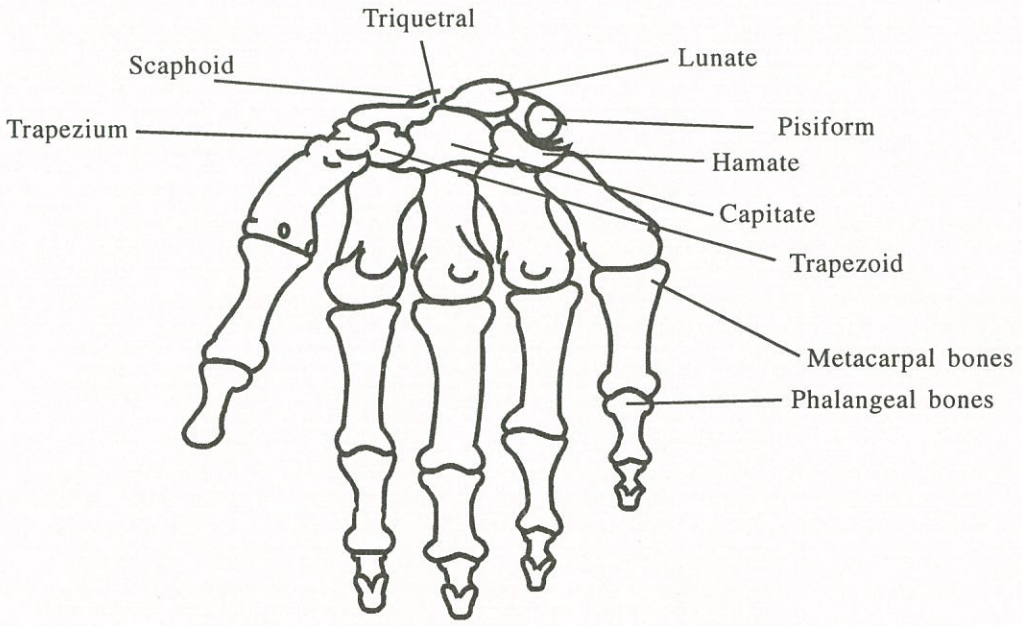


Fig. Bones of hand

BONES OF LOWER LIMB

Pelvis is the bone of lower limb which forms pelvic girdle by joining with the opposite pelvic bone and hip joint with the head of the femur on the respective side. The pelvic bone comprises of *illium, ischium* and *pubic bones.* Two pelvic bones joint together by sacral bone posteriorly and anteriorly by the pubis bones to form a pelvis. It is the flat bone, which give attachment to the muscles that act on the femur.

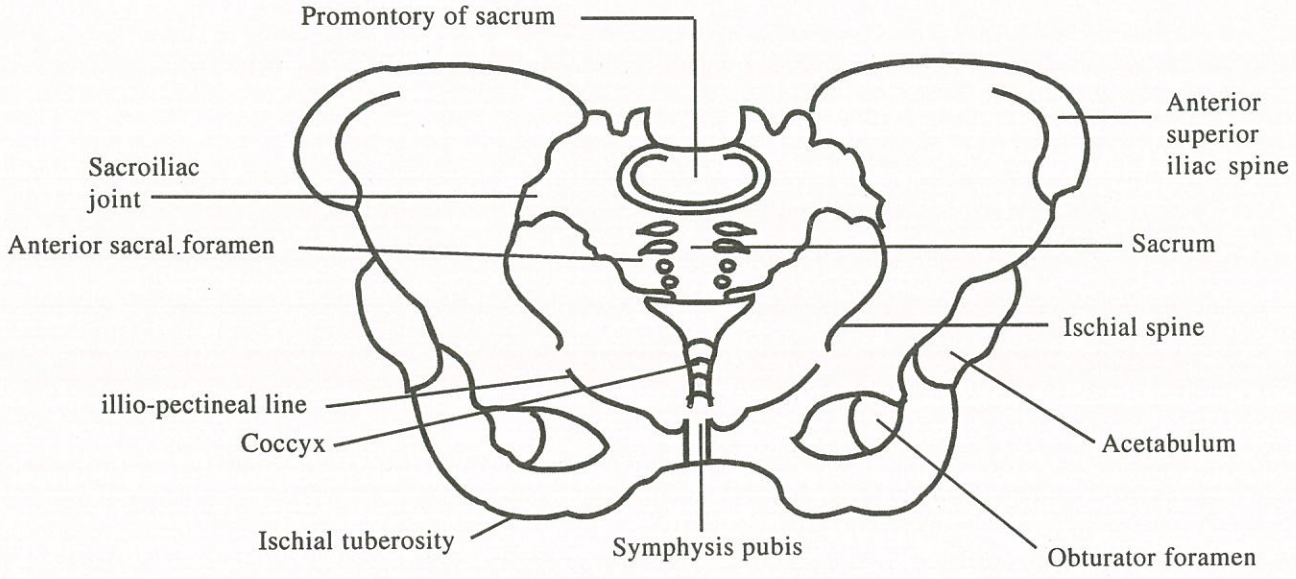


Fig. Pelvis

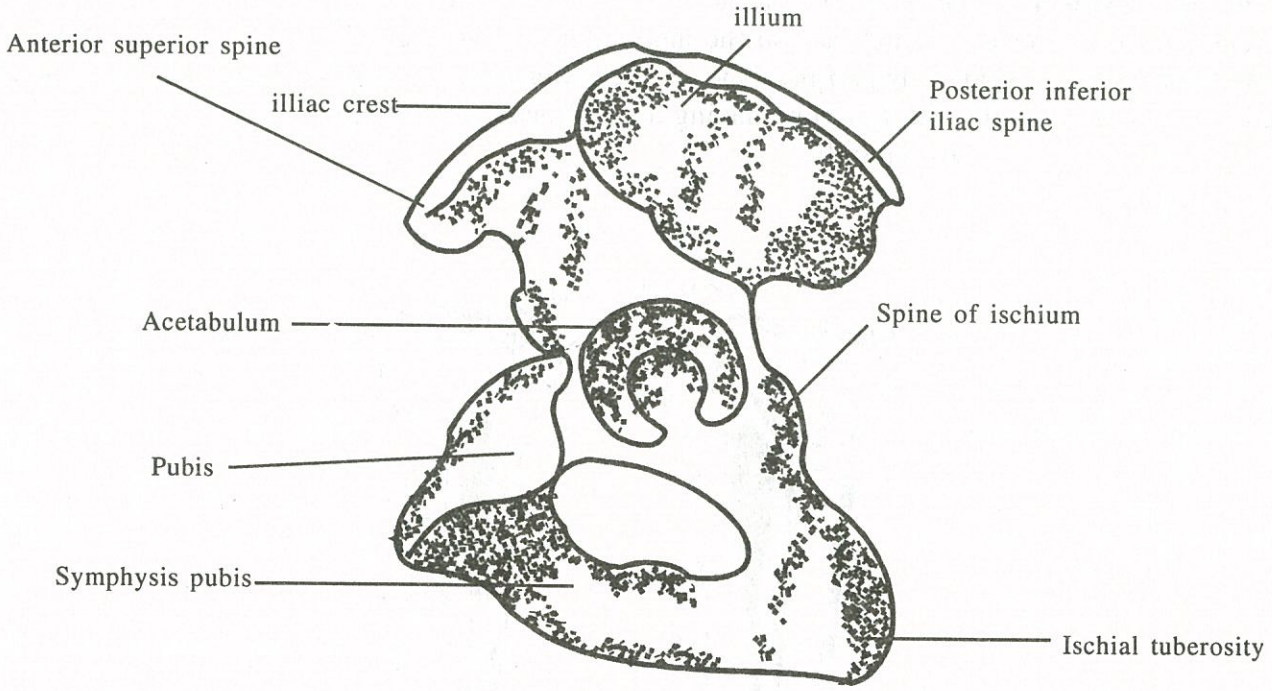


Fig. Pelvic bone

Femur is the bone of the thigh and it is longest bone of the body. The upper end has a rounded head, *greater trochanter,* and the *lesser trochanter.* The shaft is very lengthy and tripod shaped. The lower end has lateral and medial condyles. It gives attachments to the muscles of the thigh that act on knee joint, quadriceps anteriorly, hamstrings posteriorly.

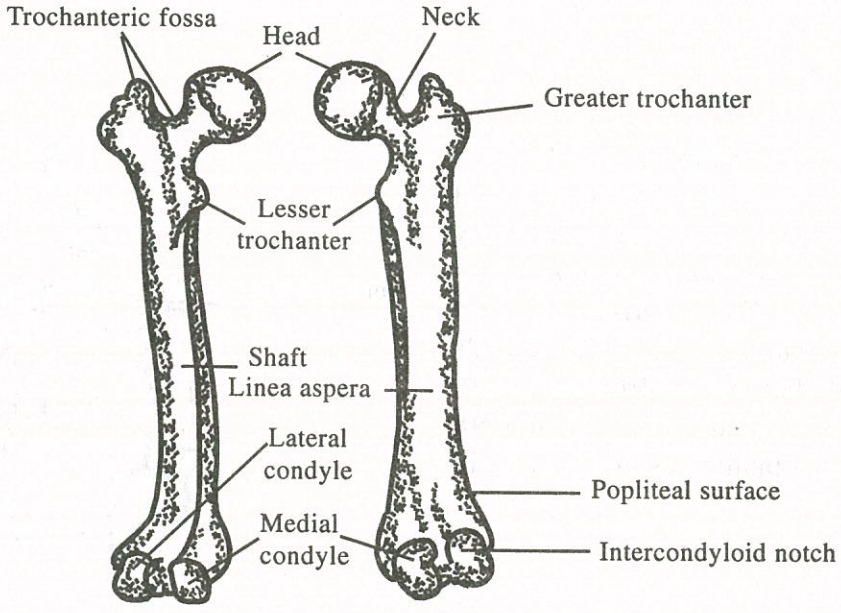


Fig. Femur

Tibia and fibula: Tibia is the medial bone of leg and fibula is the lateral bone of leg. It gives attachment to the muscles which act on the ankle and toes. Tibia in its upper end has lateral and medial condyles and shaft is tripod in shape. In the lower end, it has projection medially called the medial malleolus. Fibula is a thin bone having a small head in the upper end and slim shaft. In the lower end it has a malleolus laterally.

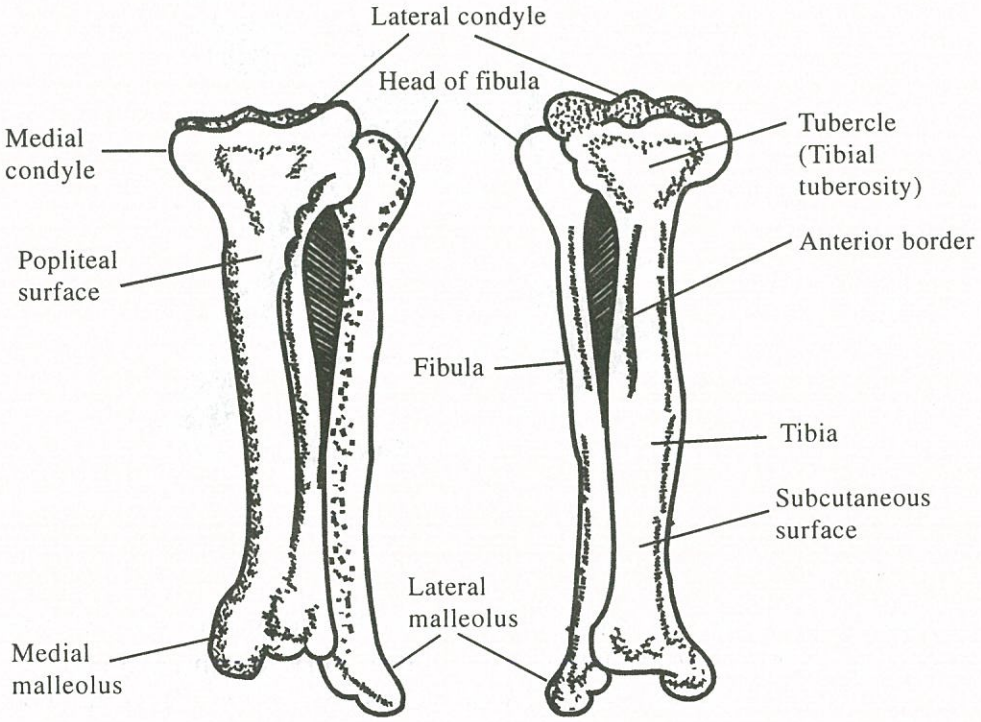


Fig. Tibia and fibula anterior and posterior views

Bones of foot are group of *tarsal bones, metatarsal bones and phalanges.* Tarsal bones are seven in number namely *calcaneus, talus, cuboid, navicular, lateral cunieform, medial cunieform and intermediate cunieform.* The metatarsals are five in number, named from medial to lateral side as 1st , 2nd, 3rd , 4th and 5th metatarsals and phalanges are located in toes.

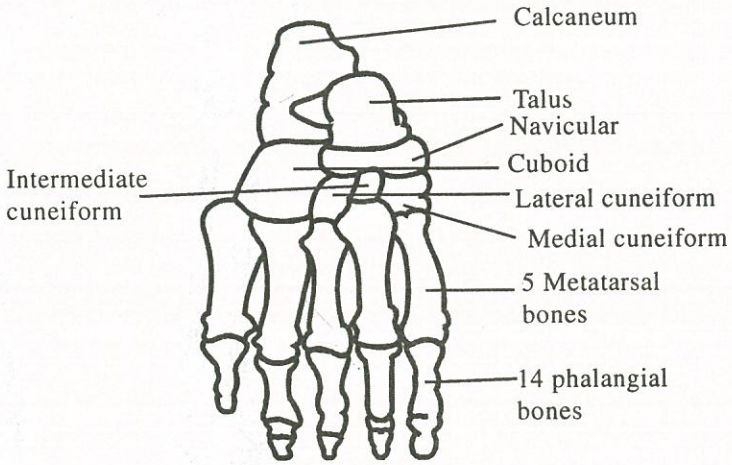


Fig. Bones of foot

Vertebral column

It is also called as spinal column, as the spinal cord runs along its neural canal. It consists of 33 vertebrae arranged in the form of a column. The spinal column consists of *7 cervical vertebrae, 12 thoracic vertebrae, 5 lumbar vertebrae, 5 sacral vertebrae, 4 coccyx vertebrae.* The *cervical vertebrae* and *lumbar vertebrae* allow movement where as, the sacral, and coccyx are immobile joints as they are fixed to each other. The vertebrae are separated by disk called *inter vertebral disk* (The function of inter vertebral disk is to maintain gap in between vertebrae and it acts as a shock absorber) which are 23 in number. A typical vertebra has a body, two transverse process, a spinous process, a vertebral foramen through which a spinal cord passes. It gives origin to spinal nerves, which supplies the muscles of upper limb, lower limb and trunk. Atypical vertebrae (cervical vertebrae one and two) does not have true body and the spines are bifid.

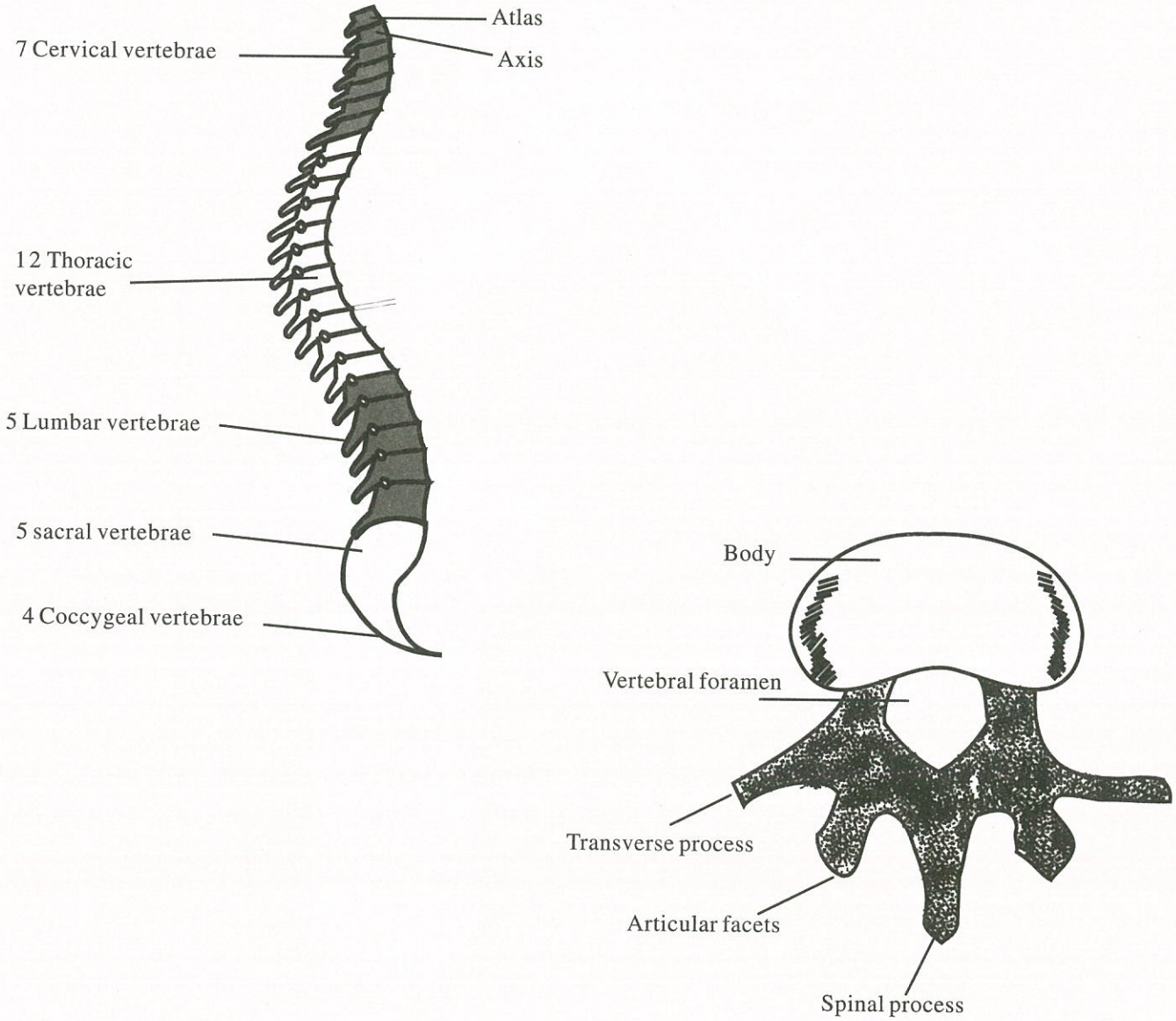


Fig. Structure of typical vertebra

RIBS

There are 12 pairs of ribs, which protect the thoracic contents. They form a cage by joining the sternum anteriorly and vertebrae posteriorly. The first 7 ribs are called true ribs. The 8,9,10th, are called false ribs as they articulate with the sternum via costal cartilages. 11th and 12th ribs are called floating ribs because they are not attached to the sternum at all.

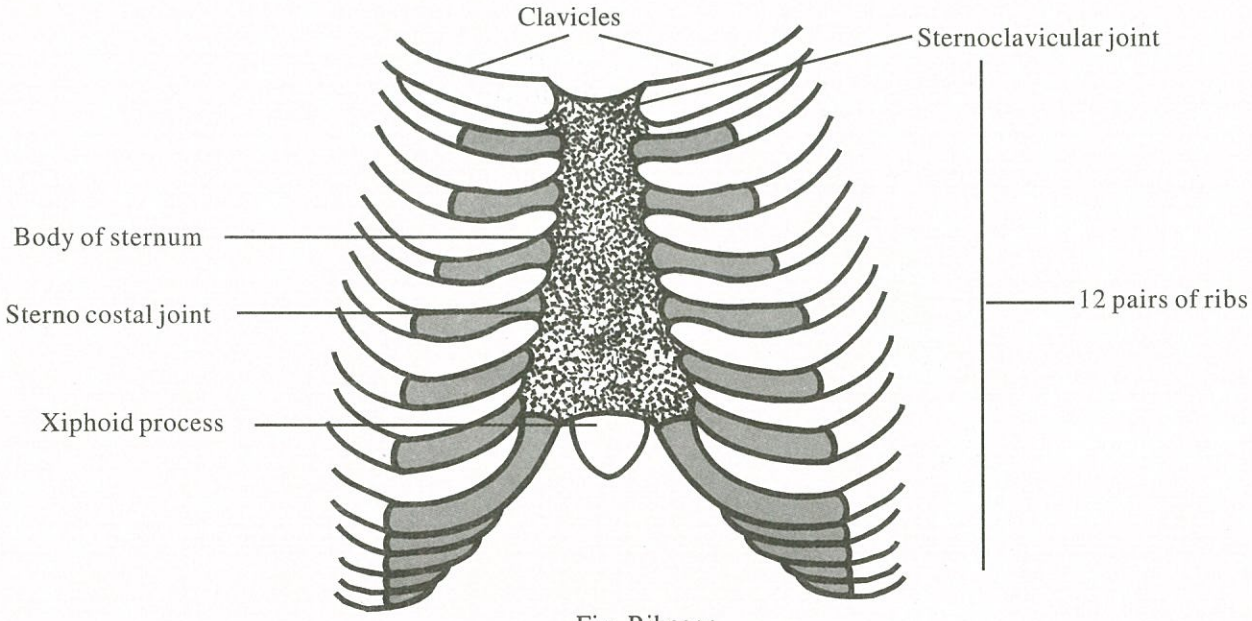


Fig. Ribcage

STERNUM

It is also called a chest bone. It has a body, manubrium, and xiphoid process. It gives attachments to the ribs and forms sterno costal joints on either sides of it. The muscles of the pectoral region arises from it.

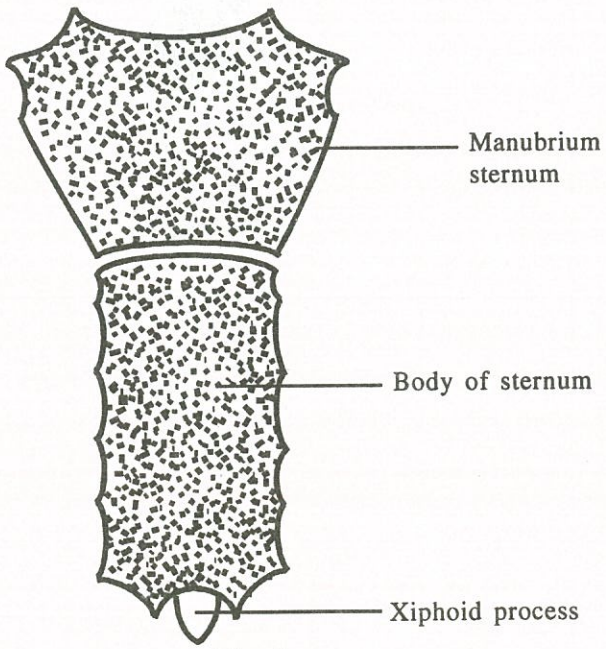


Fig. Sternum

JOINTS

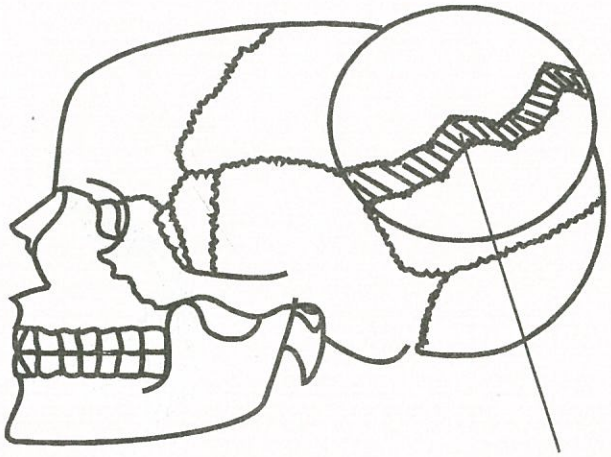
The joint is a union of two or more bones. It is classified into following types, according to the type of union among bones.

Classification of joints

1. Fibrous joints
2. Cartilaginous joints
3. Synovial joints

Fibrous joints

Joints are formed by fixed union between bones, which does not allow movement. They are also called fixed joints. e.g. sutures of skull and teeth in sockets.

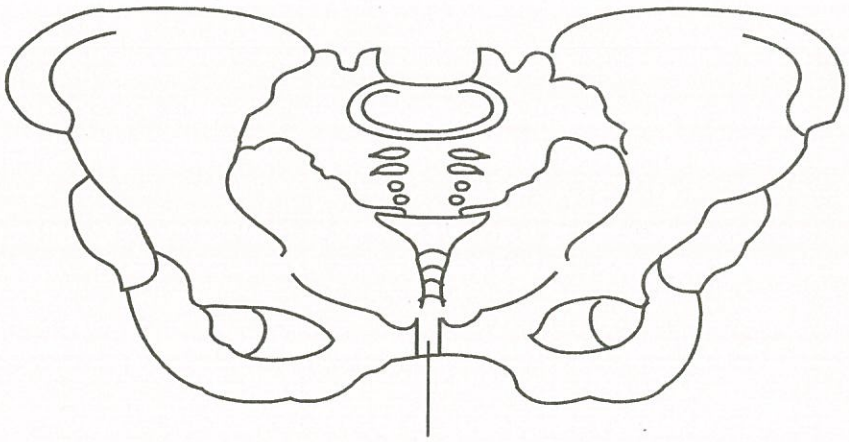


Fibrous joint

Cartilaginous joints

It is also called amphiarthosis or movable joints:

1. The articular ends of the bones are covered by hyaline cartilage.
2. There is a pad of fibro cartilage between the joint.
3. The joint is supported with ligaments.
   e.g. Symphysis pubis and intervertebral joints.



Symphysis pubis (Cartilaginous joint)

Synovial joints

It is also called as dia-arthosis or freely movable joints. The characteristics of these joints are given below:

1. Articular end of the bones are covered by hyaline cartilage.
2. Joints are supported by ligaments.
3. Joint is enclosed in fibrous capsule.
4. Capsule of the joint is lined by synovial membrane.
5. The cavity of the joint contains synovial fluid.

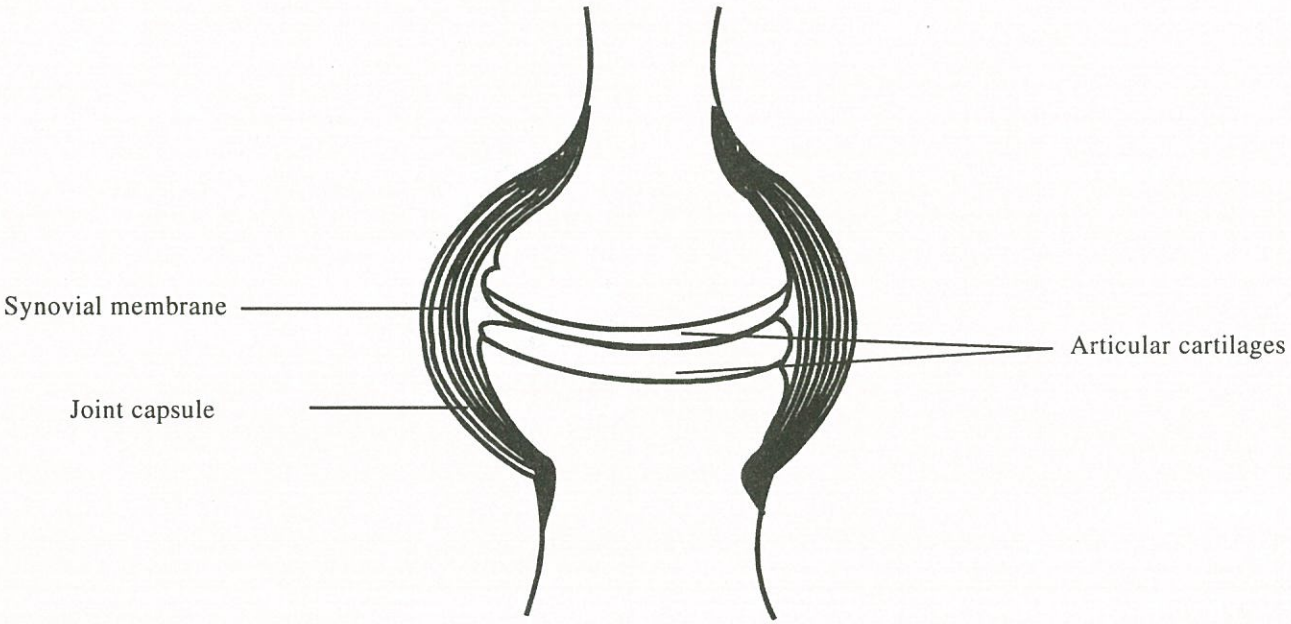


Fig. Knee joint

Synovial joints are further classified, based on the movements available at the joints.

1. Gliding joint (plane joint): Two flat surfaces of the bones glide on each other. e.g. Joint between carpal and tarsal bones.

2. Hinge joint: Movement is possible in one plane only.
   e.g. elbow joint(flexion and extension).

3. Pivot joint: In this joint, rotation is the only possible movement. e.g. joint between radius and ulna(pronation and supination).

4. Ball and socket joint: Articular end of one bone is like a ball, which fits into the socket like cavity of another bone. Movement in all directions are possible in this type of joint. e.g. shoulder joint and hip joint(flexion, extension, abduction, adduction, internal rotation, external rotation and circumduction).

5. Condyloid joint: It is similar to hinge joint but movement occurs in two planes. e.g. wrist joint(flexion, extension, ulnar deviation and radial deviation).

6. Saddle joint: It has one concave surface and one convex surface, this results in free movement in all directions. e.g. metacarpo-phalangeal joints of thumb.

Movements occuring at the joints are given below

a. Gliding / sliding movements

b. Angular movements

c. Rotatory or circular movements

A) Gliding movements. Occur when two flat surfaces move on each other. e.g. movement between carpal and tarsal bones.

B) Angular movements. It brings changes in the angle between the bones, depending on the direction in which the movement occurs, It is further classified into following movements:

1. Flexion: A movement where similar surfaces come nearer to each other. This reduces the angle between two bones. e.g. bending forearm at elbow.

2. Extension: A movement where similar surfaces go apart and the angle between the two bones is increased, it is opposite to flexion. e.g. straightening of bent forearm.

3. Adduction: A movement, that brings the limbs towards midline.

4. Abduction: It is opposite of adduction. The limb, is drawn away from the midline.

C). Rotation or circular movements: It occurs when one bone moves around or within another bone, the movement occurs around the central axis, it is further classified into the following types of movements:

i) Medial rotation, towards medial direction.

ii) Lateral rotation, occurs towards lateral direction

iii) Circumduction is a combination of rotation and angular movements. It involves flexion, extension, abduction, adduction and some rotation, this movement occurs in shoulder and hip joints.

JOINTS OF UPPER LIMB

Sterno clavicular joint is a cartilaginous, gliding joint between sternum and clavicle, a pad of cartilage is present in the joint cavity between the bones.

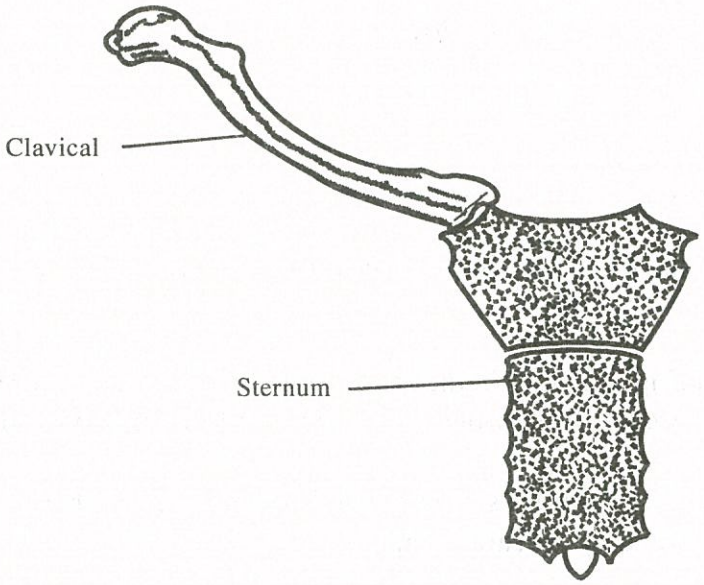


Fig. Sternoclavicular joint

Acromioclavicular joint is formed by the outer end of clavicle articulating with the acromion process of scapula, there is pad of cartilage between the ends of bones(limited movement occurs in all directions).

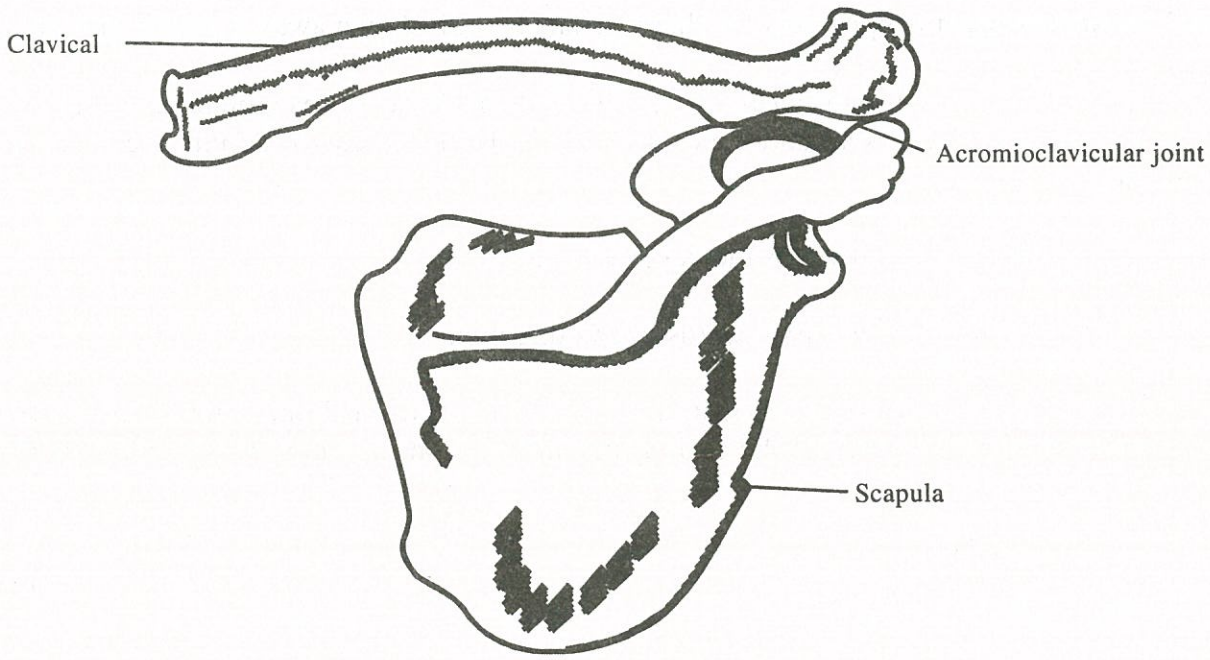


Fig. Acromioclavicular joint

Shoulder joint is a ball and socket type of joint. It is formed by the head of Humerus and glenoid cavity of scapula. The bones are further held together in place by ligaments, capsule and muscles.

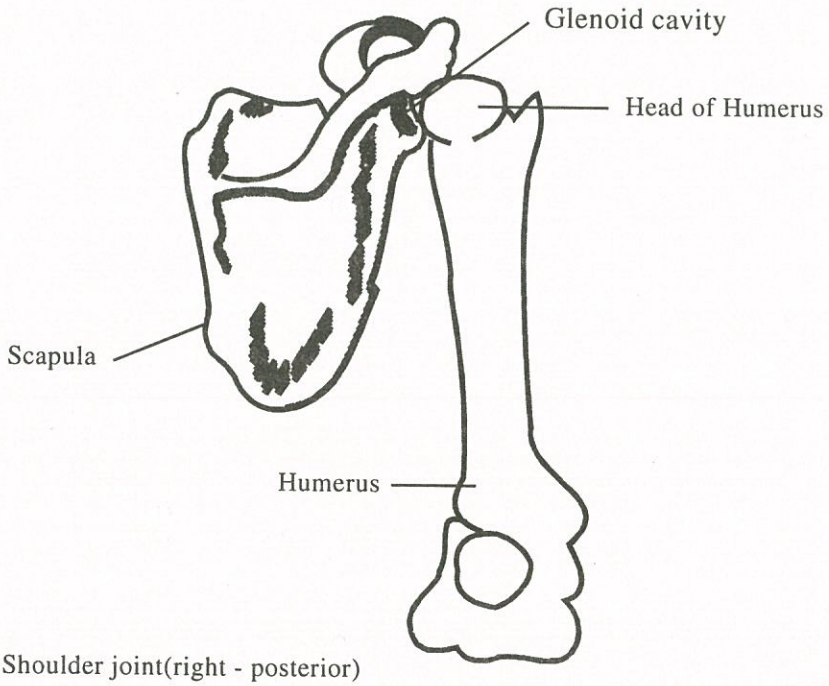


Fig. Shoulder joint(right - posterior)

Movements: All movements like flexion, extension abduction adduction, internal-external rotation and circumduction are possible.

Elbow joint is a hinge joint, it is formed by the lower and of the Humerus and the upper end of the radius and ulna.

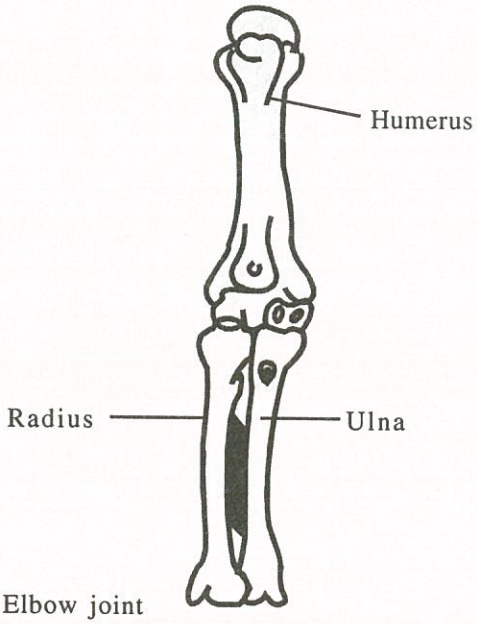


Fig. Elbow joint

Humeroulnar joint formed by trochlear notch of ulna and trochlear surface of Humerus. Humero radial joint formed by the head of radius and capitulum of Humerus. These four articulating surfaces are covered by joint capsule. Movements occur at this joint are flexion and extension.

Radio ulnar joint is formed by the articulation of radius and ulna at its upper and lower ends, by interosseus membrane.

1. Superior radio ulnar joint formed by the head of radius and radial notch of ulna

2. Inferior radio ulnar joint formed by the head of ulna and lower end of radius.

Movements: pronation and supination movements occur at this joint. Pronation means turning palm of hand down(palm faces downward). Supination means palm of hand faces up. (turning palm of hand up).

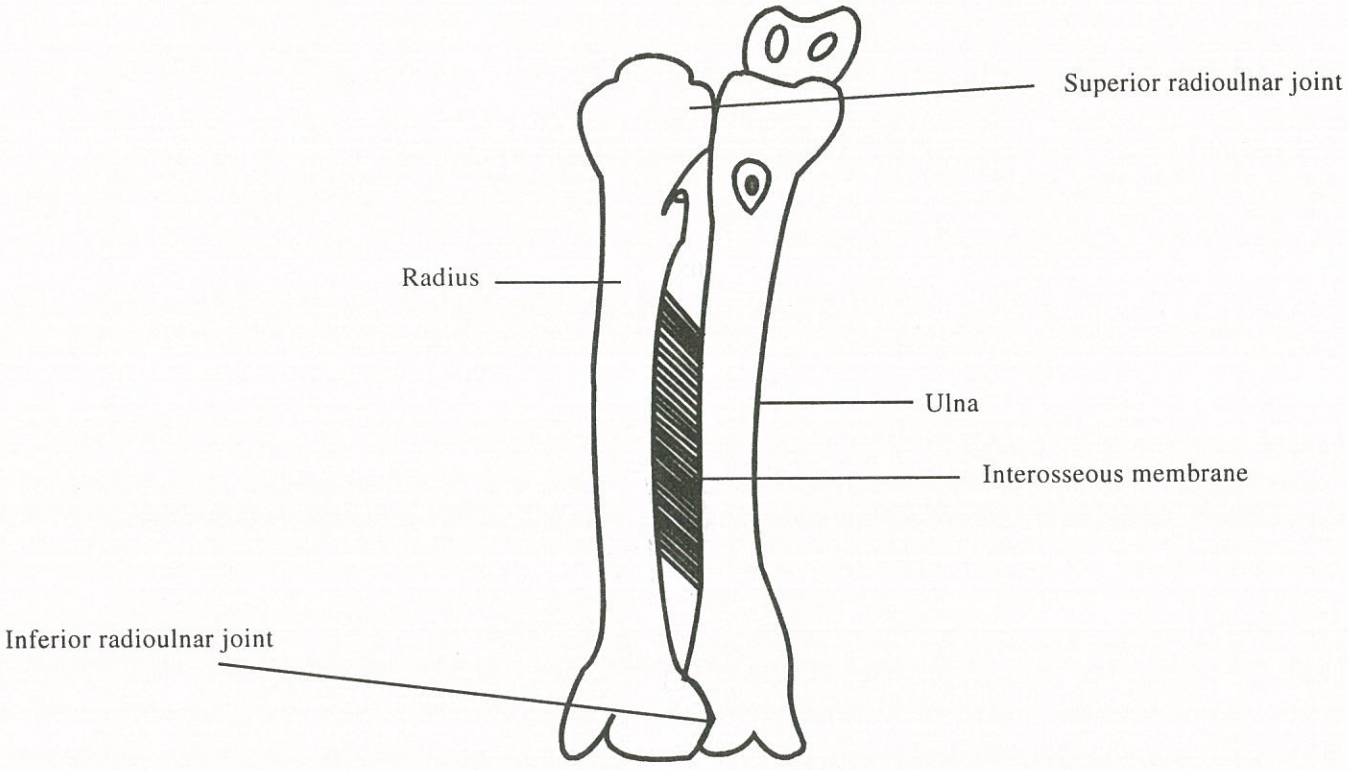


Fig. Radioulnar joints

Wrist joint it is a condyloid joint formed by the lower end of radius and three carpel bones (scaphoid, lunate and triquetral).

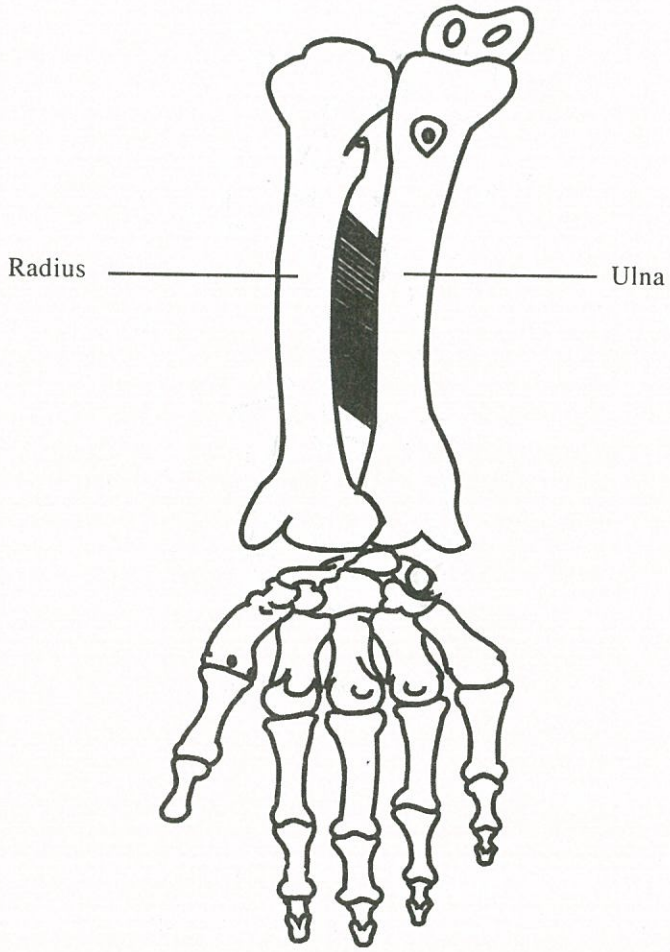


Fig. Wrist joint

Movements flexion, extension, ulnar deviation and radial deviation occurs at this joint. Ulnar deviation means, turning hand towards little fingers side. Radial deviation means turning hand towards thumb side.

Metacarpo phalangeal joints. A joint between metacarpals and phalangeal bones. The movements at this joints are flexion, extension.

Interphalangeal joints. It is formed by phalangeal bones of the same finger, flexion and extension movements are possible at this joint.

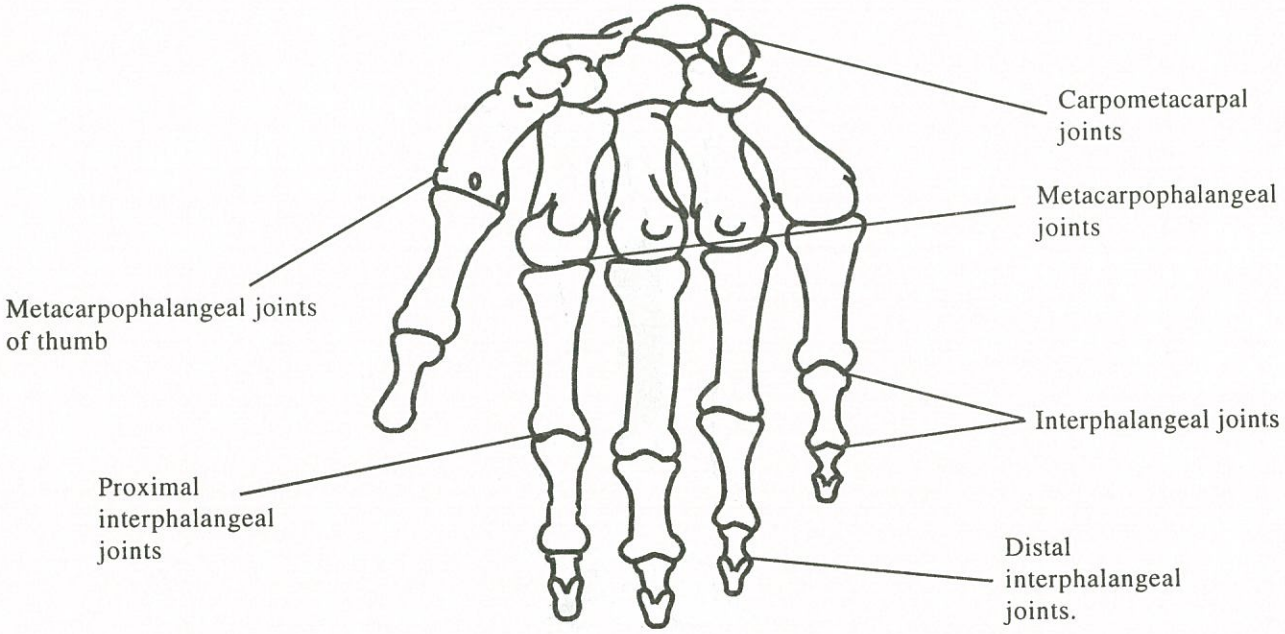


Fig. Interphalangeal joints

MOVEMENTS OF THUMB

Metacarpophalangeal joint of thumb

Flexion, extension, abduction, adduction and opposition(opposition - means the ability of the thumb to touch the tip of fingers).

JOINTS OF LOWER LIMB

HIP JOINT : It is a ball and socket type of joint, it occurs between acetabulum cavity of innominate bone and head of femur.

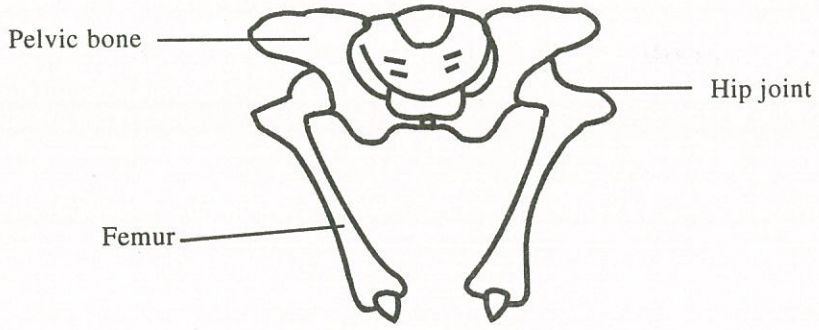


Fig. Hip joint

The joint capsule is strengthened by the following three ligaments:

1. Ilio-femoral ligament in the front.
2. Pubo-femoral ligament below.
3. Ischio femoral ligament at the back.

The head of femur is connected to the sides of the acetabular notch by means of a ligamentum teres.

Movements flexion, extension, abduction, adduction, rotation and circumduction occur at this joint.

KNEE JOINT : Is a hinge joint formed by two condyles of femur, articulating with ptella and the condyles of the tibia.

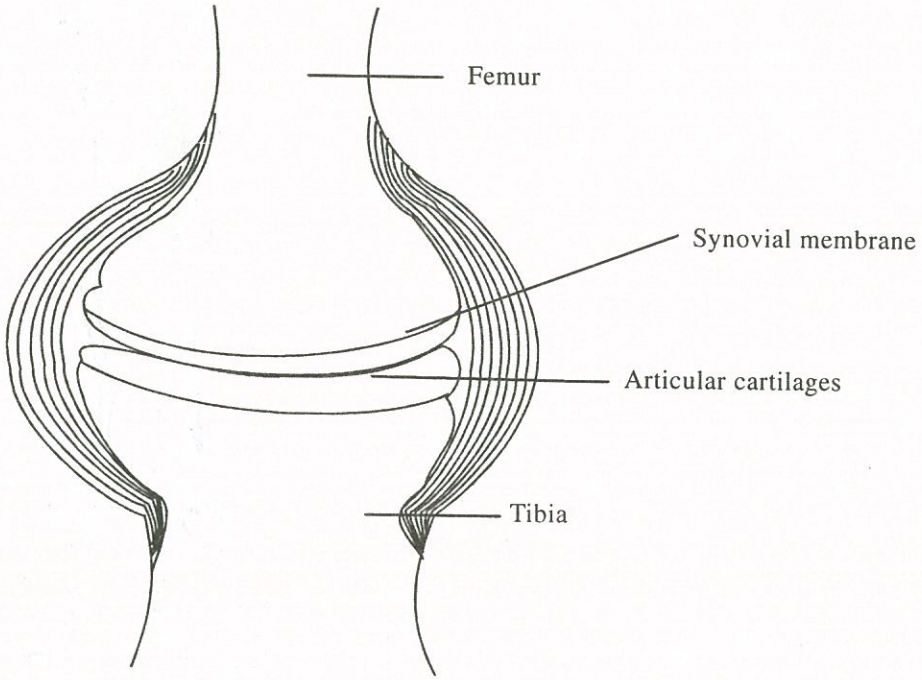


Fig. Knee joint

The structures of the knee joint is shown above:

1. Medial and lateral semilunar cartilages are attached to the upper surface of tibia.
2. Cruciate ligaments upper part is attach to intercondylar notch of femur, its lower attachment with the upper surface of tibia.
3. Synovial membrane, covers the articulating surfaces of bones.

Movements flexion and extension occur at the knee joint.

Ankle joint is a hindged joint formed by the following structures -

- Tibia and its medial malleolus.
- Lateral malleolus of fibula.
- Talus fits into the socket.

The capsule of the joint is strengthened by medial and lateral ligaments.

Movements - Dorsiflexion and plantar flexion

1. Dorsi flexion means standing on heels(bending the foot up, toward knee joint).
2. Plantar flexion means standing on toes(bending the foot down wards).

Subtaloid joint - it is located below Talus
eversion and inversion movements occurs at this joint.
Eversion - Turning sole surface of foot out.
Inversion - Turning sole surface of foot inward.

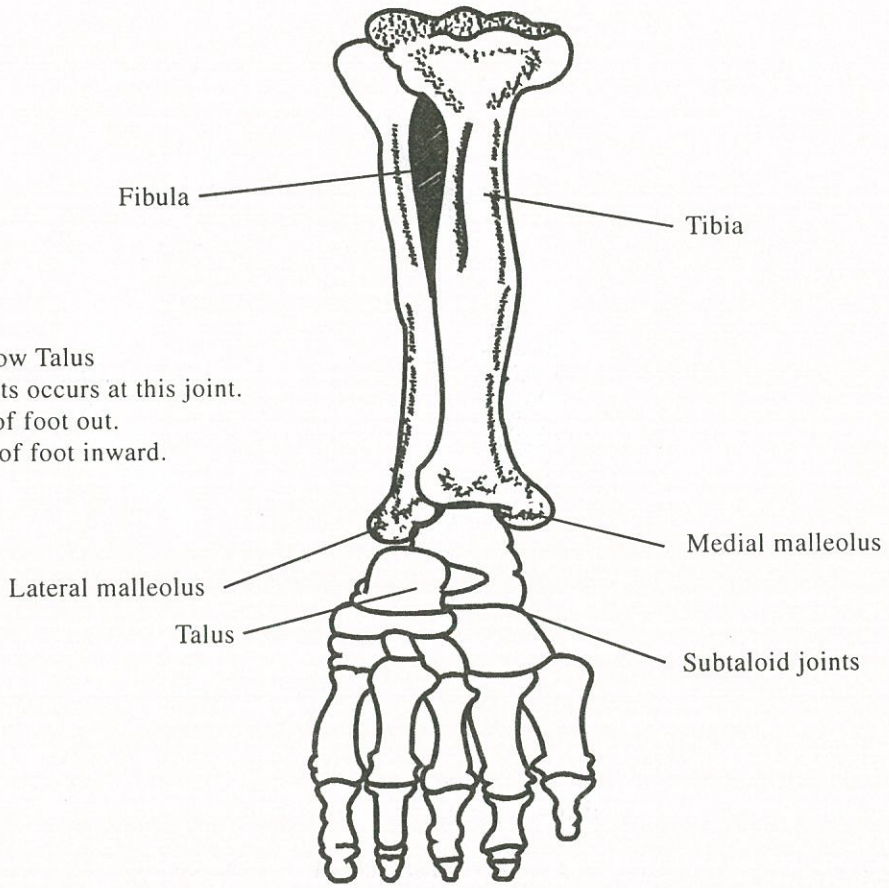


Fig. Ankle joint

Joints of the foot

1. Tarsal joints formed by talus, calcaneum and other tarsal bones.
2. Tarsometatarsal joints occur between tarsal and metatarsal bones.
3. Metatarsophalangeal joints occur between metatarsal and phalangeal bones.
4. Phalangeal bones unites with each other and forms interphalangeal joint.

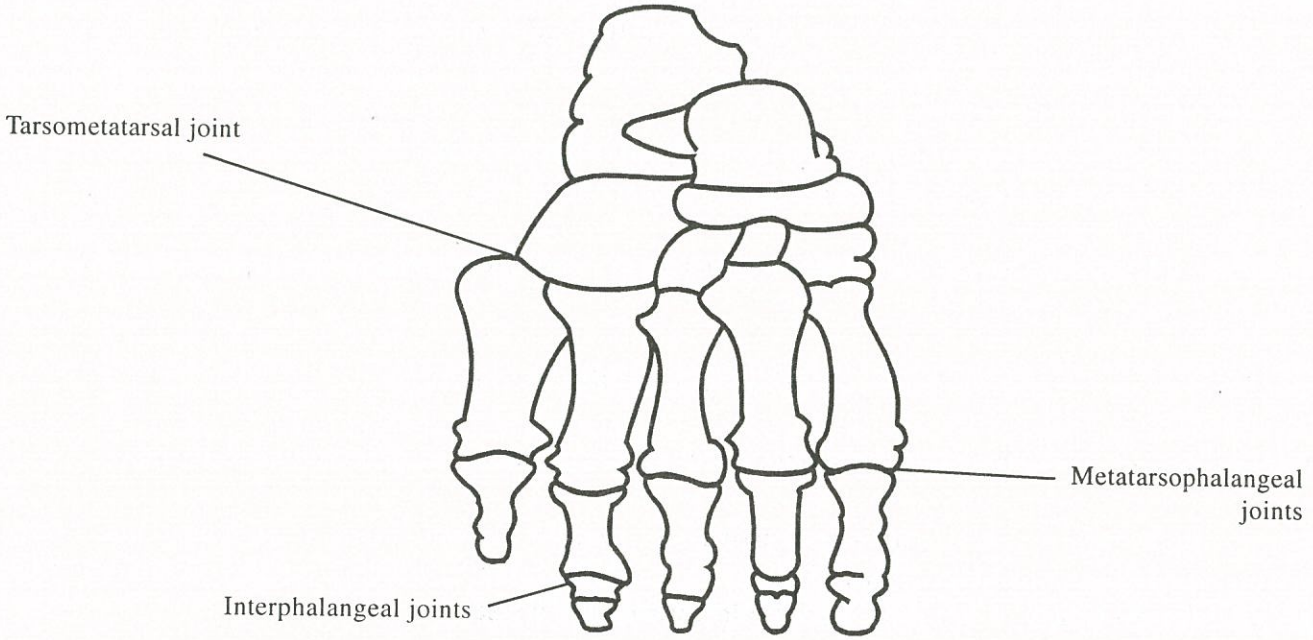


Fig : Joints of foot

MUSCULAR SYSTEM

The muscles are called red fibres of the body because they are highly enriched with blood and forms half of the body weight. Muscles are attached to the bones and its contraction brings various movements in the joints. Each muscle has an origin and insertion. Origin means proximal end and distal end is called insertion. It gives shape, form and appearance to the body and protect the vital organs of the body. It also help in venous and lymphatic drainage.

There are more than 300 muscles all over the body and are described according to its actions.

Muscles of the face and neck

Orbicularis oculi, Orbicularis oris, buccinator are the major muscles of facial expression. They act on face, closing eyes, lips, chewing and sucking actions respectively.

Platisma, sternomastoid, trapezius and *scalene* are the muscles of the neck that produces movements of the neck and shoulder girdle.

Muscles of the shoulder girdle

Deltoid, supraspinatus, infraspinatus and subscapularis. These muscles takes origin from the dorsal aspect of the scapula and produces movements at the shoulder. It produces abduction, lateral rotation, medial rotation of the arm respectively.

Muscles of the arm

Biceps and brachialis are the muscles located on front side of arm. It produces flexion at the elbow joint. It is supplied by the musculocutaneous nerve. *Triceps* is the main muscle situated in the back of the arm which produces extension at the elbow joint. It is supplied by radial nerve.

Muscles of the forearm

Flexor digitorium superficialis, flexor digitorium profundus are long flexor muscles, acting on hand and produces **flexion at interphalangeal joints** and **wrist joint.**

Flexor and extensor carpi radialis, flexor and extensor carpi ulnaris **produces radial deviation** and **ulnar deviation** respectively.

Pronator teres and pronator quadratus produce **pronation** of the forearm.

All these muscles are situated on the front side of forearm and are supplied by *median nerve.*

Extensor digitorum, brachioradialis, extensor carpi radialis longus, extensor carpi radialis brevis, extensor carpi ulnaris muscles, situated on the back side of forearm which produces **extension of the interphalangeal joints, wrist joint and deviations of the wrist.**

Abductor pollicis brevis, extensor pollicis brevis and abductor pollicis longus are the long and deep muscles in the back of forearm which produces **movements of the thumb.**

Muscles situated on backside of forearm and hands are supplied by the radial *nerve.*

Muscles of the thenar eminence-abductor *pollicis brevis, flexor pollicis brevis adductor pollicis, opponens pollicis* produces movements at the metacarpo phalangeal joint of thumb. All these muscles are supplied by the *median nerve.*

Muscles of the hypothenar eminence- *flexor digiti minimi, abductor digiti minimi, opponens digiti minimi* produce, movements of the little finger at the metacarpophalangeal joint. All these muscles are supplied by the *ulnar nerve* (Thenar means-elevated surface on thumb side of hand. Hypothenar- means elevated surface on little finger side).

Muscles of the gluteal region

Gluteus maximus, gluteus medius and gluteus minimus are the muscles of the gluteal region. These muscles produces **extensions and abduction of the hip joint.** All these muscles are supplied by the *gluteal nerve.*

Muscles on the front part of thigh

Rectus femoris, vastus medialis, vastus lateralis, vastus intermedialis and sartorius are the muscles of front part of thigh. These muscles produces **extension at knee.** All these muscles are supplied by *femoral nerve.*

Muscles located on the back of thigh

These are *biceps femoris, semitendinosus and semimembranosus* form hamstring group of muscles. These muscles produces **flexion at knee joint and extension at hip joint.** These muscles are supplied by *sciatic nerve.*

Muscles of the medial side of thigh

Adductor magnus, adductor brevis, adductor longus, gracillis and pectineas are the muscles of the medial compartment. These muscles produces adduction of the thigh and are supplied by *obturator nerve.*

Muscles infront of the leg

Tibialis anterior, peroneus longus, peroneus brevis, extensor hallucis longus, extensor digitorum longus are the muscles located on the front part of leg. These muscles produces dorsiflexion at the ankle joint, inversion and eversion movements at subtaloid joint. They are supplied by *peroneal nerve and tibial nerve respectively.*

Muscles in the lateral side of the leg

Peroneus longus and brevis are the muscles on the lateral side of the leg. It produce eversion at the subtaloid joint. It is supplied by *peroneal nerve.*

Muscles of the back of leg

Gastronemius, soleus, popliteus, plantaris,flexor digitorum longus, flexor hallucis longus, tibialis posterior are the muscles located on the back side of leg. It produce plantar flexion movement of the ankle. It is supplied by tibial nerve.

Muscles in the sole of the foot

There are as many as 20 muscles in the sole of the foot which give support to the arching of foot. They are supplied by plantar nerve.(Arch-means concavity normally present on medial side of foot).

Muscles of the thoracic region

Pectoralis major, pectoralis minor are the muscles situated in front of the thoraces and produces *adduction, medial rotation* and *depression of shoulder respectively.*

Serratus anterior which extends from the ribs to vertebral border of scapula and produces *protraction* of the shoulder.

Internal and external intercostals are the deep muscles, infront and back of the thoraces. It helps in expiration and inspiration.

Muscles of the abdomen

Rectus abdominis, external oblique, internal oblique, transverse abdominis are the muscles of anterior abdominal wall. The muscles of the abdomen, helps in protection of the organs of abdomen apart from movements (flexion and side rotation of trunk).

Quadratus lumborum, are the muscles of posterial abdominal wall. It helps in hip hiking while iliacus and psoas for anterior wall of abdomen and help in hip flexion.

Latissimus dorsi is a largest muscle in the back, produces movements of *shoulder and trunk (adduction, medial rotation, extension of arm and extension of trunk).*

NEURO ANATOMY AND PHYSIOLOGY

Nervous system of a living organism enables it to react to the changing environment. The system is concerned with physical, intellectual and emotional activities. Any disorder of this system may affect major functions. It is classified into the following parts-

1. Central Nervous System (CNS) which consists of brain and spinal cord.
2. Peripheral nervous system, which consists of nerves of limbs, head, neck, trunk, somatic, sympathetic and parasympathetic.

The central nervous system contains about 1000 billion nerve cells. Neuron is the basic unit of nervous system. Number of neurons are linked to form a nerve or nerve fiber. A nerve fibre transmit signals between the central nervous system and body tissues. Nerves which conduct sensory impulses from receptors to the CNS are called afferent nerves and nerves which conduct motor impulse from CNS to effector organs or tissues are called motor nerves.

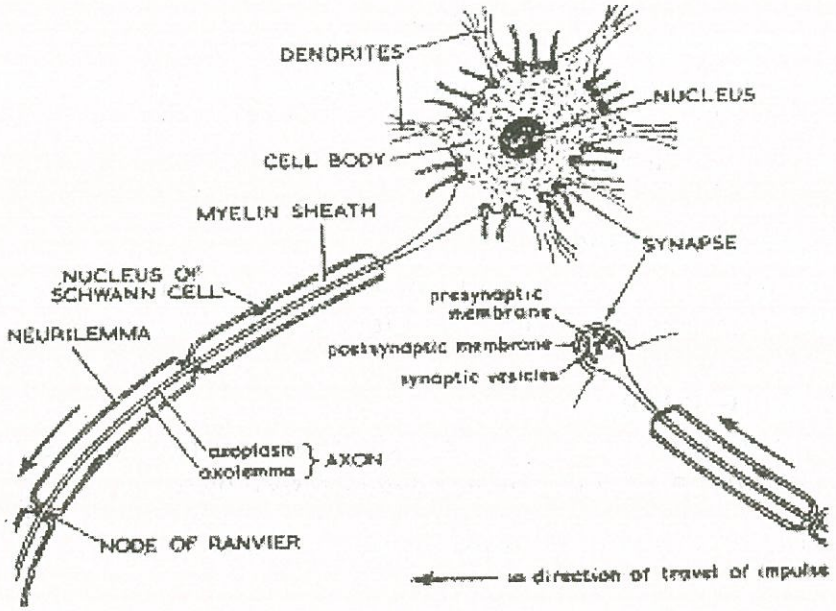
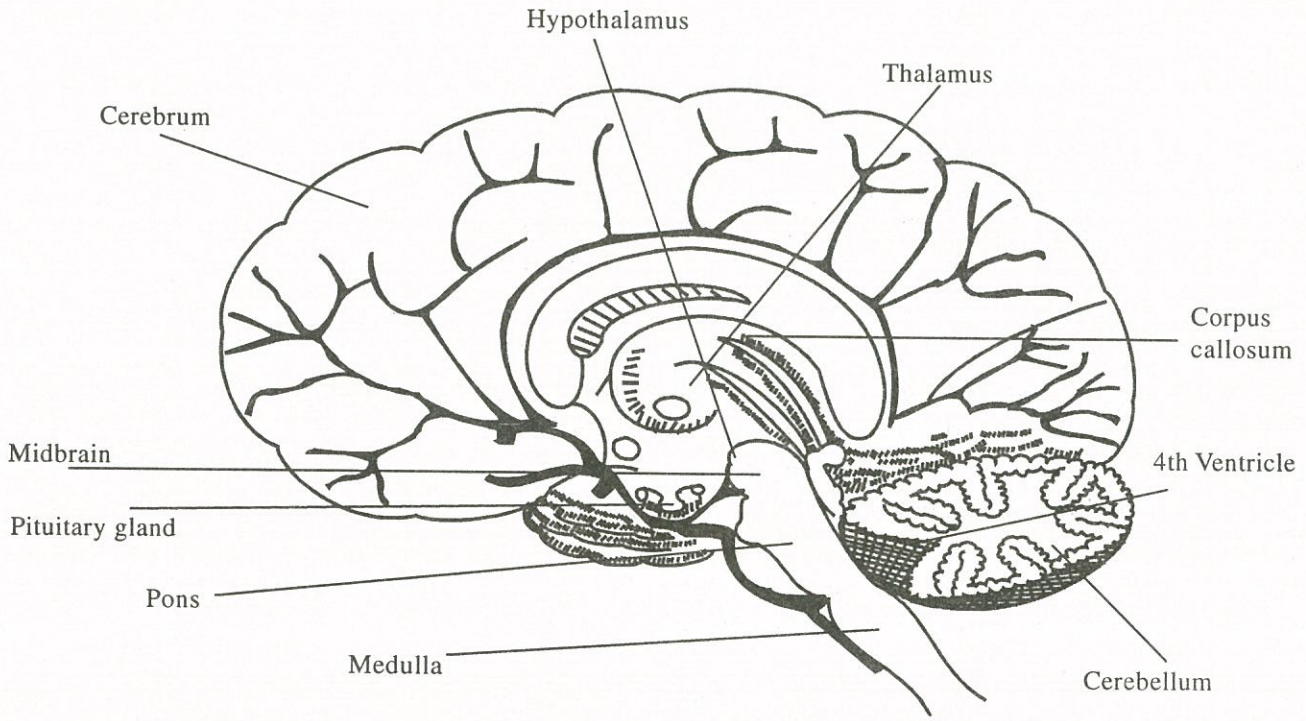


Fig. Neurone.

The fibers of peripheral nerves, are the axons and dendrites of neurons whose bodies are located within the brain, spinal cord and ganglia.

PARTS OF BRAIN



1. Cerebrum : It is the largest part of the brain, consisting of two hemispheres separated by a deep longitudinal fissure. The hemispheres are connected with each other by a structure called *corpus collosum,* which consists of nerve fibers. The most superficial part of each cerebral hemisphere is called the *cerebral cortex.* It consists of nerve cell bodies with some nerve fibers and has a grey appearance, hence it is also called *cerebral grey matter.*

The sub cortical matter which consists of nerve fibers (both afferents and efferents) lie under the cerebral cortex. As these nerve fibers are white in appearance so it is also called cerebral white matter or sub cortical white matter. Within this sub cortical white matter, there are masses of grey matter, consisting of sub cortical nuclear masses. Such masses form 'basal ganglia'.

Both cerebral grey matter and subcortical nuclear mass send efferents to many areas of brain and receives various afferents. The cerebral gray mater sends efferents to the anterior horn cells of the spinal cord and influence the other parts of the brain as well as the anterior horn cells of the spinal cord.

2. The brainstem : It consists of mid brain, pons and medulla.

Mid brain : It connects the pons and cerebellum with the hemispheres of cerebrum, it has reflex centers for eye and head, movements occurs in response to visual and auditory stimuli.

Pons : It relays impulses with in the brain and between parts of the brain and spinal cord. It Contains nuclei of origen for cranial nerves V, VI, VII and VIII.

Medulla : The lowest part of the brainstem, continuous with the spinal cord below. (It regulates heart rate, breathing, blood pressure, and other reflexes such as coughing, sneezing, swallowing and vomiting).

Cerebellum : The cerebellum consists of two cerebellar hemispheres joined together by vermis. The surface of the cerebellum is in cortex and deep in it, is the white matter, inside brain, cerebellar nueclei are found in grey matter. The cerebellum is also called small brain. It lies under the occipital lobe of cerebrum, dorsal to the brain stem. It is involved with synergic control of skeletal muscles and plays important role in the coordination of voluntary movements. It receives afferent impulses and discharges efferent impulses but it is not a reflex center in the usual sense.

It interrelates with brain stem structures in executing various movements, including the maintaining proper posture, balance, walking, running, fine movements such as writing, dressing, eating, playing musical instruments and smooth tracking movements of the eyes. It controls various aspects of movement, such as speed, acceleration and trajectory.

Afferent inputs are received from the following parts -

1. From the spinal cord - Spino cerebellar tracts as well as cuneato cerebellar tracts to cerebellum. Cerebellum receives non-conscious sensory inputs.

   The cerebellum receives information about degree and distribution of contraction of the muscles, position of limbs in space and posture(non-conscious).

2. From vestibular nucleus to the fourth ventricle to cerebellum, vestibular nuclei in turn receives fibers from the vestibular apparatus of the internal gray matter which detects abnormal position of head or movements of the body.

3. From nuclei of the brain stem of the reticular formation of cerebellum, from nuclei, fibers go to the cerebellum, positive nuclei receive collaterals from the pyramidal tract. Thus the activities of the pyramidal tract and area 4 can be monitored by the cerebellum.

4. From the cerebral cortical areas - e.g. temporal lobe, occipital lobe fibers go to the cerebellum. Thus auditory, visual and cortical activities can be monitored by the cerebellum.

5. From the olive of the medulla - Cerebellum.

Efferent outputs : There are four cerebellar nuclei, from which the vast majority of efferent fibers comes.

1. Nucleus globosus
2. Nucleus emboliformis
3. Nucleus fastigius
4. Nucleus dentatus.

The axons of the Purkinje cells converge on these nuclei and the axons of these nuclei come out of the cerebellum as efferent outputs.

The efferent outputs are given to the following areas -

i) Area 4, the motor cortex
ii) To the vestibular nucleus
iii) Nuclei of the reticular formation.

Functions of cerebellum

Efferent from the motor cortex proceed via dentate rubro-thalamo-cortical path. Controlling influences to the motor cortex and pyramidal system, are discharged through this path. There is also a cerebello-thalamico-cerebral path with a similar function.

i) It controls sub conscious skeletal muscle contractions required for co-ordination, posture and balance.
ii) Assumes a role in emotional development, modulating sensations of anger and pleasure.

Damage to these tracts are responsible for the tremor, seen in cerebellar syndrome.

The basal ganglia

Anatomy : The basal ganglia comprise of the following structures.

i. Caudate nucleus
ii. Lentiform nucleus
iii. Red nucleus
iv. Substantia nigra
v. Subthalamic body (nucleus).

Lenticular nucleus has two parts outer, lateral part called putamen and inner medial part, the globus pellidus. Substantia nigra and red nucleus are present in mid brain.

The neuro transmitters

There are many neuro transmitters acting as synaptic transmitters in the various synapses of the basal ganglia. The most important neuro transmitters are given below :

1. Dopamine 2. Acetylcholine 3. GABA 4. Serotonin 5. Norepinephrine

Functions of basal ganglia

1. The basal ganglia is an integral part of the extra pyramidal system. It has strong influences on tone of the muscle and thus on posture and equilibrium.

2. The basal ganglia is also integral part of the pyramidal system and exerts its action on motor cortex.

The spinal cord : The spinal cord is the downward continuation of medulla and descends through the vertebral canal, it ends at the level of lower border of 1st lumbar vertebrae. After that some fibers continue as cauda equina.

A cross section of spinal cord shows outer white matter consists of tracts, either sensory (ascending) or motor (descending). In the inner gray matter, anterior horn contains nerve cell bodies which gives origin to the somatic nervous(lower motor neuron) supplying the skeletal muscles. The posterior horn, receives sensory nerves via the dorsal root ganglion and the lateral horn cells in the thoracic and upper lumbar segments of the spinal cord, which gives origin to sympathetic fibers. In the central part of it (gray matter) a canal exists which is called central canal.

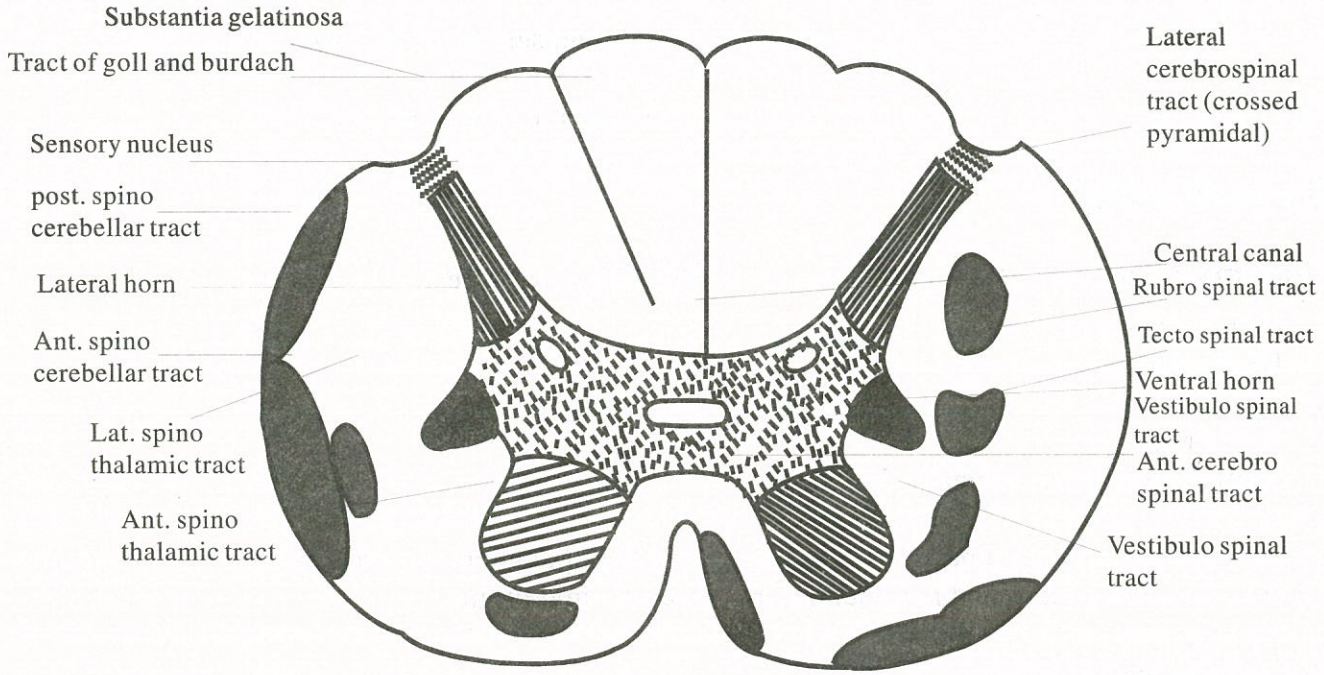


Fig. Cross section of spinal cord

The anterior horn cells cross emerge to form the ventral root or motor root. Sensory fibers from various areas, enter the posterior horn. The nerve cell bodies of these sensory neurons are situated, little outside the spinal cord and constitute the Dorsal Root Ganglion (DRG).

These two roots (the motor and the sensory), unite together, little outside the spinal cord to form a mixed spinal nerve. Therefore, a spinal nerve contains both motor and sensory nerve fibers, i.e. it is a mixed nerve.

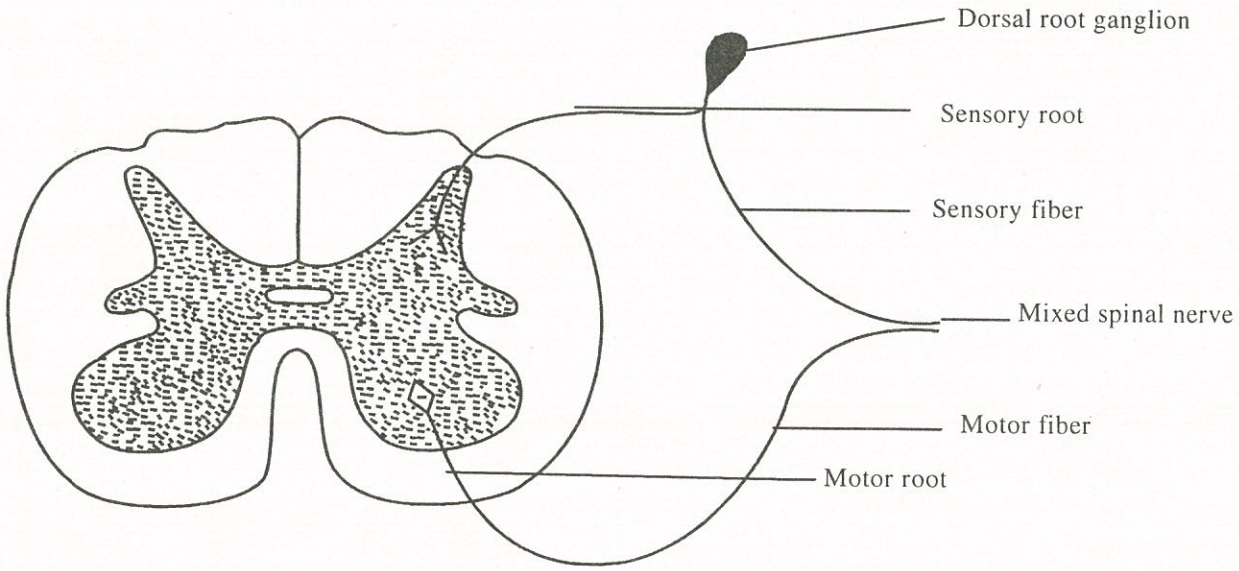


Fig. Formation of mixed spinal nerve

Meninges: The brain and spinal cord are protected by three coverings called meninges.

- Duramater is the outer covering.
- Arachnoid matter is the middle covering.
- Piamater is the inner covering.

The space between archnoid matter and piamater is called as sub arachnoid space. It contains cerebrospinal fluid.

Cerebro Spinal Fluid(CSF): It is a clear, colourless, alkaline fluid present in sub arachnoid space, Ventricles of brain and central canal of spinal cord.

Functions of CSF

1. It protects the brain and spinal cord from shock.
2. It conveys nutrients to the brain and spinal cord.
3. It removes the waste products of brain and spinal cord.

Peripheral nervous system : It consists of 12 pairs of cranial nerves and 31 pairs of spinal nerves.

Cranial nerves : Supply the organs of special senses. Some are purely sensory in function and some are mixed - (both sensory and motor in function). Some serve motor function by supplying the muscles of the face and special organs.

Spinal nerves : There are 31 pairs of spinal nerves which arise from the spinal cord, one spinal nerve on each side corresponds with each segment of the vertebral column. The trunks of the nerves unite to form plexus at certain regions of the spinal cord. It is given below :

a. Cervical plexus: Formed by the first four cervical nerves. Phrenic nerve is a part of this plexus which supplies the diaphragm.

b. Brachial plexus: lower four cervical nerves and first thoracic nerve forms this plexus. The important branches of this plexus are circumflex nerve, musculocutaneous nerve, radial nerve, ulnar nerve and median nerve. They supply the muscles of upper limbs.

c. Lumbar plexus: First four lumbar nerves form this plexus. Its main branches are Femoral nerve and obturator nerve. They supply muscles of front and middle part of leg.

d. Sacral plexus: formed by fourth, fifth lumbar nerve and first second sacral nerve. Its branch is sciatic nerve. It supplies muscles on the back of hip and thigh.

Sensations

Sensations are classified into two types.

1. *Special sensations:* eg. Sensations of smell, taste, vision, hearing (received by extra ceptive organs).

2. *General sensations are classified into -*
   a. Superficial sensations: Sensations like pain, touch, and temperature felt by the skin.
   b. Deep sensations: like pain, touch and deep pain felt by muscles, joints and other organs (received by proprioceptive organs).

Sensory path: The peripheral nerves carry superficial sensation and deep sensations to brain via spinal cord. Superficial sensations are carried upwards in the anterior column of spinal cord. Deep sensations are carried upwards in the posterior column of spinal cord. The impulses are then conveyed to sensory area of brain through brain stem, thalamus and white matter of brain.

Motor path : It consist of two neurons for voluntary movements.

- *The upper motor neuron :* Extends from the pyramidal cells of motor cortex of the brain to the anterior horn cell of the spinal cord. The fibers cross through internal capsule, pons and reach the medulla oblongata. These fibers cross each other in the medulla oblongata. They travel through the lateral column of spinal cord and terminate in the anterior horn cells.

- *Lower motor neuron:* Extends from the anterior horn cells to the peripheral nerves supplying the muscle. The fibers from anterior horn cells reach the anterior nerve root, the fibers of anterior nerve root unite with the incoming fibers of posterior nerve root and form the spinal nerve. The motor nerves emerging from the spinal cord supply the muscle.

Ascending tracts (Sensory tracts)

Pain, touch, temperature, proprioceptive and kinesthetic senses are the major senses, which are carried from the periphery to the brain.

Senses which reach the level of consciousness will first reach the thalamus and then to the cerebral cortex(area-post central gyrus: this area is also called somato sensory area, S1).

Senses which do not reach the level of consciousness are called nonconscious. These are the proprioceptive senses, they reach the cerebellum.

Somato sensory areas (S1 and S2)

Post central gyrus, or brodmans area 3,1,2 and in the area of cerebral cortex, all the conscious senses reaches except smell, all conscious senses relay at thalamus. Thus pain, touch and temperature are relayed to S1. The important sensory tracts are described below.

1. Leminescal system : Fibers carrying fine touch, two point discrimination, vibration sense and sense of positioning of limb enter the spinal cord, proceed up through the column without relay and without crossing and then relay in the Dorsal Column Muscles(DCM). It consist of first neuron.

From DCM, the second order neuron arises, crosses to opposite side crossing takes place in medulla. Then reaches to the ventral side of the brain stem close to the midline, and now the fibers constitute the medial leminescal. Then reaches the main sensory muscles of the thalamus. From the thalamus, final order neuron arises, reaches the post central gyrus of cerebral cortex, which is higher center for such sensations.

Antero Lateral System

The antero lateral system carries pain, crude touch and temperature senses. There are two tracts in this system.

1. Centero Spino Thalamic Tract(STT)
2. Lateral Spino Thalamic Tract(STT)

The senses of pain, touch and temperature are brought to the spinal cord by 1st order neuron.

The first order neuron enters the cord and terminates in the dorsal horn by synapsing with the next order neuron. The second order neuron(which constitute the lateral fibers) cross the midline, infront of the central canal from the STT. In cord, pain fibers cross immediately, in the same cord segment. Where as, the temperature fibers run some what obliquely to cross. The anterior STT fibers are constituted by second order neurons, arising from the dorsal horn of spinal cord. The fibers cross the midline, enter the ventral funiculus to constitute the anterior STT.

The two tracts anterior and lateral spino thalamic tracts occupy the Anterior and lateral funiculi respectively, enter the medulla and proceed up. From the thalamus, final order neurons, carrying the impulses of the anterolateral system arise and terminate on the post central gyrus.

Thus, both the leminiscal and anterolateral systems ultimately convey impulses to the sensory cortex (post central gyrus). The different areas of the body have a topographical representation in the post central gyrus which is called sensory homoclonus.

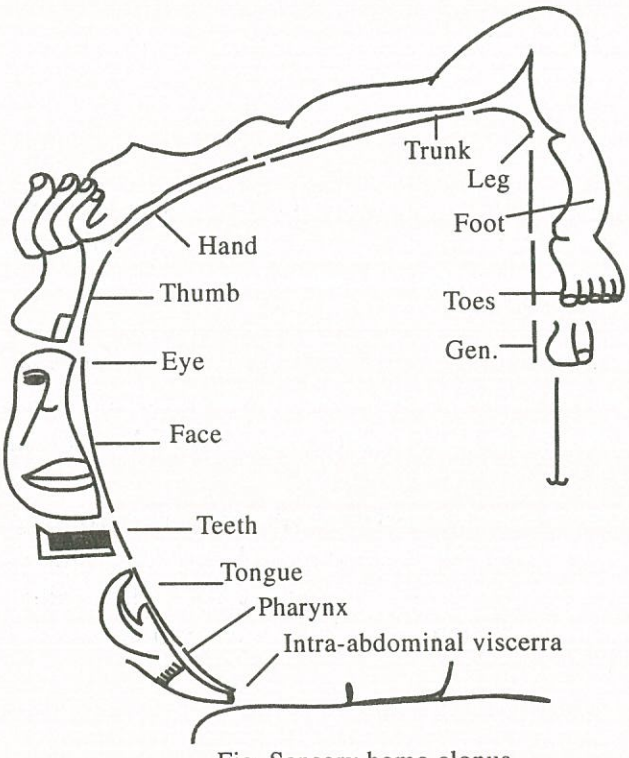


Fig. Sensory homo clonus

Spino cerebellar tracts

These tracts do not reach the level of consciousness (sensory cortex).

1. Anterior or ventral.
2. Posterior or dorsal, spino cerebellar tracts.

Dorsal spino cerebellar tract

The first order neurone arises from the muscle spindle, joints and the skin, enters the spinal cord via the dorsal root ganglion and terminates in the dark column. Situated at the base of the dorsal horn. The second order neuron arises from the dark column, proceeds up through the dorsal spino cerebellar tract of the same side, reaches medulla, turns posterior to enter the cerebellum through the inferior cerebellar peduncle.

Ventral spino cerebellar tract

First order neuron arises from the muscle spindle, joint and skin, enters the spinal cord via the dorsal root ganglion, relays in the dorsal horn. The second order neuron cross the opposite side and proceed up via the ventral spino cerebellar tract, medulla, pons and mid brain. In the mid brain, the fibers turn posteriorly and enter the cerebellum.

The spino cerebellar tracts carry impulses, arising from the muscles and joints. Both gives sensory input, to the cerebellum.

Tracts of Goll and Burdach

The first order neuron carrying senses from the muscles, joints and enters the spinal cord and then continue up via the dorsal funiculus, all such fibers relay in the medulla. The second order neuron via the medial lemniscus reaches the thalamus and then cortex. Non conscious proprioceptive fibers, arising from the accessory cuneate nucleus enter the cerebellum.

The motor parts of nervous system

The motor neuron : Motor neuron means an efferent neuron which carries impulses to the motor effector organ.

Voluntary action : The action that is produced(consciously) by which is called voluntary action. For execution of voluntary action. Following factors are necessary -

i. Pyramidal system (motor cortex and pyramidal tract fibers).

ii Lower motor neuron.

iii Skeletal muscles, cerebellum and the basal ganglia, should function properly to ensure satisfactory execution of the movement, there impulses are surveyed by the pyramidal tract.

Non voluntary action : Tone, posture and equilibrium maintenance are achieved without the participation of the will. So they are non voluntary actions, and are mediated by the skeletal muscles.

Upper motor neuron

There are two sets of motor fiber or descending fibers from brain.

i. Pyramidal tract fibers.

ii. Extra pyramidal tract fibers (EPT). Both the types of fibers ultimately terminate on the nerve cell soma of the anterior horn.

Lower Motor Neuron (LMN)

From the soma of the anterior horn cell, nerve fibers emerge to innervate the skeletal muscles. These fibers are called lower motor neuron, because both anatomically and functionaly they occupy lower plane. The LMN conducts and influences these (PT and EPT) fibers; hence LMN, is also called, 'The final common path'.

Anatomy of Pyramidal System (PS)

The term pyramidal system means the motor cortex, the axons descending through the pyramidal tract (PT). There are two pyramidal tracts, one on either side, each contains about one million fibers, many of these fibers, arise from the 'Motor cortex'.

Motor cortex

Generally, the term motor cortex, means area four of brodmann. How ever there are other areas in the cerebral cortex, when stimulated electrically, cause contractions of skeletal muscles. The other areas are called additional motor areas.

Motor homo clonus

In the precentral gyrus of human beings, the body is represented upside down. Stimulation of most medial parts of area four causes movement of toe, ankles and so on, where as stimulation of lateral most parts causes movements of jaws, tongue etc.

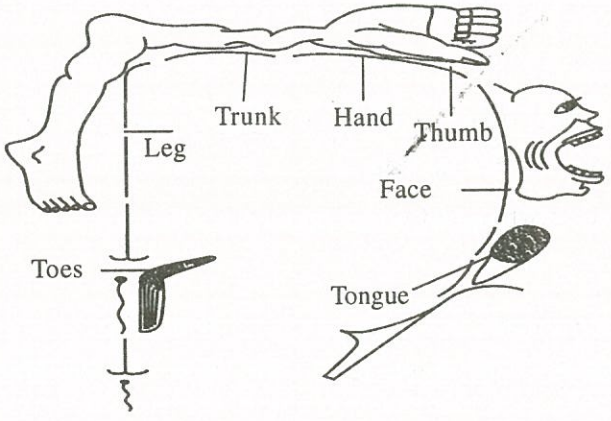


Fig. Motor homoclonus

Descending tracts (Motor tracts)

There are two sets of descending fibers, descend from the brain. They carry impulses from brain to periphery.

1. Pyramidal tract
2. Extra pyramidal system

Both the types of fibers ultimately terminate on the nerve cell soma of the anterior horn.

1. Pyramidal tract (PS): Consists of motor cortex, the axons, descending through the pyramidal tract. There are two pyramidal tracts, one on precentral gyrus of each side, arise from precentral gyrus of the motor cortex.

From the cerebral cortex, fibers of the pyramidal tract descend through the subcortical structures, first as corona radiata and then forming a part of internal capsule. The pyramidal tract fibers descend through the crus cerebi of the midbrain and enters the pons and then medulla.

Near the medulla, the fibers cross to the opposite side, on entering the spinal cord, descends through the lateral funiculus.

In the spinal cord, many of the pyramidal tract fibers terminate on the cells of the posterior horn. The post synaptic neuron arising from the posterior horn, synapses with the cells of the anterior horn. Many fibers of pyramidal tract, however, terminate on the anterior horn cells directly, these fiber's are concerned mostly with the movements of the fine muscles of the fingers.

Functions of the pyramidal system

This is the path through which descends the impulses for voluntary movements from the brain to the spinal cord or, cranial nerve nuclei.

Applied physiology of pyramidal tract

Pyramidal tract can be injured by cerebrovascular accidents caused by either infarction or haemorrhage. Pyramidal system damage can occur at various places.

1. Motor cortex
2. Internal capsule
3. Brainstem

2. Extra pyramidal system : Extra pyramidal system consists of sub cortical gray matter, the motor nuclei of reticular formation of the brain stem and the vestibular nucleus and the descending fibers, convey the impulses from these nuclei to the spinal cord.

Function of extra pyramidal system is to -

Influence and maintain tone, posture and equilibrium.

The principal tracts of extra pyramidal system are given below-

(i) Reticulo spinal tract

(ii) Vestibulo spinal tract

(iii) Rubrospinal tract

(i) Reticulo spinal tract : Arises from two major sources

a. Pontine nuclei

b. Medullary neuclei

The tracts remains uncrossed and terminate both on motor neurons of anterior horn. The tract contains both inhibitory and facilitatory fibers. Fibers from pons descend through anterior white column, whereas those from medulla descend through lateral columns of spinal cord.

2. Vestibulo spinal tract : The vestibulo spinal tract arises from the lateral funiculus of the vestibular nucleus, descends through the spinal cord, remains uncrossed and terminates on the motor neurons of the ventral horn. The tract is often called the dietero spinal tract, is facilitatory; i.e, its discharge increases the muscle tone. Another vestibulospinal tract, called medial vestibulospinal tract arising from the medial and anterior vestibular nuclei, runs through the medial longitudinal fasciculus is a bundle present in the dorsal and medial side of the brain stem, from mid brain to medulla, and extends into the upper part of the spinal cord. It consists of -

a. Fibers from the vestibular nucleus going to the cranial nuclei of 3rd, 4th and 6th nerves that is, nerves going to supply the extrinsic muscles of the eye,

b. Fibers from the medial vestibular nucleus.

3. Rubrospinal tract : Arises from the red nucleus, this tract decussates immediately and eventually proceeds downwards through the lateral funiculus of the spinal cord and terminates on anterior horn. The red nucleus receives input from the cerebellum as well as from the motor cortex.

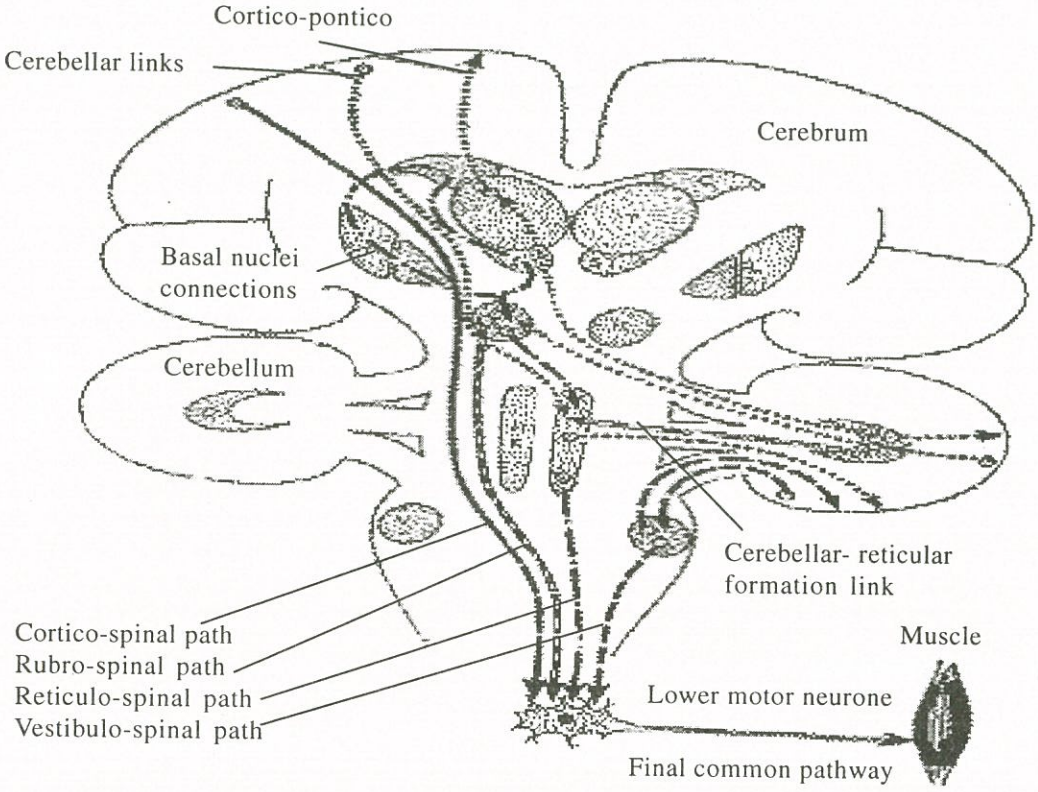


Fig. Motor neurone connections

Structure of Neuron

It consists of nerve cell (cell body) and its processes (Dendrites and axons).

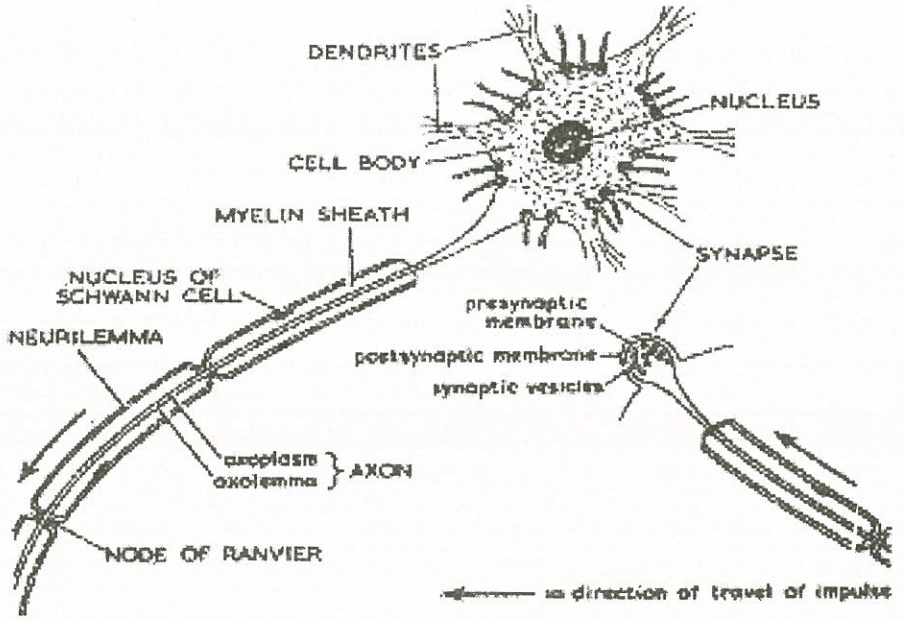


Fig. Motor neurone connections

Neurons are protected and supported by specialized connective tissue called neuroglia. In case of neuron damage, proliferation of neuroglial material will take place to fill the gap. The axon are surrounded by a fatty sheath called Myelin sheath, which has an important effect on the conduction of impulses. Axon and its myelin sheath outside the central nervous system are surrounded by a membrane called the neurilemma.

Nerves fibres surrounded by neurilemma have the capacity to regenerate if they are destroyed. Thus destruction of fibres in a peripheral nerve does not necessarily mean permanent loss of function. Whereas destruction of fibres in the central nervous system will mean permanent loss of function of those fibres.

The synapse

The synapse is an area of link between two neurons. It is formed between the terminal parts of axon and dendrites of another cell. The transmission of impulses from one neuron to other neuron is facilitated at synapse by virtue of chemical changes that brings alternation in membrane potential on the receiving neuron.

Properties of synapses

Synaptic delay: Conduction of impulses is faster through monosynaptic pathway's than through the chains of neurons.

One-way direction: Synapses allow impulses to travel in one direction.

Vulnerability: Synapses are very sensitive to anoxia and to the effects of drugs.

Summations: The effect of impulses arriving at a synapse can be added by other impulses.

Fatigue : The synapses is the site of fatigue in nerve conductivity.

Inhibition : Certain neurons have an inhibitory effect upon the post synaptic neuron, possibly because it need a different chemical mediator.

Post tetanic potentiation : This occurs, across synapses which have been subjected to prolonged and repeated activity. The threshold of stimulation at these junctions is lowered, making transmission across it more easily and this is brought about for a period of several hours.

PHYSIOLOGY OF MOVEMENT

Essential Factors for Normal Movement and Activity

Movement is the result of complex teamwork between the muscle and joints of neural system. Muscles producing movement, receive stimulation from motor neuron pool in anterior horn of the spinal cord, while cranial nerves receive stimulation from the motor neuclei of the brain stem.

Axons from the motor neuron pools pass to the muscles and constitute the lower motor neurons. The passage of impulses is depend upon the integrity of the pathway and the influence exerted upon it by cells of the motor neurone pool.

Two types of influence *(excitatory influence, and inhibitory influence)* may be exerted upon the cells by the motor neurone pool including interneurones, many neurons are converging upon the cells.

The muscles, therefore, contract or remain inactive according to the balance of excitatory and inhibitory influences will be exerted upon its motor neurone pools. The intensity of muscle contraction is dependent upon the number of muscle fibers brought into action. The number of fibres activated depends upon the number of cells in the motor neurone pool which have conveyed impulses, so greater the excitatory influence on the motor neurone pool will lower their threshold of stimulation, greater the number of active motor neurone will have greater degree of muscle contraction.

Factors exerting influence on the motor neuron pools.

1. Extra pyramidal and pyramidal parts of the central nervous system. Which convey impulses resulting in volitional, postural and equilibrium reactions.

2. Lower reflex pathways which give rise to withdrawl and stretch responses as a result of more direct influence from the afferent side of peripheral system.

The inter relation ship between them can be illustrated by a simple stretch reflex mechanism.

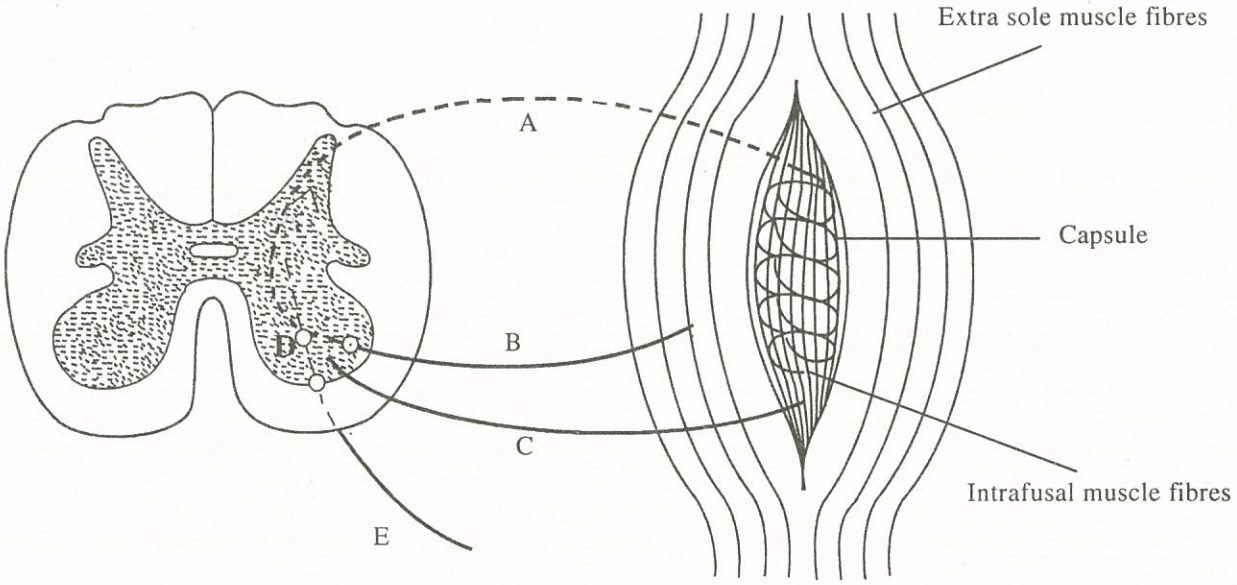


Fig. Stretch reflex

Skeletal muscles have two types of fibres. The extrafusal fibers and intrafusal fibers. The intrafusal fibers is a part of stretch reflex mechanism and has a contractile and non contractile part. The contractile part of intrafusal fibers is concerned with stretch reflex and is linked with the CNS. An afferent neurone that makes a direct synapse with the large anterior horn cell in the motor neurone pool of some muscle to which the intrafusal fibers belong.

Stretch to the muscle will therefore to the non-contractile part of the intrafusal fibre has an excitatory effect on the stretch receptor, and impulses travel along the Ia fibre to the motor neurone pool, where the large anterior horn cell is stimulated and conveys impulses to the extrafusal fibres causing them to contract while the large anterior horn cell sends an alpha efferent to the extrafusal muscle fibre. In this way, the stretch on the intrafusal fibres is reduced, the afferent fibres also influence other associated motor neurones with interneurones and it may exert an inhibitory influence on the motor neurone pools of antagonistic muscles.

The contractile parts of the intrafusal fibres has nerve supply from the motor neuron pools by means of small anterior horn cells. Impulses passing along these fusimotor fibres to the intrafusal muscle fibres will cause them to contract and exert tension upon their own noncontractile areas. Thus they are able to make the intrafusal non-contractile area more sensitive to stretch by their activity or less sensitive to stretch by their inactivity.

In other words a bias can be put upon the sensitivity of the stretch reflex mechanism, depending upon the degree of activity in the intrafusal contractile tissue and the fusimotor fibres. This bias depends upon the influences being exerted upon the small anterior horn cells which are particularly linked to the extra pyramidal pathways from the central nervous system, which in turn incorporates the balance

and postural mechanism. Through this system, the stretch reflex mechanism in muscle can be made more or less sensitive, according to the postural needs of the moment. Thus there is an interaction between excitation and inhibition between lower reflex activity and higher control.

There are at least two types of intrafusal fibres and also two types of stretch receptors, and there are at least two types of fusimotor fibres. This mechanism makes the muscle, sensitive to both velocity and degree to stretch, enables it to adjust its resting length and to be sensitive to stretch, whatever its resting length, it illustrates the simple stretch reflex mechanism and the effect of contraction of the intrafusal fibres.

Thus it may be seen that the influence of the fibres from the extra pyramidal system can adjust muscle activity to a fine degree. Since certain righting, postural and equilibrium reactions are integrated into the extra pyramidal system so it is not difficult to see that, these reactions exert their influence upon the motor neurone pools via these fibres.

These postural mechanisms and reactions make it possible to a variety of automatic responses to various stimulation. The normal human being can, however, encourage or inhibit these activities at will and can carry out activities which are not entirely automatic, but dependent upon some automatic adjustments. When these background automatic adjustments are not available, normal willed movement becomes inco-ordinate, posturally unsound and highly impossible.

TOTAL ABNORMALITIES

The following are the abnormalities of tone which leads to disturbence in movement according to the area of damage.

Atonia - (flaccidity of muscles or paralysis)

This is the result of disturbance in the lower motor neuron. The muscle or group of muscles affected may be totally paralysed, or all available neurons are put out of action. If some anterior horn neurons are involved, the muscles will show partial paralysis and will appear very weak.

Muscles are soft and flabby to the touch and non-resilient, offer no protection to the structures adjacent to it and are unable to support the joints. Because of lack of use, and lack of blood supply, atrophic changes takes place, losing the greater part of muscle bulk.

Hypotonia

It refers to reduction in the normal muscle tone. It is due to disturbance in upper motor neurone (disturbance in the function of cerebellum). It is found as a general feature and in some cases may be unilateral. The muscles appear loose with reduced tone and loss of muscle power, no respond to stretch. Tendon jerk produces pendular movements of the distal segments. Postural instability and proximal fixation for distal movements is unavailable. Balance reactions are also disturbed and when it occur, they are inclined to overcompensation.

Ataxia

Ataxia means inco-ordinated, ill timed movements, giving a deficiency of smoothness of movement. Ataxia related to hypotonia, occurs partly because of the defective postural tone and partly because of the phenomenon of dys-synergia.

Dys-synergia is loss of fluency in a movement. The teamwork between muscles is lost, giving a jerky appearance to the movements. Both stopping and starting of movements are difficult and overshooting occurs.

Ataxia may also be linked with the sensory problems and may be due to deficiency of afferent information to the cerebellum and to the cortex, making the individual unaware of his position in space. A person with the problem will show very similar symptoms to the previous form of ataxia, but he may be able to mask his problem by using his eyes and ears to access, as a substitutes for his loss of skin and joint position sensation.

Dysmetria is a term often applied to the ataxic persons. It refers to the difficulty in assessing and achieving the correct distance or range of movement.

Hypertonia

Hypertonia refers to increase in general tone of the muscles. There are two types of hypertonia, *spasticity* and *rigidity.*

Spasticity refers to abnormal increase in muscle tone which offers resistance to passive movements. It is always a part of extension or flexion synergy. Response to stretch is steady opposition to the stimulus. Extensor spasticity, in lower limb will tend to adopt hip extension, adduction and medial rotation, knee extension and foot plantar flexion, because of this abnormal pattern, weight bearing on affected lower limb is not possible. The heel is unable to touch the supporting surface and the adducted limb is unable to support the pelvis adequately.

Rigidity refers to the tightness in the muscles during voluntary movements. It is different from spasticity in that, it does not adopt the patterns of any particular reflex mechanism because of reflexes, tonic posture is not released. The 'clasp-knife' effect seen in spasticity is not available in rigidity because phasic stretch does not appear to be suddenly inhibited.

In rigidity, muscles responds to slow stretch by steady resistance, which does not particularly build up or relax off. There is a tremor, which gives a cogwheel, or lead pipe effect limbs may feel like lead when moved.

Athetosis

The persons exhibits disorder of movement because of fluctuation of postural fixation. The condition is made more severe by excitement and emotional stress. The basal ganglia is failed in its ability to encourage adequate postural fixation and fluctuations to occur. Involuntary movements occasionally occur but the symptoms are always made worse by voluntary activity.

Mixed activity

This is a series of involuntary movements, which occur in the face and limbs. They are quicker than those of athetosis and made worse by voluntary movement. Many persons show a combination of choreiform and athetoid activities, the basal ganglia is considered to be at fault in choreiform problems.

Ballismus

This term refers to wild flinging movements occur to such an extent that, it put's the persons off balance. The condition usually occurs as a result of lesion in the subthalamic region and only affects one side, it is called hemiballismus.

Dystonia

This term used to describe an increase in muscle tone that is antagonistic to the intended movement. The symptoms tend to prevent movement and may pull the individual into grotesque postures. It may affect one part of the body or the body as a whole, spasmodic torticollis is thought to be a type of local dystonia. The lesion is thought to be in the putamen.

Problems arising due to Tonal abnormalities :

Deformities

Habitual postures are due to muscle disorders, leads to adaptive shortening of some soft tissues and lengthening of others. In this way, joints may become stiff and give rise to deformities which are very difficult to correct in children with spasticity, rigidity or flaccidity. Some person may develop severe deformities if left untreated.

Vulnerability to injury

Muscle flaccidity, dys-synergia, and spasticity may all lead to abnormal joint positioning so that the joints are put on undue strain and ligaments permanently stretched. Malposturing may also lead to undue pressure on nerves and blood vessels. This may cause neuropathy, defects of venous return and oedema.

Circulatory problems

When muscle paralysis is present, pumping action of muscle is defective and venous return is reduced. Hypotonia will also give rise to defects of muscle pump activity, although the effect may not at first be noticeable because, it is more general and there is no 'normal' for comparison.

Respiratory problems

Those who have paralysis or severe hypotonia of the throat muscle will have respiratory difficulty, since the inspiratory movements tend to suck the walls of the pharynx inward.

Respiratory movements may be so impaired that it may cause difficulty in speech and coughing. Communication is therefore a problem and collection of lung secretions aggravates the problems. The person showing rigidity may have impaired respiratory function due to the difficulty in obtaining thoracic mobility.

Epilepsy

This is a recurring disturbance of cerebral activity, there is a sudden flow of discharge of impulses from neurons, which are uninhibited. If the affected area is near the reticular arousal area, consciousness may be lost. Exact events depend upon the area affected.
Seizures may be major or minor in nature but may complicate.

DISTRUBANCE OF AFFERENT INFORMATION

Diseases to the afferent pathways results in sensory disturbance. It may be due to linkage problems between thalamus and cortex or between spinal cord and cerebellum. The results of afferent disturbance vary from very slight effects to total loss of body image, disorientation and rejection of the affected area. Person with reduced afferent information faces difficulty with spatial perception, relative positions, size, heights and depths of objects may be difficult to perceive.

Appreciation of shapes, textures and weight is also important and depends upon eyes, hands and manipulative skills, in addition to skin and kinaesthetic sensation. Loss of sensory perception magnifies the loss of body image and the person may forget the affected area or even reject it.
Disturbance of sensory perception may, in some cases, be aggravated by lack of experience. If the person is prevented from experiencing certain afferent stimuli because of disability then some measure of deprivation must occur. If person experiences an abnormal sensation, he may eventually accept this as normal.

Paraesthesia is a term used to signify disturbed and diminished sensory information. It is most obvious in peripheral problems.

Dissociated anesthesia refers to the loss of appreciation of pain and temperature while tactile information is still available.

Hypolgia refers to a reduction in sensitivity to pain. When afferent information reaches the brain, it is received and interpreted. The brain processes the information so that appropriate reactions may occur. Any defect at this level makes the production of appropriate reactions difficult or impossible. The person cannot recall, learn or relearn basic patterns of movement and may be very difficult to treat.

* * *

CHAPTER 4

NORMAL MOTOR DEVELOPMENT

Introduction

Normal development is a continuous process involving vision, hearing, motor control and function, social and emotional response. Normal motor development, follows sequence of cephalocaudal development, myelination process, disappearance of some reflexes and integration of some reflexes.

Importance of normal motor development

When working with handicapped children, the information about the normal developmental sequences are extremely important.

It is important from the survival point of view, vegetative function, protection from nociceptive stimuli and the development of higher functions.

By knowing the sequence of normal motor development, one can channelise the child's development along suitable lines and encourage step by step progress without having gaps. It helps to evaluate the child's growth and development. Sequence of normal motor development helps to find out the child's developmental level and there by plan the intervention programme accordingly.

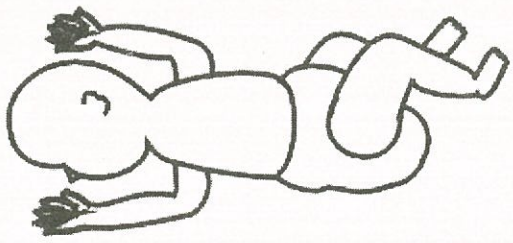
Development follows specific pattern like cephalocaudal, flexion to extension pattern, gravity dependent to gravity independent, midline to leteral and proximal to distal.

Developmental sequences of motor function can be explained in supine position, prone position and sitting.

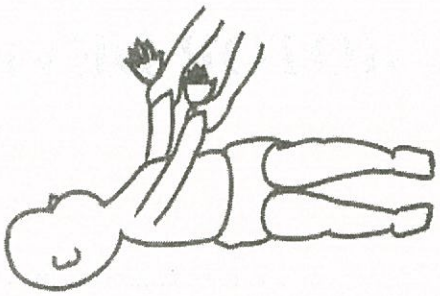
NORMAL MOTOR DEVELOPMENT IN SUPINE

0-3 months

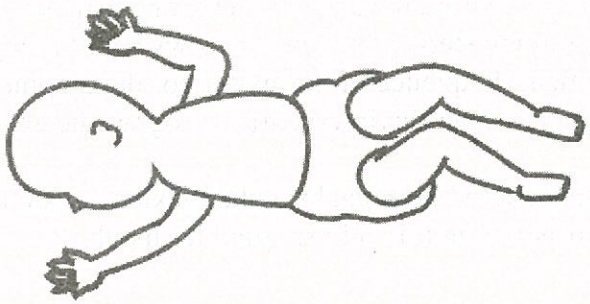
- Generalised flexion.
- Head is not in midline, turned to one side.
  No midline orientation.
- Hands fisted.
- No shoulder girdle stability.



- When lifted by holding arms, head lag is obvious.

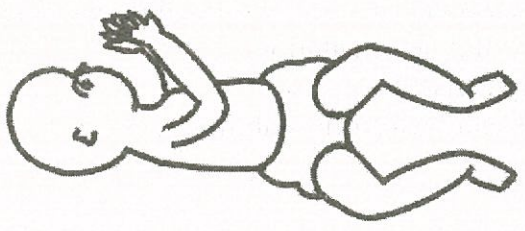


- Asymmetry in head position with the flexion of arms and legs.
- ATNR is present.
- Develops partial head control at 0-6 weeks, child extends his head upto 45^0 at 6-8 weeks, increases head extension to 90^0 at 2 months .
- Develops head control by 3 months.

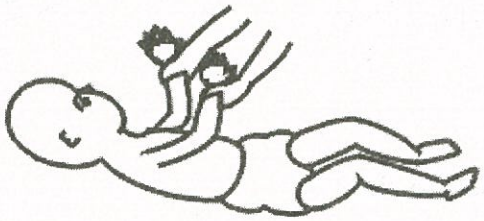


3-6 months

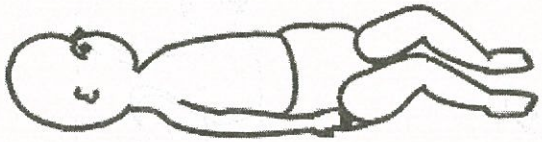
- Head and hands in midline and in line with spine.
- Symmetrical posture.
- Midline orientation.
- Develops shoulder girdle stability.



- There will be a decreased head lag, lifts head when pulled up.
- Develops trunk stability, extension of upper trunk first, then the lower trunk.

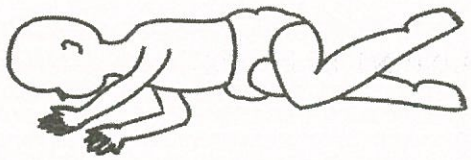


- Bridging of hips will appear.
- Some reflexes disappear.



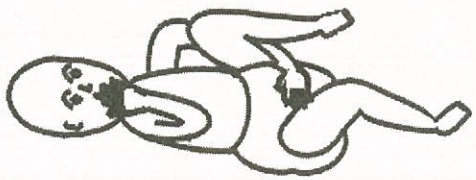
4-6 months

- Turn from supine to side(left and right), turn from supine to prone and prone to supine.
- Rolling over will begin during 6 month.



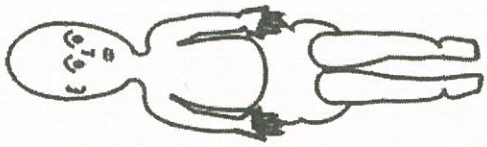
7th month

- Lies straight and symmetrically. Grasp the feet with hand.
- Develops eye foot coordination and eye hand coordination.



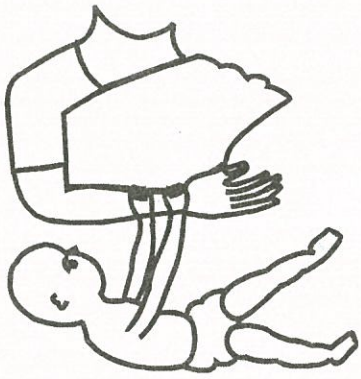
8th months

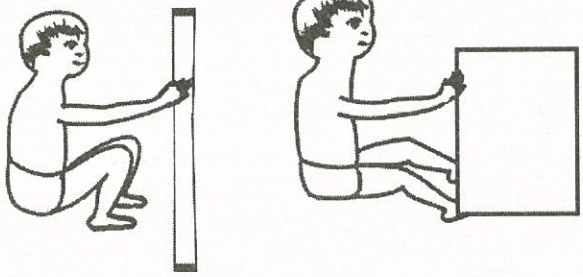
- Lies straight.
- Develops pelvic girdle stability.
- Develops kicking movements of legs.



9-12 months

- Holds support and pulls self to sitting.
- Pulls himself to standing by holding support.



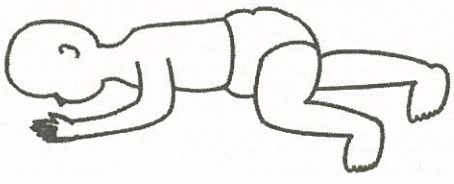


98% children go through a series of prone development. Only 2% children goes supine development. The children goes through the series of supine development shows delay in development.

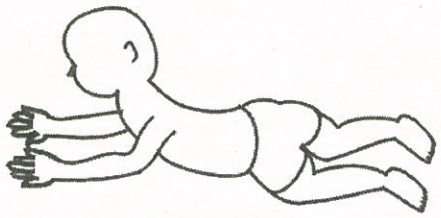
NORMAL MOTOR DEVELOPMENT IN PRONE

0-3 months

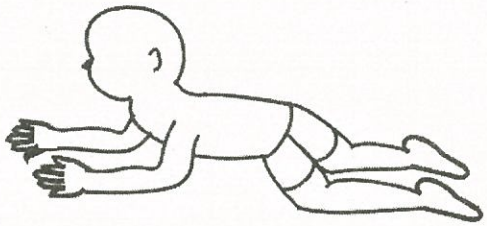
- Asymmetrical posture with generalized flexion and buttocks high. Turns to one side.
- Lifts head momentarily.
- The child attains the capacity, to lift his head but occasionally drops.
- Extension of head and neck appears.



- Head raise and hold will develop.
- Turn to prone position, turn to side either left or right then turn to prone.

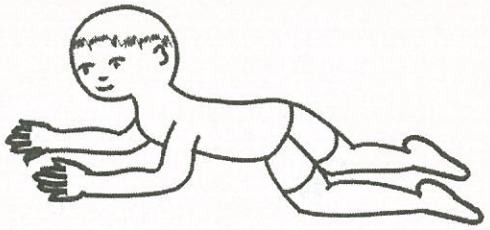


- Head raise and weight on forearms.
- Comes to forearm prone lying position. Weight bearing on forearms.

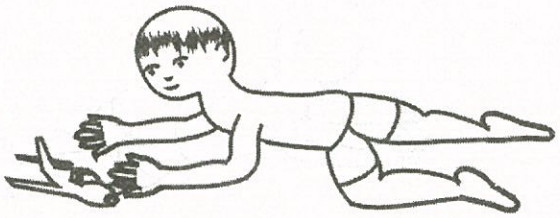


3-6 months

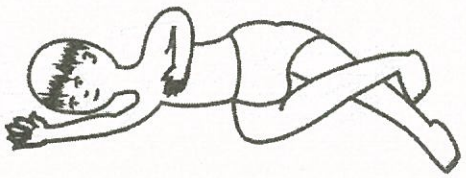
- Weight bearing on forearms and knee.
- Kicking movement of legs should begin and brings legs under abdomen. Tries to bear weight on forearm and knees.
- Transfers weight from front to back and vice versa. Transfer weight from one side to another side of the body.



- Lean on one forearm and reach with other hand for toy.
- From bilateral forearm weight bearing to unilateral forearm weight bearing.

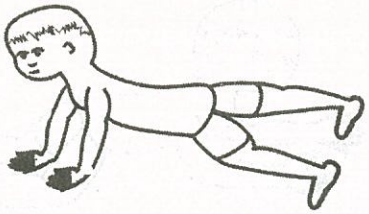


- Roll from prone to supine and supine to prone, trunk segmental rotation absent.
- Develops trunk extension and trunk stability.
- Takes leg inner abdomen.

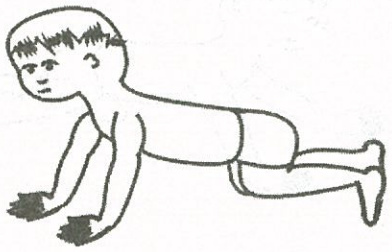


6-9 months

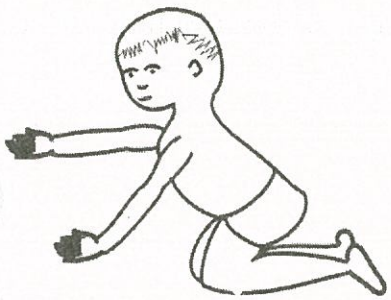
- Weight bearing on extended hands and knees.
- Develops trunk stability and pelvic girdle stability.
- Weight is taken on both hands and lifts the chest.
- Weight bearing on extended hands and legs is developed upon making him standing.
- Rolling starts from prone to supine.



- Weight bearing on hands and knees.
- Transfer body weight from right side to left side and left to right.
- Front and back movements of trunk (rocking movements of trunk).

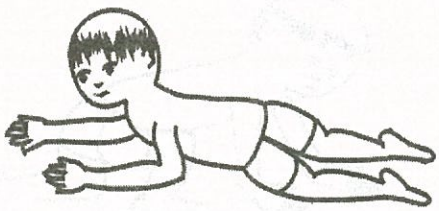


- Leaning on one hand and reach with the other (7th month). Takes weight on one hand and frees other hand for reach.

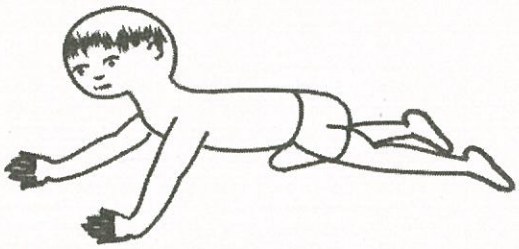


During 9-10 months

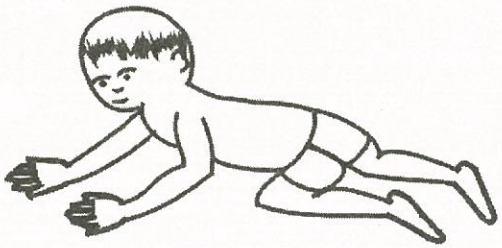
- Extend head, shoulder, hips-pivot prone position.
- Weight transference on hands improves.
- Starts taking weight on legs when supported while standing.



- Hands and knees weight bearing, lift arm, leg or both.

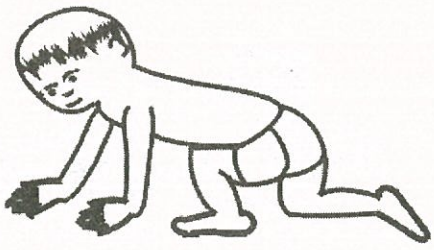


- Rise to crawl position.
- Develops alternate rhythmical, reciprocal movements of upper limb and lower limb.
- Crawling is a primitive form of locomotion. Child moves from one place to another.

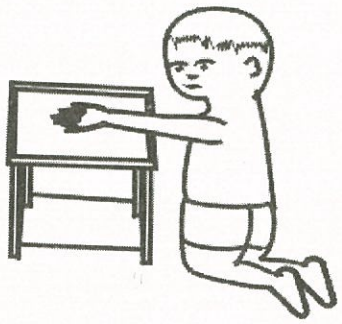


11-12 months

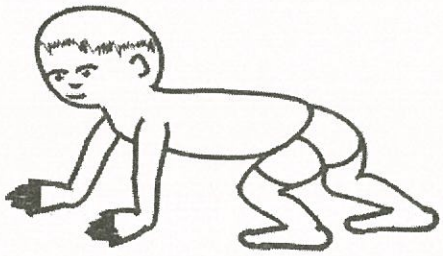
- Initiate half kneeling with weight on hands.
- Tries to come on knees, weight bearing on knees.



- Upright kneeling.
- Initially with support then without support.

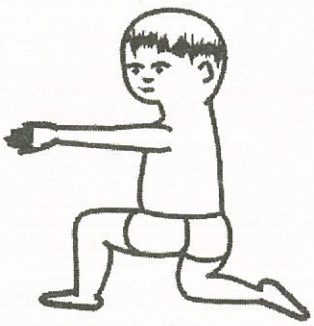


- Bear walking (on extended arms and legs).
- By this time the child will have pelvic or hip girdle stability.



12-15 months

- One leg forward and kneeling on other leg - half kneeling.
- Initially with support and then without support and comes to walk standing and walking.
- Initially bilateral, then unilateral, hold object while coming to standing.
- The average population start independent walking at the age of 15 months.



NORMAL MOTOR DEVELOPMENT IN SITTING

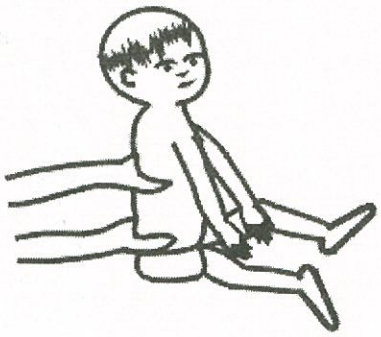
0-3 months

- Cannot assume sitting posture. Cannot sit unsupported. Sits with flexion and uncontrolled head position.
- Head lag.
- If pulled to sitting position, total flexion pattern occurs.

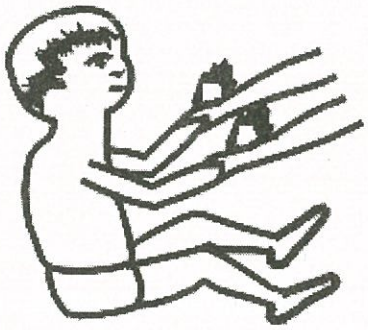
- Decreases flexion and development of vertical head control.
- Cannot sit because pelvic girdle and trunk stability has not yet developed. If pulled to sitting the child assumes flexion posture.

4-6 months

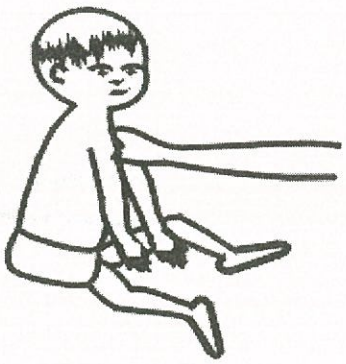
- Sitting lean on hands, flattening of upper back.
- Sits on lower part of spine because trunk and pelvic girdle stability not yet developed.



- Sits with less support, back becomes straight, legs loosely extended and externally rotated.



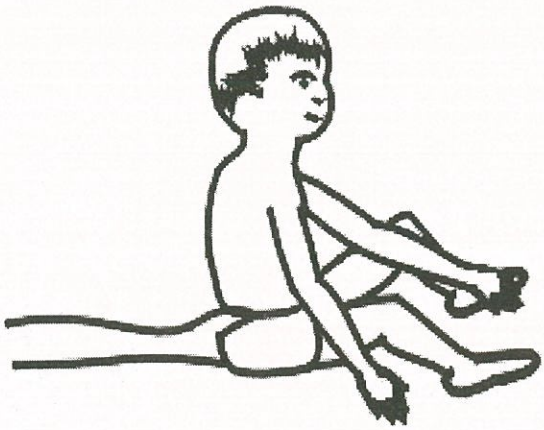
- Sits leaning on hands, hips abducted, flexed and externally rotated. Support may or may not be required. Because of development of protective extension reaction of arms.
- Flexion posture, round back, weight bearing on lower part of spine.



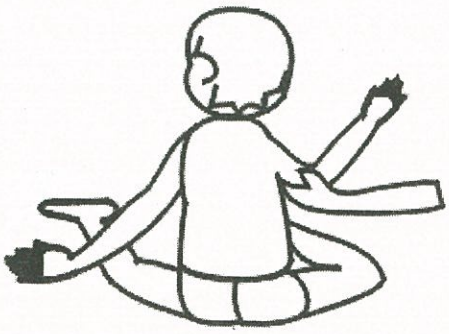
- Sits in baby chair with back straight, resting on back of the chair.

6-9 months

- Sits leaning on one hand and lifts other hand for play.
- Initially takes support of both hands(bilateral) and gradually unilateral.

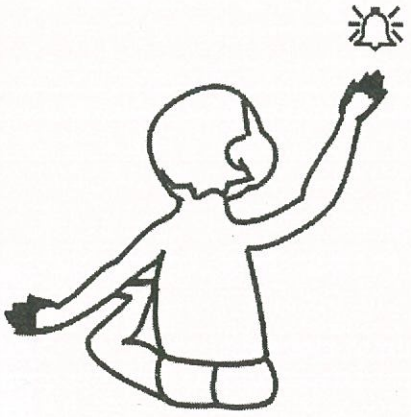


- Develops protective extension reaction of arms forwards, sideways and backward starts weight bearing on hips because of development of hip and pelvic girdle stability.



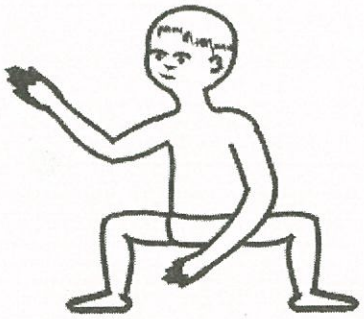
- Sits with hand support on the ground.

- Sits and reaches in all directions with one hand support.
- Initially uses only one hand for reaching and later without any support.
- Able to lift his buttocks with hands on ground.
- Moves frames from one position to other by lifting pelvis and pushes in a forward direction(bottom shuffling).



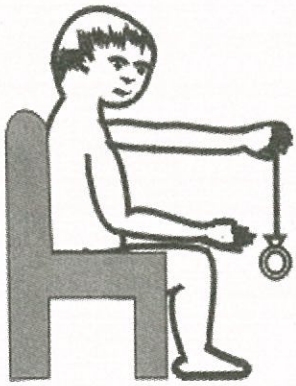
9-12 months

- Sits, turn and reach in all directions without hand support.



- Sits in various positions and pivots. Like side sitting, "W" sitting, long sitting.
- Usually hips abduction and knees flexion.

- Sits on a chair and play.



- Rises from sitting and comes to all seating position.
- Able to stand with or without support.
- By holding support pulls himself to standing position.

FINE MOTOR DEVELOPMENT

Hand functions

Functions of hand is important in performing skilled activities, as well as finer movements, to carry out activities of daily living. The development of hand functions depends upon the neck stability, shoulder girdle stability and arm control.

Basically there are mainly three components of hand functions.

1. Reach
2. Grasp
3. Release

First the infant has to learn how to reach in various direction.

Reach

Reach means the infant approaches for an object with his upper limb and visual acuity. (eye hand co-ordination)

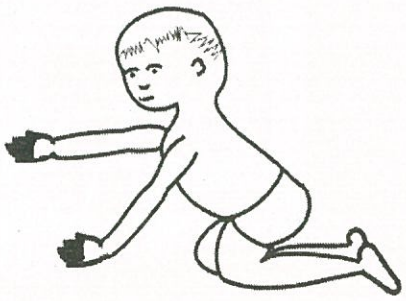
0-3 months

- In supine positions, when the object is held in front of the infant, he reaches for an object (by flexing his arm at shoulder, extending elbow and slightly wrist), within his visual acuity (reaches in forward direction while in supine position).

6-9 months

- During this time the child learn to sit independently and also the child develops and uses upper limb to reach in forward, backward and sideways direction with the developed protective extension reaction of arms in forward, sideways and backward direction.

  6-7 month forward, 7-8 month sideways, 8-9 months backward directions.



Use of upper limb initially unilateral and then bilateral

8-10 months

- Reaches in vertical direction either in kneeling position or by extending the arm in vertical direction, holds objects and tries to stand.

10-12 months

- Develops reaching in upward direction. Initially the child uses one hand for support and uses other hand for reach activity, once he masters the balance, he reaches with the two arms(bilateral).

Grasp

Grasp means holding the objects.

0-3 months

- Hands are lightly clenched, unable to hold anything with hand.
- Fingers are released when arms are extended.
- Hand will be loosely fisted.
- Grasp or palmar grasp reflex is present-(thumb across the palm of the hand and fingers are fisted upon it). (Thumb in plam deformity).

4 months

- Able to retain objects placed in hand.
- Develops palmar grasp.

The different types of grasp are :

0-5 months

- 0-3 months grasp reflex
- 4-5 months palmar grasp

1. Palmar grasp reflex :

- It is the primitive reflex present normally upto 3 to 4 months(means thumb across the palm of hand and finger upon it).
- Initially thumb is across the palm of the hands and the fingers are flexed on thumb. Later the child develops palmar grasp with thumb against the dorsum of the four fingers.

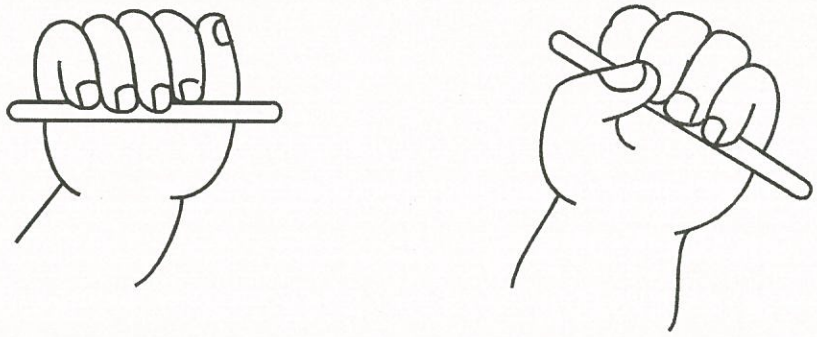


Fig. Palmer grasp

5-7 months

2. Ulnar grasp means (little finger side). (The child grasp the object by turning hand towards little fingers side).

- It develops in the 6th month.
- Palmar grasp changes to ulnar grasp.
- This grasp is weak grasp.

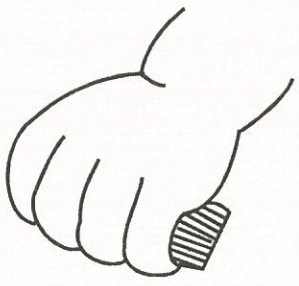


Fig. Ulnar grasp

7-9 months

3. Radial grasp (thumb side)

- It develops at 7th month.
- Ulnar grasp changes to radial grasp.
- Child turn the hand towards thumb side and holds the object.
- The object is held against the strong hold of opposition of thumb, and flexion of the other four fingers towards thumb side of the hand.
- This is a strong grasp.

Fig. Radial grasp

4. Functional grasp : It is 20^0 extension of wrist, 90^0 flexion of metacarpophalangeal and extension or flexion of interphalangeal joint and opposition of thumb.

- It develops after 10th month.
- The infant develops extension at wrist joint which indicates the graduation to pincer grasps such as pad to pad.
- Tip to tip
- Pad to side
- Tripod grasp

Pad to pad grasp develops during 12th month.

- The object is held between the pads of the index finger and thumb. eg. holding a paper

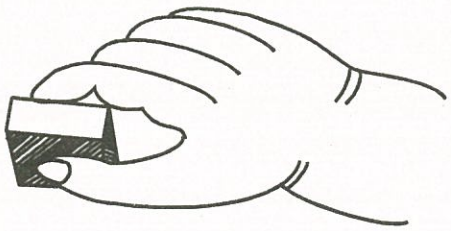


Fig. Functional grasp

Tip to tip grasp develops during 13th months.

- The object is held between the tips of the thumb and index finger.
  eg. picking up a small object from ground.

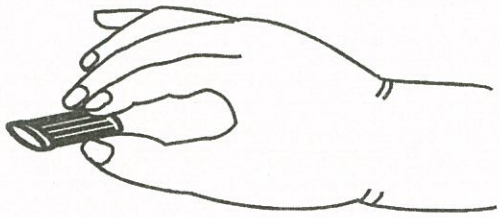


Fig. Tip to Tip grasp

Pad to side grasp develops during 14th months.

- The object is held between the pads of thumb and side of the index finger.
  eg. holding key

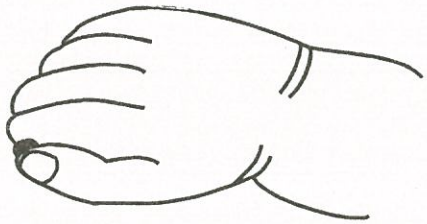


Fig. Pad to side grasp

Tripod - means use of three fingers(middle, index fingers and thumb) in opposite direction to each other. The functional tripod is evident at the age of 17 months and after wards it changes to a matured tripod grasp by 24 months.
eg. holding a pen.

Fig. Tripod grasp

Release

Release means, the objects are released by loosening the grasp.

5-7 months

- Releases the objects involuntarily.
- There is no control over release.
- Drops objects
- Presses hard against the object before releasing.

8th months

- Develops control over hand and fingers and releases objects with voluntary control.

Mature grasp

These grasp need maturity of the hand function, so child develops maturity in later stages of development. The hand and fingers will adjust according to the shape and size of the object and hold them as securely as possible. By this time, opposition movement of metacarpophalangeal joints of thumb develop to touch tip of the thumb towards the tip of the fingers. The following are the various types of grasps used in activities of daily living.

a. Cylindrical grasp :

- It requires flexion of finger and thumb in order to maintain the grasp on the object.
- It acquires almost the functional position of the hand.
- It is also called as power grasp.

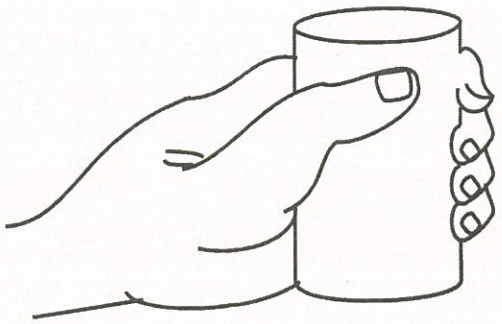


Fig. Holding heavy object - Cylindrical grasp

b. Hook grasp :

- It is primarily the function of fingers.
- The finger flex at interphalangeal joint and surround the object(only with the finger).
  eg. carrying a suitcase.

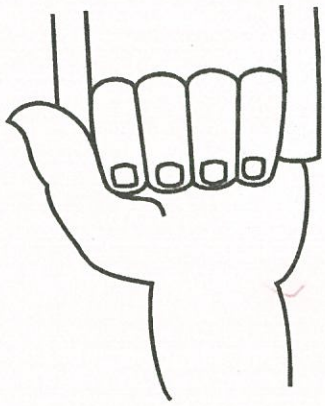


Fig. Holding a hook - Hook grasp

c. Spherical grasp:

- The object with spherical shapes such as balls are held with this grasp.
- The object are held in the palm with hand pressure by the flexion of fingers around object.

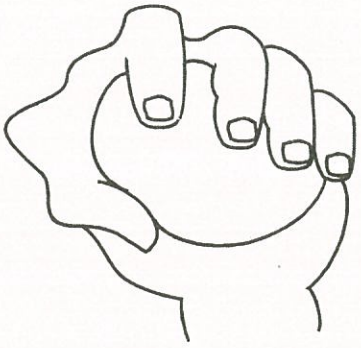


Fig. Holding a cricket ball - Spherical grasp

d. Plate grasp :

- The flat objects such as plates are held by this grasp.
- The objects are held between the fingers and the thumb.
- The finger and thumb are flexed only at the metacarpophalangeal joints.

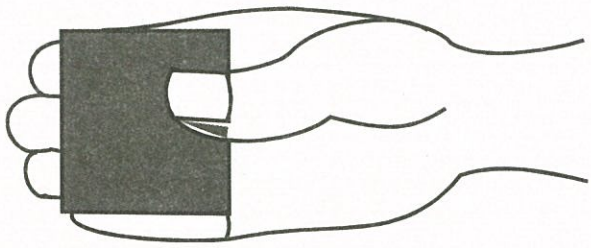


Fig. Plate grasp

e. Key and pincer grasp:

- These grasps are used to hold small objects.
- The objects are held between the pads of four fingers and the pad of the thumb.

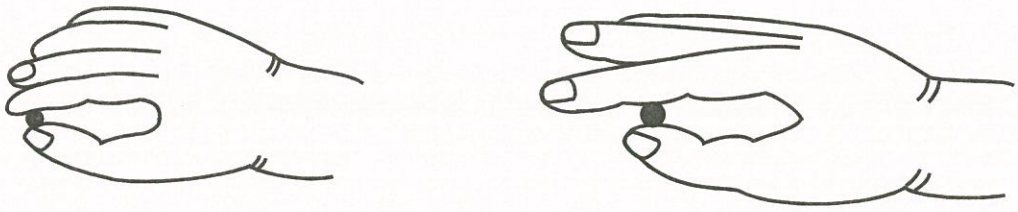
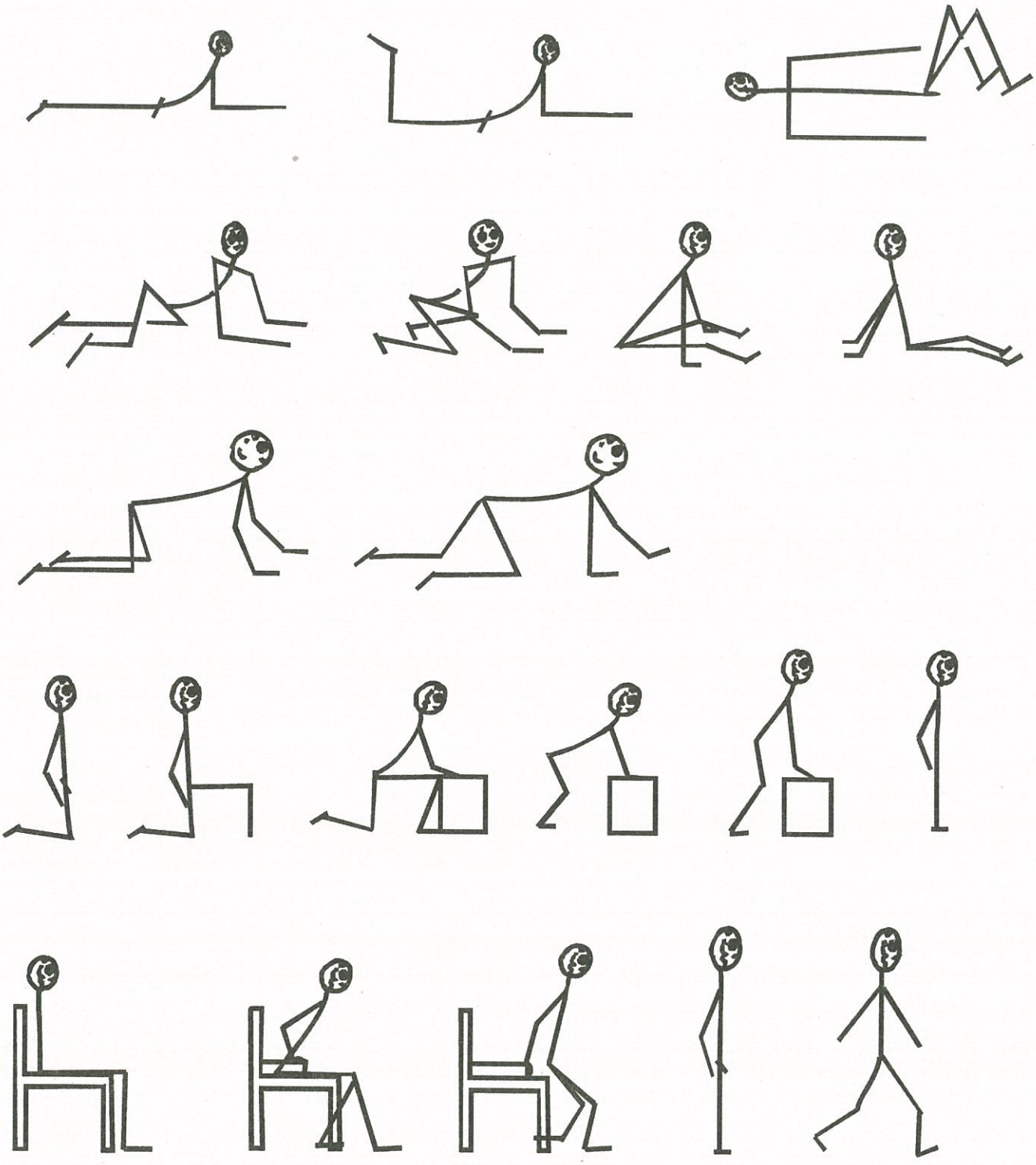


Fig. Holding key of lock or opening lock - Pincer grasp

STAGES OF THE GROSS MOTOR DEVELOPMENT



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CHAPTER 5

PRIMITIVE REFLEXES

Definition : A Reflex is an involuntary stereotypical motor response to sensory stimulus. Reflexes are specific and predictable. They are purposeful and adaptive. They depend on intact neural pathway between the stimulation point and responding organ(brain, motor cortex). This pathway is called reflex arc.

The essential neural portions of a reflex, include a sensory and motor neuron and connecting neuron. Several structures are involves.

1. A receptor: Special sensory organ, cutaneous end organ, as neuromuscular spindle, stimulation of which initiates an impulse.

2. An afferent (or sensory) neuron: Which transmits the impulse through a peripheral nerve to the central nervous system where the synapse occurs with an internuncial neuron.

3. An internuncial neuron: Which relays the impulse to the efferent nerve.

4. The efferent neuron: Which pass outward in the nerve trunk, delivers the impulse to an effector.

5. An effector : Such as a muscle or gland that produces the response.

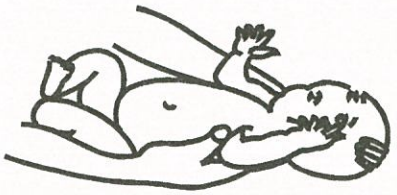
Interruption of the reflex arc at any point will interrupt or disturb the response.

Importance of reflex

The instinctive motor behaviour at lower stages is largely governed by reflexes. Human, motor behaviour is more a matter of exposure; and reflexes are subordinated as basic defense mechanisms. The reflexes are extremely important in the diagnosis and localization of neurological lesions. Reflexes are acting at specific levels of nervous system. They are protective in nature, important from survival point of view. Initially reflex is immature and later matures and gains control from nervous system. Repetition of reflexes helps to make the person perfect in that activities which were reflexive. Some reflexes disappear at particular age and some reflexes develops control from the nervous system. From the development point of view, some reflexes should disappear and some reflexes should mature and integrate.

Developmental reflexes

These reflexes are normally present during infancy. After integration into the CNS, they become part of the motor behaviour, underlying normal motor control and helps in the development of movement. There are three categories in developmental reflexes.



1. Primitive reflex / Spinal reflexes

a. Reflex - Flexor withdrawl
Stimulus - Pinprick to the sole of the foot.
Response - Toes extend, foot dorsiflexes, entire leg flexes uncomfortably.
Normal - 1-2 months
Significance - Persistence will interfere with baby's ability to stand and step.

b. Reflex - Crossed extension
Stimulus - To the balls of foot of extremity fixed in extension.
Response - Opposite lower extremity flexes, then adducts and extends.
Normal - 1-2 months
Significance - Persistence will interfere with baby's ability to stand and step.

c. Reflex - Moro reflex (Modified form of startle reflex.
Stimulus - With body in supine lying, lift head and let it drop back in extension.
Response - Wide abduction and extension of arms with hands open followed by adduction of arms.
Normal - Upto 5-6 months.
Significance - Persistent of this primitive reflex interferes with the babies stability and hand function, rolling over and asymmetry of body.

d. Reflex - Startle
Stimulus - Sudden loud or harsh noise.
Response - Sudden extension and abduction of arms.
Normal - Persists
Significance - Disappearance interferes with the protective extension reaction of arms.

e. Reflex - Plantar grasp
Stimulus - Press the sole of the feet below the toes.
Response - The baby flexes or claws toes.
Normal - 0-9 months.
Significance - If present beyond the normal age limits, it interferes with the child's ability to bear weight on his feet.

f.	Reflex	-	Palmar Grasp Reflex
	Stimulus	-	Put your finger on child's palm, from ulnar side.
	Response	-	The baby will fist hand. The thumb is across the palm of the hand and fingers are fisted upon the thumb. The child makes involuntary grasp, difficult to open.
	Normal	-	0-4 months
	Significance	-	Persistence of this reflex will interfere with voluntary grasp and release.
g.	Reflex	-	Galant or trunk incurvation.
	Stimulus	-	The child in prone lying position, stroke the back just lateral to the spine on both sides (in between scapula and vertebral column).
	Response	-	The child will flex his trunk laterally to the side of the stimulus.
	Normal	-	0-2 months
	Significance	-	Persistence of this reflex will interfere with the development of baby's trunk stability, symmetrical posture and scoliosis.
h.	Reflex	-	Placing reaction.
	Stimulus	-	Hold the baby upright and rub the anterior aspect of his tibia, or dorsum of foot against a table.
	Response	-	The baby responds by flexing knee, lift leg and put it on the surface of the table.
	Normal	-	Remains throughout life.
	Significance	-	This reflex is present throughout life, although it is modified in adults and comes into play when we step in dark room.
i.	Reflex	-	Automatic walking. (stepping)
	Stimulus	-	Hold the baby in standing position, tipped forwards.
	Response	-	The baby initiates stepping with flexion and extension of legs.
	Normal	-	0-2 months.
	Significance	-	persistence interferes with the balance in standing.
j.	Reflex	-	Sucking reaction.
	Stimulus	-	Put your little finger in the mouth.
	Response	-	A strong sustained sucking action.
	Normal	-	6-9 months.
	Significance	-	Absent at birth, indicates neurological dysfunction, hypotonia, immaturity, bulbar palsy.

k. Reflex - Rooting reflex.
Stimulus - The corner of the mouth is stroked.
Response - The child turn towards the side of stroking.
Normal - Upto 2 months.
Significance - Absence at birth indicates neurological dysfunction, hypotonia, immaturity, bulbar palsy.

l. Reflex - Parachute reaction sideways.
Stimulus - With the baby in unsupported sitting, gently push to the right and left.
Response - The child reacts by extending his arms sideways to save himself.
Normal - Develops with in 6-9 months of age saves and protects child from falling down.
Significance - Absence of this reflex indicates cerebellar lesion.

m. Reflex - Parachute reaction forwards.
Stimulus - With the baby in sitting, push forward.
Response - The baby extends arms forwards to save himself.
- Usually rotates body and uses one arm to prevent falling.
Normal - Develops with in 7-8 months.
Significance - Absence of this reflex indicates cerebellar lesion.

n. Reflex - Parachute reaction backwards.
Stimulus - With the baby in sitting, push backward.
Response - The baby extends arms backwards to save himself.
Normal - Develops with in 10th month.
Significance - Absence of this reflex indicates cerebellar lesion.

2. Tonic / brainstem reflexes.

a. Reflex - Asymmetric Tonic Neck Reflex (ATNR).
Stimulus - With baby in supine, turn the head to one side.
Response - Extension of arm and leg on face side. Flexion of arm and leg on skull side.
Normal - Upto 0-4 months. Starts fading away by the age of 6 months.
Significance - If it persists(beyond 4 months) it interferes with the midline orientation of head, arms symmetry of body and the child will have feeding problem prevents bilateral hand activities and rolling over.

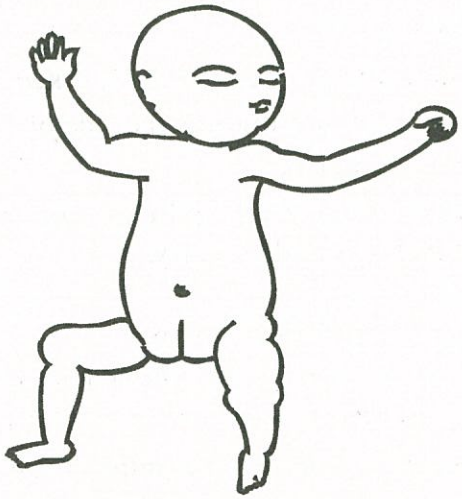


Fig. Asymmetric tonic neck reflex

b.	Reflex	-	Symmetric Tonic Neck Reflex (STNR).
	Stimuli	-	With child in supine and prone, flex and extend the head.
	Response	-	With head flexion; flexion of arms and extension of legs occurs. With head extension; extension of arms and flexion of legs will occur.
	Normal	-	Upto 0-8 months.
	Significance	-	Persistence prevents the baby from developing coordinated crawling, upright posture and sitting on chair.
c.	Reflex	-	Symmetric tonic labyrinthine reflex.
	Stimulus	-	Supine or prone.
	Response	-	In supine, extensor tone increases(extension of all limbs, trunk and neck). With prone, flexor tone increases(flexion of all limbs and trunk).
	Normal	-	Upto 6 months.
	Significance	-	If it persists (beyond 6 months) it interfere with the baby's ability to lift his head from the mat i.e. against gravity and verticalization.
d.	Reflex	-	Positive supporting.
	Stimulus	-	Contact to the ball of the foot in upright standing position.
	Response	-	Rigid extension of the lower extremities.
	Normal	-	Upto 6 months.
	Significance	-	Persistance beyond six months leads to delay in standing and difficulty in walking
e.	Reflex	-	Negative support.
	Stimulus	-	Hold the baby upright in a standing position with feet touching the supporting surface.

	Response	-	The baby will respond by flexing his limbs.
	Normal	-	3-5 months.
	Significance	-	If present abnormally, this will interfere with the baby's ability to bear weight actively on extended legs, assume and maintain standing position.

f.	Reflex	-	Associated reactions
	Stimulus	-	Resisted voluntary movement in any part of the body
	Response	-	Involuntary movements in the resting extremity.
	Normal	-	Upto 8-9 years
	Significance	-	Persistence beyond nine months leads to asynchronus walking pattern. e.g. Clenching the teeth while opening the tight lid of the bottle.

3. Mid brain /cortical reflexes

a.	Reflex	-	Neck righting reaction.
	Stimulus	-	Passively turn the head to one side when the baby is in supine lying position.
	Response	-	The child will turn to one side as a whole(straight or erect symmetrical posture).
	Normal	-	Upto 0-5 months
	Significance	-	Persistence of this reflex interferes with correcting the parts of the body in relation to each other and symmetrical posture.

b.	Reflex	-	Body righting reaction
	Stimulus	-	Rotate upper or lower trunk segment in supine
	Response	-	Body segment not rotated follows the direction of rotated body segment
	Normal	-	Upto 5 years
	Significance	-	Persistence of this emerging reflex interferes with the baby's ability to isolate the movement of the pelvis, trunk and head from one another and prevents lateral rotation and flexion of trunk to the other side.

c.	Reflex	-	Body righting reaction, acting on head.
	Stimulus	-	Place child in supine or prone position.
	Response	-	Head orients to vertical position.
	Normal	-	Upto 5 years, later controlled and integrated.
	Significance	-	If it persists, it interferes with the controlled movement of the head.

d.	Reflex	-	Protective extension.
	Stimulus	-	Displace centre of gravity outside the base of support.

	Response	-	Arms and legs extend and abduct to support and protect the person from falling.
	Normal	-	Persists
	Significance	-	If it is absent, it interferes with the protective reaction of upper and lower limbs.
e.	Reflex	-	Equilibrium reaction-tilting.
	Stimulus	-	Displace the centre of gravity by tilting or moving the support surface gradually.
	Response	-	curvature of the trunk towards the upward side along with extension and abduction of the extremities on that side.
	Normal	-	Persists
	Significance	-	If it is absent, balance reactions are not developed.
f.	Reflex	-	Equilibrium reaction-postural fixation.
	Stimulus	-	Applying a displacing force to the body, altering the centre of gravity in its relation to the base of support.
	Response	-	curvature of the trunk towards the external force with extension and abduction of extremities on the side to which force was applied.
	Normal	-	Persists
	Significance	-	If it is absent, balance reactions are not developed.
g.	Reflex	-	Labyrinthine head righting.
	Stimulus	-	Occlude vision, alter body position by tipping body in all directions.
	Response	-	Head orients to vertical position.
	Normal	-	Persists
	Significance	-	If it is absent it interferes orientation of head to the change in the body posture.
h.	Reflex	-	Optical righting
	Stimulus	-	Alter body position by tipping body in all directions.
	Response	-	Head orients to vertical position.
	Normal	-	Persists
	Significance	-	If it is absent it interferes, orientation of head to the change in the body posture and also vision.
i.	Reflex	-	Balance reaction.
	Stimulus	-	Position the child on unstable surface and move him.
	Response	-	child will try to maintain his position.
	Normal	-	Persists.
	Significance	-	If absent, it interferes with the ability to balance on uneven surfaces.

Deep tendon reflexes

Deep tendon reflexes are elicited by tapping over the muscle tendon with a standard reflex hammer or with the tips of the fingers. The reflexes can be graded simply as *absent* (when there is no muscle contraction), or *diminished* (when there is a slight or sluggish muscle contraction with slight joint movement) or *Exaggerated* (when there is a clearly visible, brisk muscle contraction with moderate joint movement or abnormal strong muscle contraction with sustained clonus).

Significance of abnormal reflex responses

- Diminished or absent reflexes indicate lesion that interrupts the reflex arc. e.g. peripheral nerve disease, grey matter of spinal cord involvement, cerebellar disease, etc.
- Exaggerated deep reflexes indicate lesion of motor cortex or pyramidal tracts.

Deep tendon reflexes can be elicited at the following tendons

a. Reflex - Jaw- (trigeminal nerve)
   Stimulus - On sitting, jaw relaxed and slightly open tap downward on the top of the finger in a direction which causes the jaw to open.
   Response - Jaw rebounds.

b. Reflex - Biceps (C5-6)
   Stimulus - On sitting, arm is supported in abduction, elbow is flexed. Tap directly on the tendon.
   Response - Elbow flexes.

Fig. Biceps jerk

c. Reflex - Triceps(C7-8)
Stimulus - On sitting, arm is supported in abduction, elbow is flexed. Tap directly on the tendon.
Response - Elbow extends.

Fig. Triceps jerk

d. Reflex - Supinator jerk.
Stimulus - Arm is supported in abduction. Elbow in flexion and forearm in midprone tap directly on the tendon.
Response - Forearm supinates.

e. Reflex - Brachioradialis jerk.
Stimulus - Shoulder in abduction and elbow in flexion. Tap directly on the tendon just above the wrist.
Response - The forearm comes to mid prone position and elbow flexes.

f. Reflex - Knee jerk(L2-4)

Stimulus - On sitting knee is flexed and unsupported. Tap directly on the tendon of quadriceps

Response - Knee extends

Fig. Knee jerk

g. Reflex - Ankle jerk(S_1- S_2)

Stimulus - On prone foot over the end of the plinth with knee flexed and foot held in slight dorsiflexion. Tap tendon just above its insertion on the calcaneous.

Response - Foot plantar flexes.

Fig. Ankle jerk

Superficial cutaneous reflexes

Superficial cutaneous reflexes are elicited with a noxious stimulus usually a light scratch applied to the skin. The expected response is brief contraction of muscle innervated by same spinal segments receiving the afferent inputs from the cutaneous receptors.

a.	Reflex	-	Plantar (S_1- S_2) (Babinski sign).
	Stimulus	-	Stroke with the pin along the lateral border of the foot and across the ball of the foot.
	Response	-	Flexion of great toe and other toes.
	Abnormal	-	Dorsiflexion of big toe with fanning of the lateral four toes. Indication of corticospinal dysfunction.

Fig. Plantar reflex

Fig. Plantar reflex

b.	Reflex	-	Chaddock sign
	Stimulus	-	Stroke around lateral side of ankle and up lateral aspect of foot to the base of the little toe.
	Response	-	Flexion of great toes.
	Abnormal	-	Dorsiflexion of big toe with fanning of the lateral four toes. Indication of corticospinal dysfunction.

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CHAPTER 6

THERAPEUTIC TECHNIQUES

There are various neurophysiologically and neuro developmentally based approaches for the treatment of person with motor control problem. Some of them are Rood's approach, Bobath techniques and Proprioceptive Neuro Muscular Facilitation (PNF), vojta therapy and others.

1. **Rood's Approach :** It is devised by Margaret Rood which is based on the basic concept that "Motor patterns are developed from fundamental reflex patterns present at birth which are utilized and gradually modified through sensory stimuli until the highest control is gained on the conscious cortical level".

There are four major components of Roods theory.

1. The controlled sensory input is used to elicit muscular response reflexively.

2. Muscular response reflexively obtained is used in developmental patterns in an effort to develop supraspinal control of those responses.

3. As movement is purposeful, activity is used to demand a purposeful response from the person in order to subcortically elicit the desired movement pattern. Here the cortex does not direct each muscle individually, but the attention is drawn to the end goal or purpose, not the movement.

4. Repetition of sensorimotor responses is necessary for learning.

Methods for sensory stimuli to elicit muscular responses

The following methods have been founded to be facilitating or inhibiting.

Facilitation Methods

Tactile stimulation : It can be done in two ways -

Fast brushing: It refers to brushing of the hairs or skin over muscle by using a soft camel paintbrush. It is effectively done on the skin of the dermatome served by the same spinal segment, as those muscles in which the therapist is attempting to sensitize the muscle spindles. It is done for 30 seconds. Fast brushing of the skin over the distribution of the posterior primary ramie adjacent to the vertebral column facilitates the tonic, deep muscles of the back, not the superficial ones. Fast brushing over the skin of the rest of the body, supplied by the branches of

primary rami, facilitates a tonic response of the superficial muscles of the dermatomes corresponding to the muscles which are brushed.

Precaution

Brushing of pinna of the ear activates the vagus nerve which slows the heartbeat, produces bronchial constriction and bronchial secretion. Brushing over S_2 - S_4 will cause bladder retention.

Light stroking: Light touch of stroking, activates the low threshold, 1**a** - size sensory fibers, to activate reciprocal action of the superficial phasic or mobilizing muscles. Light stroking of the dorsum of the webs of fingers or toes or the palms of the hand or the soles of feet, elicits the phasic withdrawl motion of the stimulated limb. Repetitive stimulus to these areas will result in crossed extension reflex pattern.

Thermal stimulation is done by using ice.

C - icing is a light threshold stimulus used to stimulate postural tonic responses via the sensory fibers. It is done by pressing the ice cube in place for three to five seconds, then wiping away the water.

A - icing is the application of quick swipes of ice cube to evoke a reflex withdrawl, similar to the response of light touch. It is used with flaccid, types of muscles only. A - icing of the upper right quadrant of the abdomen in the dermatomal representation for T_7 - T_9 will result in stimulation of the diaphragm.

Touching the lips with ice opens the mouth (a withdrawal response), but ice applied to the tongue and inside the lips closes the mouth.

The other forms of stimuli are :

1. *Proprioceptive stimuli :* This stimulus last only for few seconds as long as the stimulus is applied. Quick stretch is low threshold stimulus which when applied to light work muscle, a physiological flexor or adductor, facilitates the muscle and inhibits its antagonist. *Tapping* of the tendons or the belly of the muscle done with the finger tips produces the stretch reflex.

2. *Pressure* on the muscle belly by pressing manually elicits a stretch on the spindles.

3. *Stretch* to the intrinsic muscles of the hand or the foot causes facilitation of co- contraction of the proximal stabilizer muscles.

4. *Resistance* is a form of stretch in which many or all of the spindles of muscles are stimulated.

5. *Eccentric contraction* against resistance provides a great amount of stretch.

6. *Joint compression* facilitates co-contraction of muscles around the joint.

7. *Weight bearing position* of prone on elbows, prone on hands, quadruped, and standing stimulates proprioceptors.

8. *Pressure over bony prominences* have both facilitatory and inhibitory results. Example, pressure over the lateral aspect of the calcaneous facilitates the dorsiflexion while inhibiting the calf muscle to allow dorsiflexion and vice - versa.

9. *Auditory and visual stimuli* can be used to generally facilitate or inhibit the central nervous system of the person.

Inhibitory Methods

- Joint compression is used to inhibit the spastic muscles.
- Slow stroking of the posterior primary rami inhibits muscle tone in general and relaxes the person.
- Slow rolling of the person from supine to side lying is generally inhibitory.
- Pressure on the tendinous insertion of a muscle inhibits the muscle through the receptors located under the tendinous insertions.
- The extrinsic flexors of the hand may be inhibited by applying constant pressure for the entire length of the long tendons.
- The extensors, flexors of the hand may be inhibited by applying constant pressure for the entire length of long tendons.

Motor patterns and muscle types

Two more sequences that Rood identified.

1. Sequence one

a) *Light work muscles* lie superficially, laterally or distally and have tendinous origin and insertion. They are multiarthrodial and under more voluntary control and do phasic work. They are activated by light stretch or low threshold exteroceptor stimulation and inhibited by unresisted contraction. Rood identified the light work or mobilizing muscles as flexors and adductors but this includes multiarthrodial extensors also. These muscles are termed physiologic flexors.

b) *Heavy work muscle* located deep close to the joint and are uniarthrodial. They are located proximally and medially. They are tonic stability muscles, and antigravity extensor muscles capable of prolonged, sustained contraction. They are under reflex control and are activated by heavy resistance or maintained stretch and high threshold receptor stimulation. They are

primarily extensors and abductors. Phasic flexors are facilitated if they are positioned so that their motion starts from the lengthening range. Tonic extensors should start their contraction in their shortened range.

2. Sequence two

This sequence helps in the development of motor control. There are four phases described below.

1. Muscles contract through their range with reciprocal inhibition of the antagonists. The movement first appears as phasic. The stimulus for this type of response is quick, light stretch or stroking or stroking of distal parts or other low threshold.

2. Muscles around the joint contract simultaneously to provide stability. This tonic holding contraction is a basis for maintaining proximal stability to allow exploration of the environment and development of skill by the distal segment of the body. The stimuli for stability responses are high in threshold.

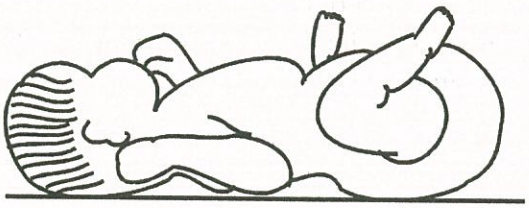
3. Proximal muscles contract to do heavy work, super imposed on distal co contraction "Mobility super imposed on stability". Sensory stimuli from high threshold spindle and joint receptors.

4. Skill. This level of motor control, the proximal segment is stabilized and distal segment moves.

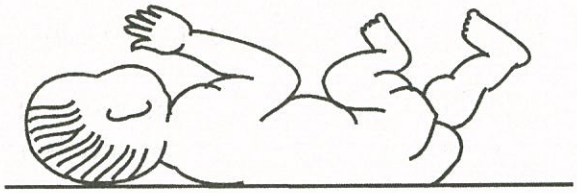
Patterns of motor development

There are *eight patterns* of motor development

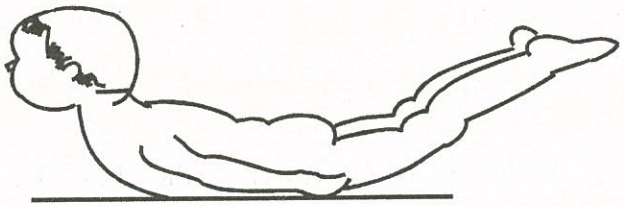
1. **Supine withdrawl:** The upper extremities cross the chest. The lower extremities flex and abduct. This pattern is used to obtain flexor responses when the person has no movement or has predominant extensor responses. This postures demands heavy work of the trunk and proximal parts or the extremities. To elicit the withdrawal motor patterns, fast brushing of the low back and the dermatomes of C_1-C_4 posterior primary ramie distribution. A small wedge is placed under the head and another under the pelvis to stretch the short extensors of the back which facilitates the flexors via the secondary endings.



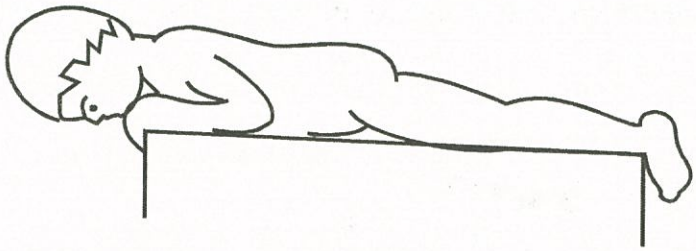
2. **Roll over:** The arm and leg on the same side flex. Activities like roll over to reach for an object, moving it around to the sides there by causing the person head to move and maintain visual contact with the object, the body will follow the head.



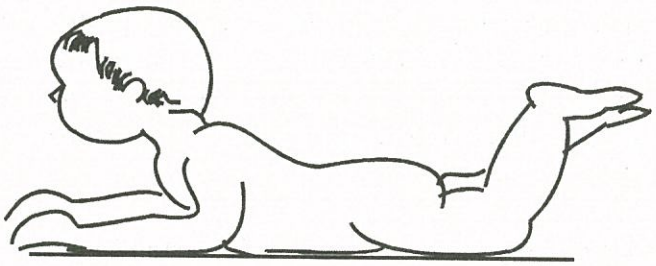
3. **Pivot Prone:** Involves extension of the neck, trunk, shoulders, hips, and knees, abduction and external rotation of the shoulders and elbow extension. This is the first postural pattern, on which other depend. Activities such as pulling back on the string of a talking doll or toy, pulling back on an elastic-propelled plane in preparation for shooting it, using a sling shot and rowing. The force of activity is in the direction of extension.



4. **Neck contraction:** It is the pattern used to develop head control and is first activated in the prone position. The short neck muscles are activated first by brushing the flexor distribution of C2. Next, the long neck flexors the sterno-cleidomastoids, are activated. The person is then placed prone and he is asked to extend his head against gravity. It stimulates labyrinthine righting reaction and this helps the person to allign his head so that eyes are parallel and his nose is perpendicular to the surface on which he is lying. As the head bobs into flexion, the neck and trunk extensors are stretched and thereby facilitates to contract. The upper trapezius in activated to maintain the extension. Activities, which require the person to look up while prone lying, are used to demand the neck muscle co-contraction pattern.



5. **On elbows is a pattern** of vertical extension, where the shoulder are brought into forward flexion, so that the person can bear weight on his elbows, the extensor muscles of the proximal upper extremity are stretched, therefore it facilitates the cocontraction of flexors and adductors at the shoulder in this position.

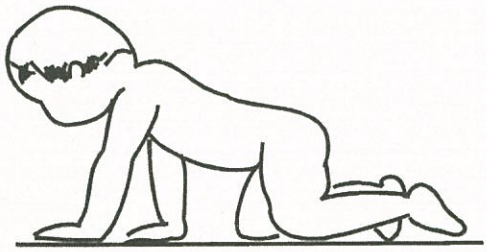


A procedure to achieve on elbows pattern is as follows.

The back and neck extensors are C-brushed. The glenohumeral extensors and abductors are C-brushed and iced. The person is asked to assume and hold the pivot prone position in which resistance is added. The person is placed in the prone on elbows position, so that there is a good joint compression at the shoulder. Pressure and vibration are applied to the extensor and abductor muscles of the glenohumeral joint as needed to gain co-contraction.

An activity that demands resisted grasp, is introduced to obtain reinforcement of shoulder co-contraction. The person lies on the floor to watch TV so that the person must raise his neck and upper trunk to look at it.

6. **All-fours pattern:** Occurs when the neck and upper extremities have developed stability; this position helps the trunk and lower extremities to develop co-contraction. At first, the quadruped position is static. Later the person is able to lift one or two points of support.

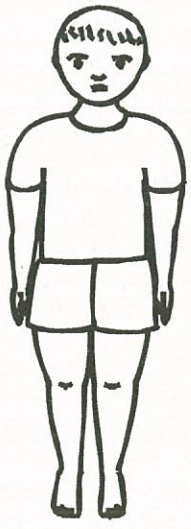


A suggested procedure is to develop the all-fours pattern is as follows. The back and neck extensors are C-brushed.

The glenohumeral and hip extensors, abductors and the elbow extensors are brushed and iced. The person assumes and holds the pivot prone position while resistance in added. Then the person is placed into the all-fours position so that there is a good joint compression at the elbows, shoulders and hips. Activity include holding a sling shot prepared to shoot, weaving on a large loom adapted to resist elbow extension.

Activity suggestions include doing craft activities while standing on a high table and writing on a wall black board. Playing ball or throwing beanbags help to develop balance while standing.

7. **Standing** is first done in a bilateral posture then progresses to unilateral standing. Activities can be given in standing.



8. Walking is higher level of standing. It consists of stance, push off, lift, swing and heel strike.

Treatment Programme

The person is evaluated to determine the distribution of muscle tone and level of motor control. According to the developmental sequences, appropriate stimuli are given to facilitate the muscles. Simple motor pattern is selected. Then he is progressed through the sequences, as he master's each skill.

The Bobath Neuro Developmental Approach

Dr. and Mrs. Bobath, Neurologist and physiotherapist respectively have devised methods of evaluation and therapy for persons with cerebral palsy and hemiplegia.

They believe that the sensations and movements are basic postural and movement patterns learned, later elaborated on the functional skills. Every skilled activity takes place against a background of basic patterns of postural control, righting, equilibrium and other protective reactions, reach, grasp and release functions.

When the brain is damaged, abnormal patterns of posture and movement develops, which are in compatible with the performance of normal every day activities. The abnormal pattern develop because, sensations are shunted into these abnormal patterns. To get back the person has undeveloped control over his output, the developmental sequence must stop the abnormal patterns.

The phasic patterns of posture and movement, the righting and equilibrium responses elicited by providing the appropriate stimuli, while abnormal patterns are inhibited. The sensory information of corrected movement is necessary for development of improved motor control.

Therapy, concentrates on handling the person in such a way, as to inhibit abnormal distribution of tone and abnormal postures while stimulating or encouraging the next level of motor control. The abnormal postures and tone are controlled by using key points while using movements or patterns. If the person lacks tone, sensory stimulation or tapping is used while the sensory inflow will not shunt into abnormal patterns.

Evaluation is the integral part of the therapy. It includes the determination of the extent and distribution of hyper and hypo tonus.

Reflex-inhibiting patterns

Reflex - inhibiting patterns are used to inhibit patterns of abnormal muscle tone, such as caused by the influence of predominating primitive tonic reflexes. The reflex inhibiting patterns prevent shunting of the sensory inflow into abnormal patterns and redirect it into normal ones. Inhibition of abnormal tone is always used concurrently with facilitation of the righting and equilibrium reactions.

Reflex inhibiting patterns are designed after examining the child's overall pattern of posture to determine the distribution of abnormal tone. Reflex inhibiting patterns must be individualized for each person after a careful analysis of the person's motor problems.

Examples of reflex inhibiting patterns

- Lifting the head into hyperextension facilitates extensor tone of the rest of the body and inhibits flexor tone.
- Internal rotation of limb facilitates extension where as external rotation of the limb inhibits flexion.
- Horizontal abduction or diagonal extension of the Humerus inhibits flexion of the neck, arms and hands.
- Lifting the arms over head facilitates extension of the hip and trunk.
- Flexion of the hip and knee combined with abduction of the hip inhibits extensor tone of the trunk, head and limbs.

Handling

It is used to influence postural tone; to regulate co-ordination of agonists, antagonists and synergists to inhibit abnormal patterns; and to facilitate normal automatic responses.

At first, the therapist handles the child or move him passively in correct patterns or movement while the person is encouraged to cooperate during therapy. The therapist withdraws the support, as the person is able to initiate to move in correct patterns.

Righting and equilibrium reactions

True inhibition can be gained only through facilitation of the righting and equilibrium reaction. These are elicited for each posture and movement during therapy. The neck righting reaction and body righting reaction are elicited by moving the child in the fundamental motor pattern which normal children develops during the first two years of life (ex. supine to prone, on elbows, to quadruped, to kneel standing, and finally standing). When eliciting neck righting and body righting, the head is used as the key point. When eliciting labyrinthine righting reactions, the key points used are scapula or shoulders.

Equilibrium reactions are elicited by displacing the person's centre of gravity, while he is in one of the developmental patterns. The elicitation of this reaction can be progressed from the normal surface to the beach ball.

Sensory stimulation

It is used for hypotonic person or a person having sensory disturbances. It should not be done unless the child is in reflex inhibiting patterns.

Methods of sensory stimulations

1. *Weight bearing* with pressure and resistance is used to elicit increased postural tone and a decreased involuntary movements.

2. *Placing and holding:* Placing refers to the ability of person which arrest a movement at any stage automatically or voluntarily. Holding refers to the ability, to hold a position without assistance, once the limb is placed.

3. *Tapping:* a) It may be a pressure. b) Inhibitory tapping is used to activate muscles that are weak. c) Tapping is used to stimulate balance reactions and is done by pushing the child by light "taps" back and forth from one position to other position.

Therapy programme

The combination of tone influencing patterns, facilitation of a righting reaction and equilibrium reaction are used to manage the disorders.

An example of such combination pattern is as follows. Starting in supine, the neck is flexed to inhibit the extensor tone, then elicit the neck righting reaction, which is log roll to prone.

The head is held in extension to inhibit flexor tone.

A gentle upward movement of the head prompts person to assume on elbows position.

Flexing the neck to encourage flexion of the hips combined with backward pressure against the top of the head can result in assumption of quadruped position.

To facilitate sitting up, the person's head is lifted and rotated to one side. Before he reaches a side lying position, pressure is exerted backward against the top of the head to flex the spine and hip, while continuing the rotation of spine.

This results in sitting. Equilibrium responses would be elicited when the person had control of each posture.

VOJTA THERAPY

Vojta therapy is developed by Dr. Vaclov Vojta a neuro peadiatrician in Czechoslovakia.

It is based on the nine trigger points and application of three-dimensional pressure by using these nine trigger points opposite to each other.

These nine trigger points are :

1. Seventh and eighth rib.
2. Medial border of scapula.
3. Acromion process of scapula.
4. Medial epicondyle of Humerus.
5. Radial styloid (styloid process of radius).
6. Gluteus medius.
7. Anterior superior iliac spine.
8. Medial condyle of femur.
9. Medial or later part of calcaneous.
   With one auxillary point under the chin.

According to Dr. Vojta, most of the children who end up with the label cerebral palsy are not born with cerebral palsy but with Central Coordination Disturbances (CCD). Dr. Vojta also believes that, it is very difficult to diagnose CCD because of lack of symptom but by using seven postural reactions in the early stages it is quiet possible to diagnose CCD. These postural reactions are given below.

1. Traction reaction
2. Axillary reaction
3. Landau reaction
4. Vertical suspension reaction
5. Horizontal reaction-collis
6. Side tilt reaction

According to Dr. Vojta, if the child shows abnormal responses of 3-5 postural reactions then the child is grouped under mild CCD. If the child shows abnormal response of postural reactions then the child is grouped under moderate CCD if the child shows 5 and 5-7 abnormal responses, in postural reaction, then the child is grouped under severe CCD.

Dr. Vojta believes that, in most of the cerebral palsy children, there is a block either at the synaptic level or the reflex mechanism is blocked, so the child does not progresse accurately. But by using continuous pressure on trigger points or continuous bombardment of sensory impulses, the information and sensation will travel to higher centers and motor cortex either by circumnavigating the block or by penetrating the block. (which is present in cerebral palsy children) by establishing or re-establishing the new tract which will carry response and sensations as correct as possible and if the child gets response then he will be able to do activities.

Application of pressure on the trigger points helps to increase the blood circulation due to vasodilatation effect, so that the soft tissues and muscle will get more nutrition and hence metabolic process will increase and in this way muscles will build up and if the muscles are build up then it will provide stability to joints and if the joints gets stability then the child will be able to do motor activities.

Sensorimotor Integrative Treatment

Any lesion of the Central Nervous System(CNS) results in diminution of the bilateral nature of the nervous system. i.e. both side of the individual are affected in a structural and functional sense. The gross motor deficits that appears on one side of the body following brain injury on the contralateal side. In reality both sides are affected, one side being more involved and the other to a lesser degree in such a way that the good side fails to function normally.

Principles of sensorimotor integrative therapy are founded on the following points.

- Developmental sequence
- Spatiotemporal orientation
- Spatiotemporal adaptation and
- Principle concerning the subcortical sensorimotor integrative action of the nervous system.

There are Ten cardinal principles of sensory motor therapy.

1. Prevention of sensory deprivation.
2. Active participation.
3. Repetition with and without variation
4. Meaningful
5. Motivation
6. Forcing
7. Cervicocephalo caudal law of development
8. Subcortical integration precedes cortical integration.
9. Facilitation and inhibition.
10. Patience and care

All these principles play an important role in development, learning as well as in rehabilitation.

Each principle will be discussed briefly in order to explain its role in relation to recovery of function following Cerebro-Vasculo-Accidents (CVA).

1. Prevention of Sensory Deprivation

I) *Sensory deprivation* is defined as any change in the internal or external environment that deprives an individual of normal and necessary sensorimotor or re-afferent stimuli.
Following equipment and therapeutic measures would be useful to prevent sensory deprivation.

1. The persons bed would be equipped with a vibrator that is capable of vibrating the mattress, a small computer would activate the vibrator at varying intervals and also at different frequencies(100-350Hz range) for brief movements, the frequency would drop below 50Hz preferably into the 1 to 26Hz range in order to cause an alerting reaction in the reticular system.

2. The bed would be mechanized so that it would gradually flex and extend the knees, hips, trunk, and neck, and if possible gently shift the person from one side to another.

3. Music interspersed with everyday noises of traffic, conversation and recording of the voices of loved ones, and friends would be piped into the room at odd intervals during the day. This would be varied so that loud, sharp alerting sounds, as well as soft or far away noises (dog barking at the distance or passing of an, aeroplane overhead) would be an integral part of the music and voices.

4. At least 3-4 times a day, limbs are moved passively and by using, vibrator(100-300Hz range). This will stimulate major functional muscle groups, and for activating the Tonic Vibratory Reflex(TVR) of the various muscle groups of the body.

5. Talking to the person in varying tone and changing the pitch of voice, visitors should be instructed to talk to the person and repeatedly touch them or hold their hand, arm or shoulder firmly, but with gentle pressure.

6. The temperature and lighting conditions in the room would be varied to stimulate a more normal environment and occasionally various odours would be used to help activate the persons reticulo-limbic system.

These measures would help to prevent the long and short term effects of sensory deprivation and helps to maintain the functional integrity of the nervous system. These techniques stimulates the basic needs of the persons nervous system.

II) *Active participation :* In sensorimotor integrative therapy, every effort should be made to get the person actively involved in the rehabilitation process. So that the person learns how to carry out purposeful and sequential movement patterns. The total body is always involved bilaterally, symmetrically and reciprocally along with midline stability and mobility patterns, therapeutic techniques that enable the person to utilize total developmental pattern. Such as mat exercises, rolling over, forearm weight bearing, forearm kneeling, crawling and rocking back and forth diagonally and sideway's etc. Use of Balance beam, Balance board, Tilting board enables the nervous system to re-organize itself subcortically as it is forced to respond to more

normalized bilateral pattern of movement. Person should begin to perceive the forces that are impinging upon different body surfaces including joints, and other parts of the body in relation to the total spatiotemporal environment.

III) *Repetition with and without variation :* In any therapeutic technique that utilizes repetitive patterns of stimuli or movement pattern should be a sufficient variation or change incorporater into the technique to prevent central nervous system from adapting or habituating. Variation should be simple to complex, changing voice suddenly, for changing the person's perception virtually, putting them slightly off balance; tapping or vibrating the group of muscles being resisted or number of techniques that alerts the system.

Sometimes habituation and adaptation can be a beneficial part of the rehabilitation process. This is especially true for persons having hypertonicity, repetitive pattern such as gentle stroking, slow rolling and slow rhythmical soft stroking patterns are not only soothing the nervous system but they tend to relax and inhibit muscular tone.

IV) *Meaningful:* Activities utilized in therapy must be meaningful to the persons nervous system i,e. it needs to be based upon normal physiological reflex response or sequential sensorimotor movement patterns.

V) *Motivation :* One of the major goals in sensory motor integrative therapy is to motivate the person over a long enough period of time until self motivation is restored. This process of external motivation must be reality orientated and not based upon fake hopes and promises. Also it needs to be a step-by-step procedure.

VI) *Forcing :* As long as any potential function remains in a given sensorimotor system the individual will continue to rely upon it, and few learn to utilize other more viable sensorimotor system and substitute these for perceiving and functioning optimally in their environment unless they are forced to do. The principle of forcing the nervous system is to use viable alternative system.

VII) *Cervicocephalocaudal law of development:* Cervical area should be considered as the key for gaining midline orientation. This area controls the head and the special senses. These in turn, along with the neck, controls the rest of the body.

VIII) *Subcortical integration precedes cortical integration:* Many of the therapeutic technique used in rehabilitation are used upon this principle. Therefore, instead of giving a command to a person and telling him to perform a specific task, the person is positioned; resisted and assisted in moving through a total body integrated movement pattern. This is done in such away that desired activity is performed automatically. Sometimes additional stimuli are given to a specific muscle group in order to enhance performance. Every attempt is made to prevent the person from performing cortically. (Cortical integration precedes subcortical and then the movements becomes automatic.)

IX) *Facilitation and Inhibition :* Attempt is made to re-establish this critical facilitory-inhibitory balance in order to regain muscle synergy. In this technique, it is to inhibit as much as possible, an undesirable total body primitive reflex patterns, while attempting to facilitate a more normal response. This might be as simple a procedure as gaining total body relaxation before attempting movement or positioning a person in such a way that the upper limb automatically extend in response to a sudden external movement that changes the person's centre of gravity.

Patience

X) The progress of rehabilitation is usually a long and tedious process. By taking appropriate mesures. These facilitation and inhibition techniques are attempting to prevent sensory deprivation, at the same time they are forcing the system to actively undergo meaning full reorganization, primarily at sub cortical levels. The child may become self motivated to the extent that will continue to carry out various prescribed therapies and gradually improve or at least maintain, the progress that was gained while undergoing active therapy.

THE PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION (PNF)

Definition : It is the method of promoting the response of the neuro muscular mechanism through stimulation of the proprioceptors.

Many techniques will be applied within the patterns of movement and posture and attention is given to the various sensory stimulation like manual contacts, visual cues and verbal commands to bring as many favorable influences as possible to the persons.

Principles: There are eleven basic principles which encompass the developmental concepts are drawn from the fields of neuro physiology to motor learning and motor behaviour.

1. All human beings have potentials, that are not fully developed.
2. Normal motor development proceeds in a cephalo caudal and proximodistal direction.
3. Early motor behaviour is dominated by reflex activity.
4. The growth of motor behaviour has cycle trends as evidence by shifts between flexor and extensor dominance.
5. Goal - directed activity is made up of reversing movements.
6. Normal movement and posture are dependent upon "synergy" and a balanced interactions of antagonists.

7. Developing motor behaviour is expressed in on orderly sequence of total patterns of movement and posture.

8. Normal motor development has an orderly sequence but lacks a step by step patterl and sequence overlapping occurs.

9. Improvement of motor ability is dependent upon motor learning.

10. Frequency of stimulation and repetition of activity are used to promote retention of motor learning and for development of strength and endurance.

11. Goal - directed activities, coupled with techniques of facilitation are used to initiate learning of total patterns of walking and self care activities.

Evaluations

The evaluation reflects the developmental sequence, proceeding from proximal to distal direction.

1. Vital and related body functions are considered first. Functions *of respiration, swallowing, voice production, facial and tongue motions* are evaluated with *impairments, weakness, or asymmetry,* also movements in response to visual, auditory and tactile stimuli are elicited to determine which sensory cues to be used to reinforce movement and posture.

2. Observation of head and neck positions is made during performance of developmental and functional activities. The following points to be observed and noted.
   a. Dominance of tone - flexor or extensor.
   b. Alignment - midline or asymmetrical.
   c. Stability versus mobility - balanced or deficient in one or both areas.

3. Combinations of diagonal patterns of the extremities. The person is asked to perform bilateral symmetrical and bilateral reciprocal combinations following areas are assessed, head, neck, and trunk reaction; range of motion, rotation is not complete in any pattern; quality of movement, smooth, rhythmical and normal timing, with the distal component heading in coordinated movement.

4. Developmental postures are observed by asking the person to assume and maintain positions in the developmental sequence - these total patterns are assessed to determine how muscle groups function in relation to other in a given pattern.

5. Functional activities, as performed in self care tasks and transfers, are observed finally to determine any discrepancies between the person's ability to perform individual and total patterns and his ability to perform in these movements performance of a total tasks.

Therapy

For every major part of the body : The head, neck, trunk and extremities, two pairs of diagonal patterns of movement exist. Each pair of antagonistic patterns consists of three motion components. These are flexion, extension components combined with rotation, either external or internal, and with abduction or adduction.

For example: In diagonal, flexion of upper extremity, combines with adduction and external rotation. In diagonal, (D2) flexion, combines with abductions and external rotation. In development, the diagonal pattern appear in the functional movements of rolling and prone locomotion. Diagonal one derives from rolling and diagonal two from crawling on the belly. Thus, diagonal movements are combinations of the three pairs of antagonistic motions of flexion or extension, abduction or adduction and external or internal rotation. Diagonal pattern always in cooperation with rotation components. Use of diagonal pattern reinforces the component of rotation, necessary in the performance of functional tasks.

Bilateral symmetrical patterns occur when paired extremities perform movements at the same time.

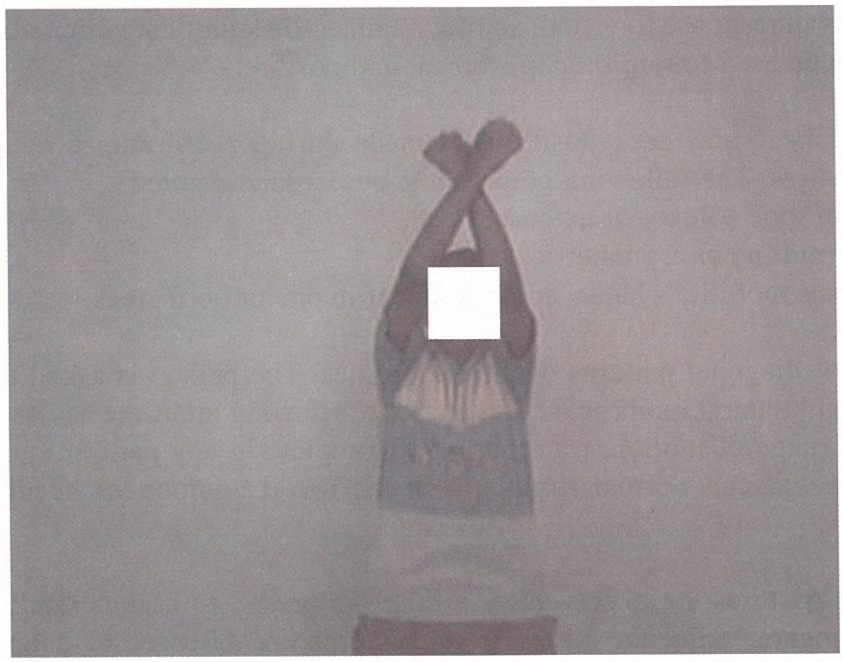


Fig. Bilateral symmetrical D1 flexion

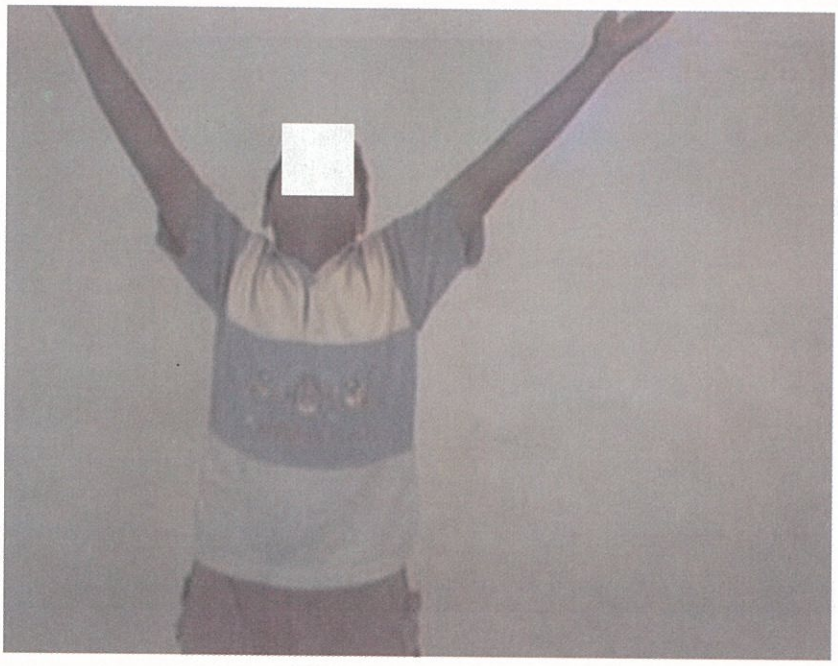


Fig. Bilateral symmetrical D2 flexion

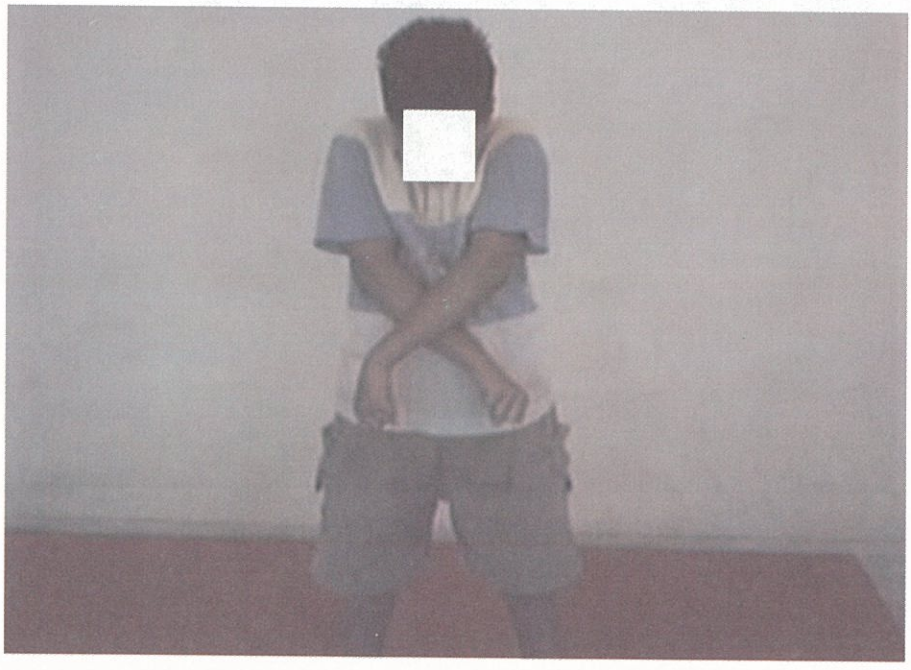


Fig. Bilateral symmetrical D2 extension

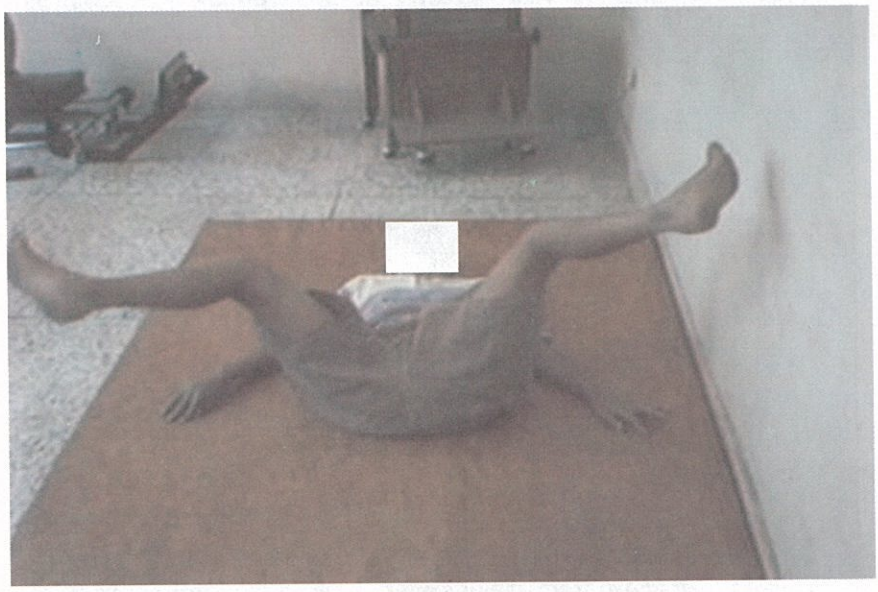


Fig. Bilateral symmetrical D2 flexion

Fig. Bilateral symmetrical D1 flexion

These pattern influence head, neck, trunk flexion and extension. It play's an important role in facilitating a reciprocal relationship between flexor and extensor dominance. These patterns of upper extremity occurs in daily activities. e.g. riding a bicycle.

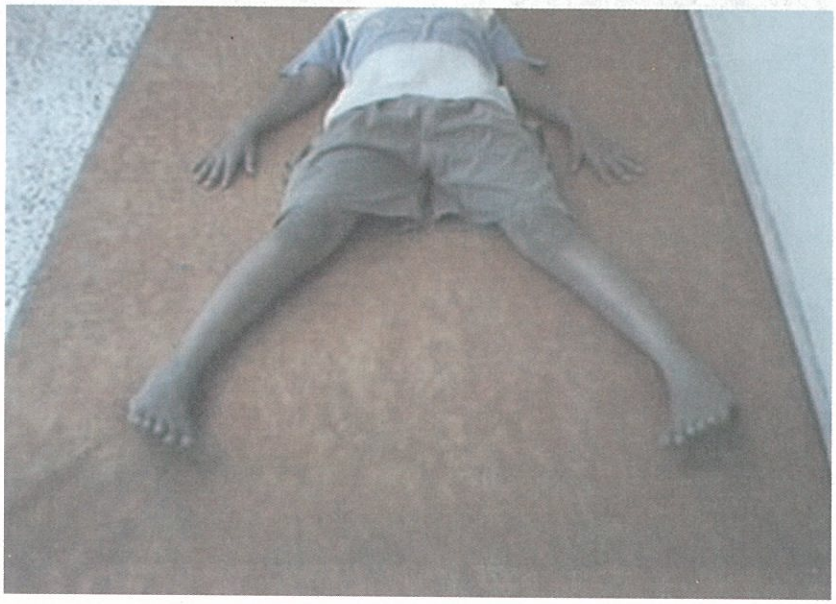
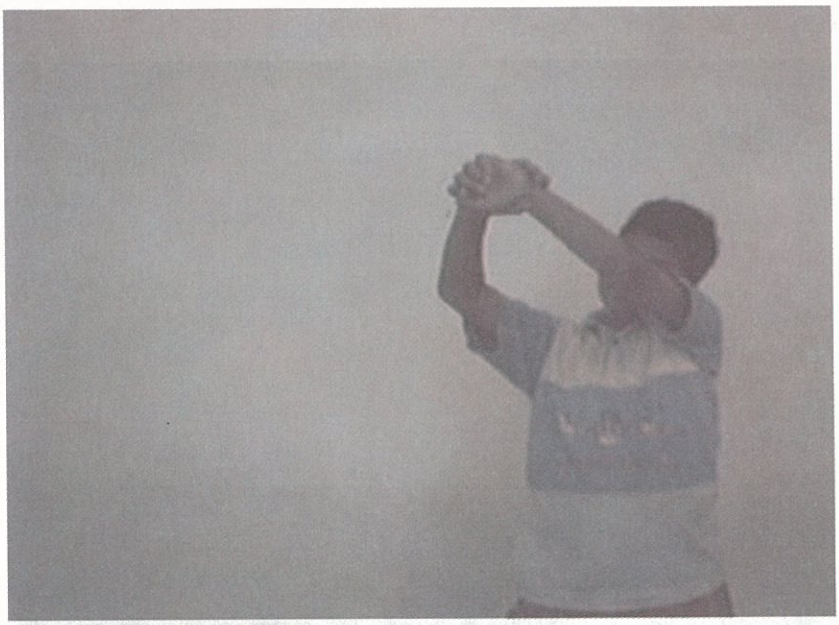


Fig. Symmetrical bilateral D1 extension

Fig. Symmetrical bilateral D2 extension

Bilateral asymmetrical patterns occur when paired extremities perform movements toward one side at the same time.



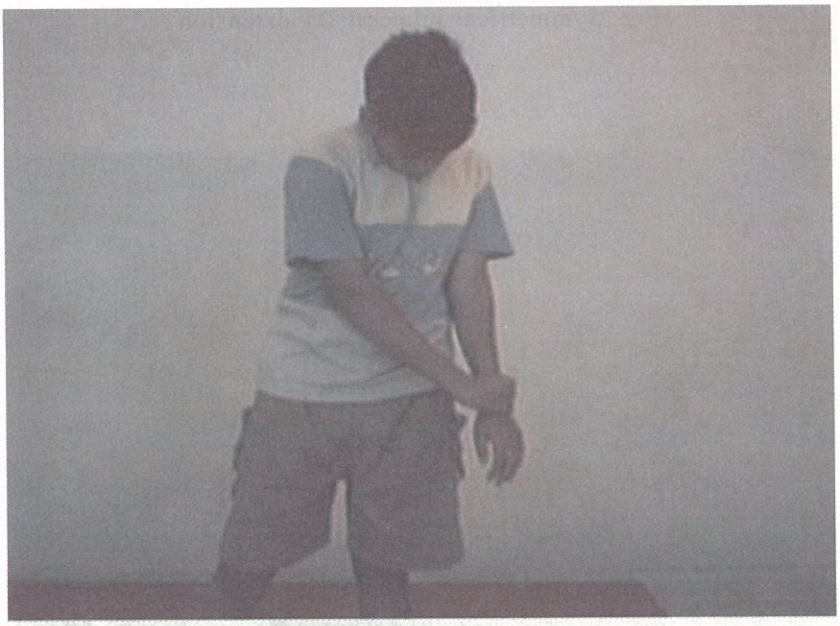


Fig. Asymmetric bilateral pattern in D1 flexion
Fig. Asymmetric bilateral pattern in D1 flexion
Fig. Left arm in D1 flexion and right hand grasping dorsum of the left wrist.

Fig. Bilateral asymmetric pattern, the right arm in extension and right hand grasping the left wrist.

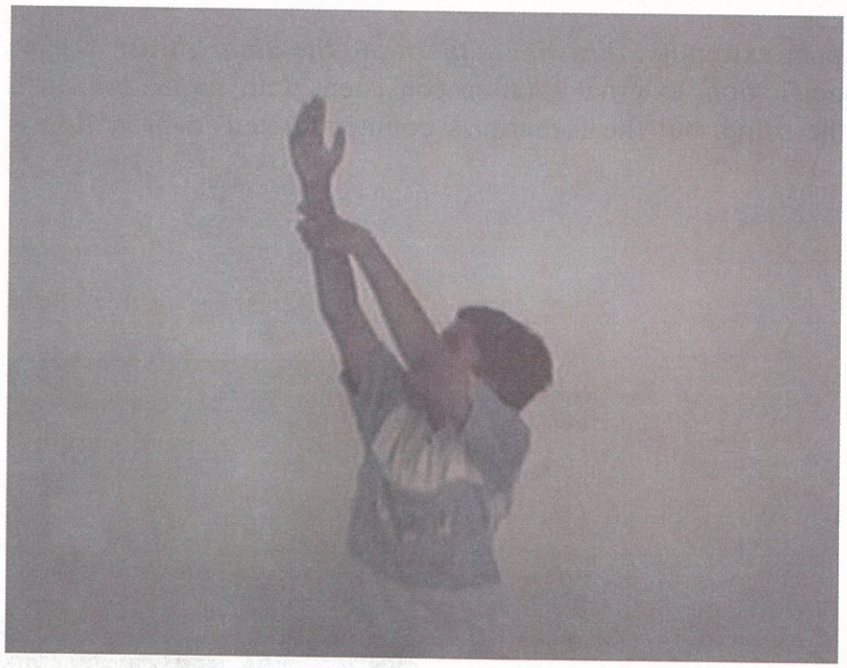


Fig. Right arm D2 flexion, left arm in D1 flexion.

It play an important role in facilitating a reciprocal relationship between flexor and extensor dominance.

Bilateral asymmetrical patterns occur when paired extremities perform movements toward one side, at the same time. Bilateral asymmetrical patterns influence the head, neck, and trunk movements in patterns of flexion with rotation or extension with rotation. Swinging a bat and side sitting are the examples of bilateral asymmetric patterns in the upper and lower extremities respectively.

Bilateral *reciprocal patterns* occur when both limbs perform movements in opposite directions at the same time. The reciprocal pattern have a stabilizing effect on head, neck and trunk because one extremity flexes while the other extends producing stability in the trunk. Examples of reciprocal movements are *walking, running and swimming.*

Unilateral patterns In developing motor behaviour, emerge from the bilateral patterns.
In skilled tasks, the two diagonals (bilateral and unilateral) may interact or one may dominate. Diagonal one in the upper extremity is observed in activities such as feeding and washing the face on the opposite side. Diagonal is seen in zipping a front zipper and winding a watch. Diagonal one in the lower extremities is observed in pushing one foot through a pant and in crossing one leg to put a socks. Diagonal is seen in lower extremities as in swinging.

The two diagonals interact in activities like washing the face. In washing the face, when the right hand contact the left side of the face, it is flexion. When the right hand washes the right side of the face, it is in D2 flexion with elbow flexed. Diagonals change and interact as the hand crosses the midline of the face and body.

The two pairs of upper extremity, *thrusting pattern* are the *ulnar thrust,* D1, and the *radial thrust D2.* In diagonal, one flexion, external rotation consistent with supination. In D1 ulnar thrust, the shoulder remains the same, but the forearm is counter-rotated in pronation and the hand opens to the ulnar side.

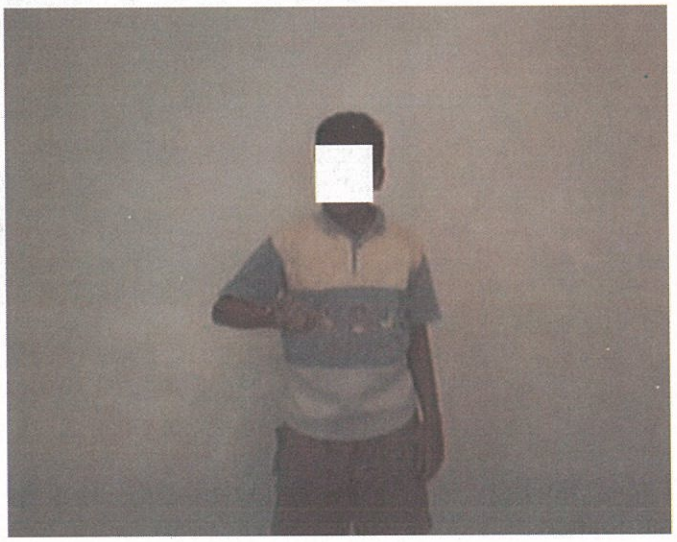


Fig. Unilateral D1 ulnar thrust

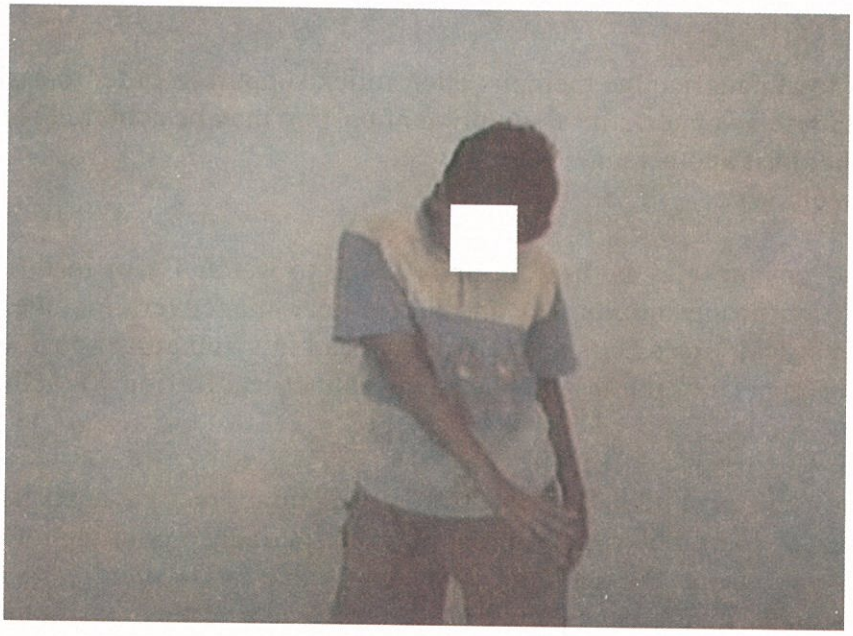


Fig. Unilateral D2 radial thrust

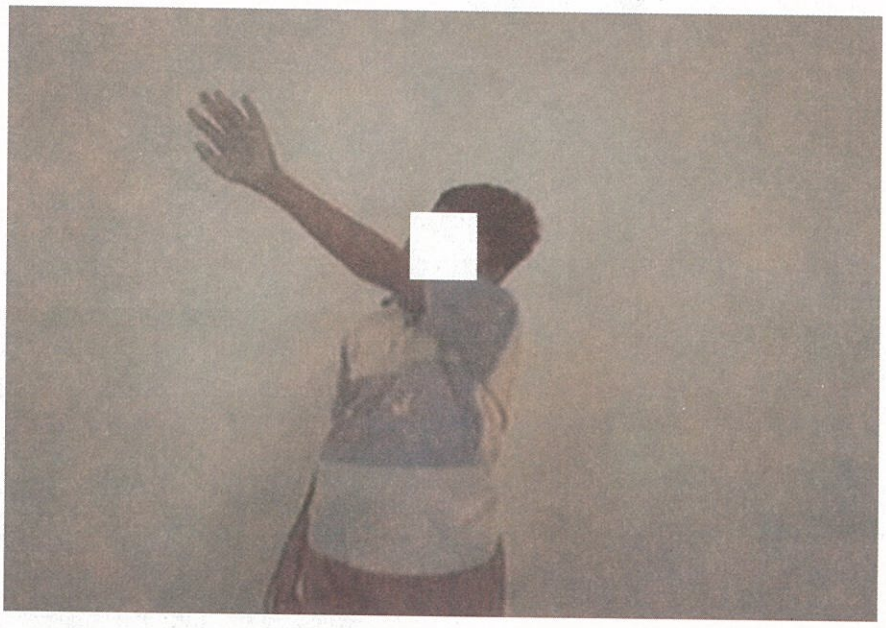


Fig. Unilateral D1 Ulnar thrust

In diagonal two, extension, internal rotation is consistent with pronation. The shoulder remains but the forearm is counter rotated in supination and the hands open to the radial side.

Thrusting patterns represent primitive patterns of protection, defense, reach and grasp. The movement of thrusting occurs more forcefully than motions in other diagonal patterns. In therapy, thrusting is a good pattern to retrain elbow extension with wrist extension.

Total patterns

In this sequence of total patterns, the therapist elicit reflex support in order to assist a more severely involved child. With reflex support, the assumption of posture may be achieved with minimal support on the part of the therapist and person.
Example : prone on elbows.

The prone on elbow posture may be used in daily living to watch TV or read on a floor. To assist person in this position(prone on elbows), the preparatory maneuvers include placing the lower extremities in symmetrical, extension and placing the head in symmetrical position or turned to one side for comfort. The upper extremities are placed in symmetrical flexion with elbows flexed, fingers pointed to the nose.

Manual contacts, the hands in mitt like position, fingers and thumbs relaxed, apply stretch and assistance or resistance. The hands, placed over the pectoral region with finger's pointing towards the umbilicus, stimulate a muscle response in the shoulder adductors which lands stability to the posture. Hands should be placed medially to allow the person arms to assume a vertical position.

Fig. Position of therapist and child for assisting the person from prone lying to prone on elbows.

Auditory commands are also used so that the person's superior region is elevated with fore -arm falling into place.

Application of activity, prone on elbows provide good position, in which to work for control of the head and neck extension with weight bearing, to facilitate stability in the scapulo-humeral joint. Various activities may be performed, depending on the person's ability.

In *level one,* practicing assumption, rocking, raising and lowering the head and depressing the scapulae may be all that the person can perform.

In *level two,* the person is able to maintain an adequate posture for long periods of time.

In *level three,* the person will begin to perform manual activities with the elbows immobile and bearing weight. The tongue receives a stretch stimulus in this position. If person can perform for short periods in prone, his performances in sitting may improve faster.

In *level four,* the person is able to decrease the support needed to maintain posture and lifts one extremity from the surface, as in playing a table game.

An outline of other sequence for assisting persons into developmental posture follows.

Posture : Supine to side lying.

- Reflex support : ATNR.
- Preparatory maneuvers : Position upper most leg and arms in D1 flexion.
- Position of the therapist : One side toward the direction of person's movement.
- Manual contact : Scapula and pelvis.
- Commands : "Look here", Person is assisted in side lying.
- Activities : Grasping and releasing objects in diagonal patterns, sliding the hand on a wall in various direction.

Posture : Side lying to side sitting.

- Reflex support : Body on body righting.
- Preparatory maneuvers : Position legs and arms is asymmetric flexion.
- Position of therapist : Behind child's hips.
- Manual contacts : Shoulder girdle.
- Commands : On the count of three, look back at me, one, two, three, look at me; Person is assisted to come up to side sitting.

Posture : Supine to long sitting.

- Reflex support : Labyrinthine righting, optical righting.
- Preparatory maneuvers : Place legs on symmetrical extension and abduction.
- Position of therapist : Astride at person's knees.
- Manual contacts : Dorsum of wrists.
- Commands : "On the count of three, look at your feet and sit up. One, two, three, look at your feet. Person is assisted to come up to long sitting.

Alternate sequence : Side sitting to long sitting.

- Preparatory maneuvers : Assist to come up to side sitting position.
- Position of therapist : Behind person.
- Manual contacts : Shoulder girdle, one anteriorly, the other posteriorly.
- Commands : Tell person to look towards the direction of turn and reach over for support with moving arm. Assists person to rotate, distributing weight on both lips.

Posture : Prone to hands - knees.

- Reflex support : STNR (head midline), or ATNR (head rotated).
- Preparatory maneuvers : Position so that hips are flexed and thighs are vertical to floor.
- Position of the therapist : Astride, person holding hips securely between the therapist knees.
- Manual contacts : Considerting the practical problem of child.
- Commands : "On the count of three, look up, one, two, three look up". Person is assisted to head and knees.

Kneeling

- Reflex support : Labyrinthine, optical righting and equilibrium reactions.
- Procedure : Varies depending on method of assumption, heel sitting, hand-knees and side sitting.

Hand knees to plantigrade

- Reflex support: Labyrinthine, optical righting and equilibrium reactions.
- Preparatory maneuvers: Assist the hand, knee posture, position of the therapist, behind person.
- Commands : "Straighten your knees" or bring one foot forward and place it flat on the floor, then on the other.

Techniques

Techniques for facilitation and inhibition, include a battery of procedures that may be used singly or in combination, according to the abilities and needs of the person. All techniques are superimposed on the patterns of movement and posture.

Irradiation, the facilitation of one voluntary motion by another, spreads in a specific patterns of muscle groups. The stimulus for irradiation is generated by tension in contracting muscles and related structures, as in repeated contractions may elicit irradiation for the purpose of using the motions of the stronger muscle groups to facilitate movement in weaker group of muscles.

Successive induction is also a process of facilitating one voluntary motion by another. However, the stronger antagonist facilitates the weaker, as in resisted reversals of antagonists. In therapy, when techniques of slow reversal and slow reversal-hold are used, a contraction of stronger muscle groups is elicited to, effectively facilitate the weaker muscle groups.

Reciprocal innervations is a process of inhibiting reflexes by voluntary motions. In this agonist is facilitated or contracted against resistance, the antagonist lengthens and provides control as the agonist contracts so that the smooth movement is achieved. In therapy a slow reversal-hold-relax technique may relax spastic or tight muscle groups. Relaxation of spastic antagonists can also be achieved by facilitation through patterns of irradiation, stretch and supporting reflexes.

Stretch may be applied in two ways, as the stimulus for initiation of movement or as a quick stretch to initiate voluntary motion within the pattern and to increase strength and timing of a weak response. When applied as a stimulus, stretch must be given in the extreme lengthened range of the desired motion, coupled with persons voluntary effort. All motion components are stretched, especially rotation, as it is a rotatory component which elongates the muscle fibers in a given pattern. A sudden or quick stretch is used primarily where there is no voluntary control of movement. For example, the hyperactive flexor reflex in a hand may be reduced by repeated quick stretch of the extensors. Use of stretch stimulus and quick stretch aid the person in learning to initiate and perform patterns with greater ease.

Traction means : Separating joint surface, stimulates joint receptors to promote movement. Traction is maintained through out the active range of motion.

Approximation : Also stimulates joint receptors by compressing joint surfaces. In therapy, approximation promotes stability and postural responses.

Maximal resistance : Resistance is applied according to the persons ability to over come it by moving smoothly through the full range of pattern or maintain an isometric contraction. In therapy, maximal resistance is provided by the therapist on motions before and during activity or by equipment, such as pulleys and weighted tools.

Repeated contractions : Repeated contractions are used to increase range and endurance in weaker components of patterns through a technique of emphasis. For example, if a person is unable to reach his mouth for eating, he would be instructed to 'hold' with an isometric contraction of all components at the points where the active motion decreases in power. Then the person is asked repeatedly to "pull again" towards his mouth, shifting from isometric to isotonic contractions.

Rhythmic initiation : It is used to improve the ability of person to initiate movement. This technique involves passive rhythmic motion, followed by active motion. Resistance may be gradually increased as the persons response increase. For example, a person may lack the ability to initiate reaching for a glass on the table, due to tightness from severe spasticity. The therapist would ask the person to relax and "let me move you". Thus the therapist moves the part through available range, until relaxation is felt. The person is directed to begin, moving actively with the command " Now help me to move". As the person response increases, resistance may be added to reinforce the movement. The person is then asked to move actively by himself and complete the task.

The *reversal of antagonist technique :* These are primarily used for strengthening or gaining range of motion. Either isotonic, isometric, or a combination of both types of contractions may be used.

Slow reversal alternating isotonic contraction of antagonists. The procedure begins by asking the person to perform the weaker agonist pattern. Example, flexion will be the agonistic pattern. Manual contact with maximal resistance are applied to determine the persons response. The person performs the antagonistic pattern, extension against maximal resistance. The antagonist pattern is now repeated, with an increase in power or range of motion expected due to low successive induction. Resistance must be graded to facilitate a strong contraction of the antagonist followed by maximal range of motion, in the weaker agonist. Activities performed with the assistance of a pulley automatically use a *slow reversal* technique. In *slow reversal-hold,* an isometric contraction follows the completion of isotonic contraction.

Rhythmic stabilization : Is the simultaneous isometric contractions of antagonists, which results in co-contraction of the isometric. The technique promotes stability by eliciting a more balanced response between antagonistic muscle groups. Relaxation is often achieved following the stabilization. This technique cannot be incorporated into an activity, as it is an isometric exercise. It is used before an activity, to enhance performance during activity to prevent and correct imbalance, built up during the activity.

Relaxation techniques include passive rotation, *slow reversal hold relax* and hold relax : Passive rotation coupled with range of motion exercises is an effective technique used prior to splinting a limb, in which the muscles are shortened or spastic. Place manual contacts on the intermediate and distal joints and perform range of motion exercises. When restriction occurs, repeat rotation of all components of the pattern at the point of limitation, moving slowly and gently, as relaxation is felt, movement may continue through further range.

Contract-relax includes an isotonic contraction of the antagonist relaxation, then passive movement of agonistic pattern by the therapist. Hold-relax includes an isometric contraction of the antagonist, relaxation, then active movement of the agonist by the person. Slow reversal-hold relax includes as isotonic contraction followed by an isometric contraction of the antagonist, relaxation followed by active movement of the agonist.

* * *

CHAPTER 7

ASSOCIATED CONDITIONS

Cerebral Palsy

Definition : Cerebral Palsy is a non progressive neurogolical disorders affecting mainly posture and movement, that occur secondry to damage to the immature brain before during or after birth.

Some of the reflexes which may persists in cerebral palsy are given below -

a. Persistently closed hands and strong grasp reflexes.

b. Asymmetry due to persistence of the Moro reflex.

c. Excessive startle responses.

d. Persistance of ATNR on turning the baby's head.

e. Absence of walking and placing reflexes.

f. The symmetric tonic neck reflex (STNR) is exaggerated and persists after 6-8 months(on passively extending the head there is increased extensor tone in the arms and flexor tone in the legs. Flexion of the neck has the opposite effect).

g. The tonic labyrinthine response is evoked by changing the position of head in space. In supine, a massed extensor patterns and in prone the generalized flexion patterns evokes.

Causes

Prematurity

Preterm babies are more prone to brain-damage because of trauma at birth or because of soft skull, and immature cardio respiratory system(which causes to develop hypoxia and low blood pressure. Immature liver, make hemorrhage to occur).

Asphyxia : It is caused by accidents at birth, umbilical cord around neck. Results in the problems on motor, speech, hearing, vision or a combination of problems.

Trauma

(a) Cephalopelvic disproportion means large head and shoulder of the infant make the passage of the infant difficult through birth canal.

(b) Forcep's delivery

(c) Breech delivery

(d) Rapid delivery

Severe jaundice

A high level of unconjugated bilirubin in the blood, damages the basal ganglia and may result in athetoid cerebral palsy.

Hypoglycaemia

Low blood sugar for a long period can cause brain damage and epilepsy.
The cerebellum is vulnerable, if affected, causes ataxia.

Intra-uterine virus infection

If mother is infected with rubella virus especially in the first three months of pregnancy and cytomegalovirus infection causes brain damage.

Meningitis

Infection and inflammation of meninges cause brain damage.

Vascular causes

Narrowing, rupture or diseases of occlusion of the internal carotid or middle cerebral artery may occur before or after birth and cause hemiplegia.

Types of cerebral palsy

Depending on the extent and location of brain damage the symptoms are seen on different parts of body.

Classification of cerebral palsy on the basis of the area of brain affected.

Type	Area affected
Hemiplegia	One side of the body affected.
Quadriplegia	All four limbs are affected(upper limbs affected more than lower or one side is more affected than other).
Bilateral hemiplegia	Both sides are affected, one side more than the other.
Diplegia	Lower limbs are more affected than upper limb.
Monoplegia	Only one limb is affected.
Spastic	Motor cortex or tracts adjoining the motor cortex.
Athetoid	Basal ganglia, cerebellum is affected.
Ataxic	Cerebellum or sensory tracts are affected.
Hypotonic	Damage below the level of crossing of tracts or cerebellum.
Mixed	It could be a combination of any two areas of brain.
Dystonic chorea-athetosis	This type is characterized by involuntary movements. It is caused by the damage to the basal ganglia.
Athetosis	It is defined as the slow, writhing movements, due to in coordinated activity between agonist and antagonists, which will become worst by attempting voluntary movement.
Choreic movements	Choreic movements are rapid involuntary jerks, present at rest and increased during voluntary activities.

[Note : Reference is made to high risk factors rather than causes, as there are many infants who have the problems stated under above mentioned heading do not have cerebral palsy.]

Clinical features of children with cerebral palsy are given below:

- Spastic hemiplegic, quadriplegic or diplegia in cerebral palsy child.
- The common abnormal pattern of movement is adductors spasm at the hips, flexion at the knees and equines at ankle are present.
- The knee and ankle jerks are exaggerated.
- The plantar response is in extension.
- The child when made to walk with support exhibits scissoring gait(crossing of lower limbs).
- If upper limbs are affected, the shoulder is held in adduction, internal rotation.

- The elbows flexed with forearms pronated.
- Wrist is flexed and thumb is adducted and opposed.
- Fingers are flexed at the metacarpophalangeal joints.

[Note : These clinical features are not applied to all children with cerebral palsy.]

Common motor problems seen in children with mental retardation are given below:

1. Delayed gross motor and fine motor development.
2. Hypotonia(generalized) as seen in down syndrome cases.
3. Instability of joints.
4. Muscles weakness.
5. Subluxation of joints.
6. Dislocation or displacement of joints.
7. Contracture and deformities.
8. Abnormal muscle tone(hyper tone, hypo tone and fluctuating tone).
9. Abnormal pattern of movement.
10. Abnormal reflex activity.
11. Muscle wasting and atrophy of muscles.
12. Reduced or loss of tone and bulk of muscles.
13. Postural problems.
14. Physical fitness problems.
15. Obesity.
16. Balance.
17. Gait problems.

Management

- Management is based on the presentation of problems. It is always begin with therapy and facilitation of development leading to improvement in daily living skills and gait training, balance training, general physical fitness programme, facilitation of development, and postural training etc. In addition to this the specialized therapy techniques and management programme is given below.

- The condition should be detected even in the neonatal period by the pediatrician to initiate early therapeutic measures. The management and rehabilitation of the spastic children need the coordinated effort of the orthopedic surgeon, neurologist, psychiatrist, physiotherapist, occupational therapist, special educators and psychologist.

Aim of management

The aim of management is to achieve the maximum functional ability and skill that the child can acquire. Each child requires a regime that is appropriate to its developmental age and severity of involvement, contractures and deformity.

1. In mild cases with good IQ the deformities can be corrected by physiotherapy.
2. In moderate cases, severe cases, the aim is to try to prevent the deformity with physiotherapy and orthotic appliances and make them walk independently.

Surgery

It may be necessary to correct the deformity such as talipes equinovarus, adducted thighs or flexed knees etc. Unfortunately the deformity may tend to reoccur if intensive physiotherapy is not given following surgical correction, as the muscle imbalance is still present.

Physiotherapy

Assessment

Assessment is first carried out as soon as any abnormality or delay in movement or lack of movement is detected. If abnormality is present, the child must be assessed regularly and therapy advised.

Physiotherapy mainly consists of :

1. Positioning
2. Retraining Activities of Daily Living(ADL)
3. Correction of contractures and stretching.
4. Slow rhythmical passive exercises to relax the spastic muscles.
5. Active exercises are given to establish movement patterns and teach rhythmic contractions and relaxations of muscles.
6. Calipers or below knee orthosis are prescribed to make the child stand and train in walking.
7. Night splints are used to maintain the correct position of the knee, foot and hand.
8. Head control,
9. Rolling,
10. Balance in sitting,
11. Kneeling,
12. Creeping
13. Crawling
14. Standing
15. Walking should be advised and practiced.
16. Activities for inhibition of abnormalities and facilitation of normal should be instructed.

Therapies to facilitate development

Neuro developmental approach : Developmental sequence of movement patterns together with inhibition of abnormal patterns.

Correct handling of the child with the use of key points of control and various sensory stimuli are used and taught to the parents.

Facilitation of normal postural control is stressed, as the child is unable to perform functional activities. The parents must be shown how to handle the child at home for feeding, bathing, dressing and other, functional activities.

Sensory stimulation for activation and inhibition of movement : Stimulations of cutaneous, such as stroking sensation, muscle stretching, in order to activate or inhibit motor activity. The developmental sequence of movement is used to activate normal patterns.

Proprioceptive neuromuscular facilitation(PNF) : It makes use of functional patterns of movement rather than individual muscles or groups. These patterns include rotatory and diagonal components. Sensory stimulation is used to facilitate the movements, such as touch, quick stretch of the muscle, traction or compression of joints, pressure and deep pressure.

MUSCULAR DYSTROPHY

It is a disorders of the muscle, resulting in difficulties of locomotion, these are primary. Progressive and degenerative diseases of the muscles without the evidence of regeneration.

Types of muscular dystrophy

1. Pseudo Hypertrophic Muscular Dystrophy (Duchenne): It is characterised by Hypertrophy of muscles with weakness.
   a. It begins before 5 years. The child has difficulty in getting up from squatting position, stand on one limb to get up (gowers sign).
   b. The calf muscles appears bigger than normal.
   c. The child develops equinus deformity. Walks with waddling gait and lumbar lordosis, due to gluteal muscle weakness.
   d. Muscles of shoulder girdle are wasted and weak.
   e. After 10-15 year of age the child will not be able to stand and walk.
   f. Develops deformities at ankles, knees, hips and spine.
   g. Fascial muscles, respiratory muscles and muscle for swallowing are unaffected.
   h. Involvement of cardiac muscles, in children due to pneumonia.

2. Fascio-scapulo humaral dystrophy : It is less common and less severe, affecting the muscles of the shoulder girdle and the face.

Management

- To maintain muscular balance and stabilization.
- To make him walk independently.
- Weak muscles are strengthened with active exercises, he is helped with calipers.
- Keep the child active, and happy as long as possible.

Spina bifida

It is a congenital abnormality, due to the developmental defect in the spinal column. Causes of this condition are incomplete closure of the vertebral canal, failure of fusion of vertebral arches. It affects the neuromusculoskeletal and genitourinary system.

Classification

Spina bifida occulta: This is a asymptomatic condition, the most common site is lower lumbar spine. There is no displacement of neural tissues, skin changes occurs over the defect.

Spinabifida cystica: Meningocele means, displacement of the meninges by protrusion containing cerebrospinal fluid, occurs from the unfused vertebral arches. The sac is covered by skin or membrane.

Myelomeningocele: It involves spinal cord, nerve roots and meninges, it protrude through the vertebral defect. The commonest site of myelomeningocele is lumbosacral region.

Clinical Features

- Flaccid paralysis
- Muscle weakness.
- Muscle wasting.
- Diminished or absent tendon reflexes.
- Decreased or absent exteroceptive and proprioceptive sensation.
- Rectal and bladder incontinence.
- Hydrocephalus.

Management

Considering all the above features, management requires, involvement of a team of neuro, orthopedic surgeons, physiotherapy and orthotics. Each, individual problems has to be managed accordingly.

Physiotherapy

As muscle paralysis is the main disabling factor, physiotherapy management involves in preventing deformities, improving muscle power and making the child functionally independent :

- Prevention and management of deformities.
- Management of muscle paralysis.
- Care of skin and joints.
- Management of bladder and bowel incontinence.
- Training in ambulation and selfcare.

HYDROCEPHALUS

It is usually associated with spina bifida and occurs when there is an increase in the cerebrospinal fluid which circulates around the base of the brain, spinal canal and down the central canal.

The fluid is produced by the choroid plexuses situated in the cerebral ventricles and circulates through the ventricular system. It is absorbed by the arachnoid granulation into the sagital sinus. If there is a block in the pathway, particularly around the base of the brain, the CSF cannot be reabsorbed and pressure begins to build up; In infant, the head enlarges in size easily as the sutures of the skull and fontanels are very flexible.

Neurological features

1. Spasticity
2. In-coordination, poor balance and clumsiness.
3. Sensory loss, weakness in arms and hands.

Management

Physiotherapy management involves in dealing with the neurological problems. The surgical management is shunt. It is put up to drain the cerebro spinal fluid into the right atrium of the heart or into the peritoneal cavity.

* * *

CHAPTER 8

MUSCLE POWER GRADING

Muscle Power : It can defined as, the ability of the muscle to contract and produce movement at a joint. The power of a muscle can be graded according to the range of motion it produces at a joint with or without resistance.

Muscle tone : The state of partial contraction of muscles at rest, that contributes to posture and co-ordination is called as muscular tone.

Hypertone : It is the increase state of tone in the muscle. If it increases due to the lesion in upper motor neuron it is called spasticity. The tone of the muscle also increases due to pain and it is called as spasm. Spasticity is a generalized condition which affects either the flexor or extensor synergy of the body. Spasm is a local increase in muscular tone and is protective in nature. Ex. Spasticity and rigidity. In spasticity one group is involved while in rigidity, both group of muscles are involved.

Hypotone : It is a state of decrease tone of the muscle. It is a generalized condition, in which, muscles of the whole body are affected due to the lesion in lower motor neuron or lesion of the cerebellum. Ex. Ataxia.

Fluctuating tone

Muscle tone keeps varying so it is called as fluctuating tone, generally in all athetoid cases there will be fluctuating tone.

Types of muscle work

Isometric or static muscle contraction : In this type of muscle contraction, there will be an increase intramuscular tension without change in the muscle length and no significant movement is produced.

Uses

- It is useful in maintaining muscle bulk.
- Prevent muscle atrophy due to disuse.
- To retain memory of muscle action.
- Helps in venous and lymphatic drainage.
- It is used during immobilization, to prevent muscle atrophy.

Isotonic : The muscle contraction, which produces intramuscular tension and change in the length of the muscle and in turn produces movement. Isotonic movements may be either concentric or eccentric.
Concentric muscle work :-

In this type of muscle work the muscle contracts and becomes shorter and thicker as their attachments are drawn close together resulting in joint movement. A person doing concentric muscle work performs a movement.

Eccentric muscle work

In this type of muscle work the muscles attachments, move away from each other and results in a movement where the body parts move away from each other.

Uses of isotonic movements

- Maintain the joint range of motion.
- Concentric contraction will maintain the contractile property of the muscle tissue.
- Eccentric contraction will maintain the elasticity and eccentric strength of the muscle.

Ranges of muscle work

Muscle works to produce a movement is called as range of muscle work.

Full range

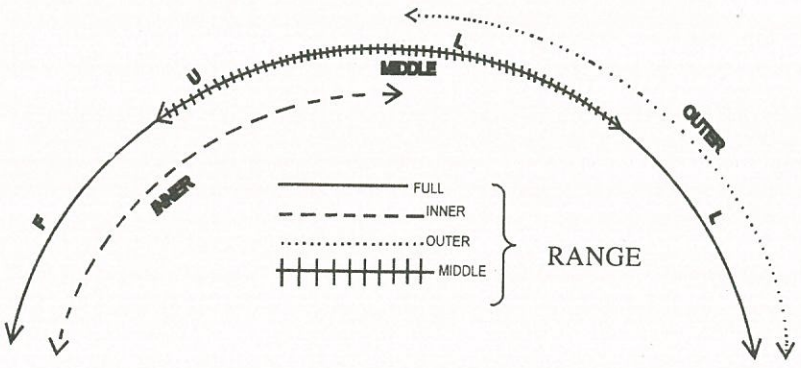
This is a range of movement in which the muscle contracts from a fully relaxed position to a position where the muscle is fully contracted.

Inner range

This is a range of movement in which the muscle contracts from a position where it is partially contracted to a position where it is fully contracted.

Outer range

This is a range of movement in which the muscle contracts from a fully stretched position to a position where it is partially contracted.



Position of Full Contraction

Position of Full Stretch

Middle Range
This is a range where in the muscle is neither fully stretched nor fully contracted.

THE GROUP ACTION OF MUSCLES

There are *four* basic types of muscle groups.

1. The *prime movers,* or agonists, are the group, which bring about the movement by their contraction.
2. The *antagonists,* which are the opposing group, relax and lengthen progressively so that the movement is controlled but not impeded.
3. The synergists are the muscles, which work or relax to modify the action of the prime movers. .
4. The *fixators* are muscles, which fix the origin of the prime movers or the synergists.

MUSCULAR WEAKNESS AND PARALYSIS
Muscular weakness or paralysis in any group of muscles results in loss of movement or stability of a particular joint, and creates a state of muscular imbalance which affects all the groups concerned in the production of co-ordinated movement.

CAUSES OF WEAKNESS OR PARALYSIS
As contraction is the only means by which muscle power can be maintained or increased, any lesion or habit, which prevents or limits contraction will result in muscle wasting and incorrect posture. Complete loss of ability to contract the muscles is known as paralysis, partial loss as paresis.

1. Diseases affecting the motor pathways.
2. Diseases affecting the muscle tissue.
3. Diseases nerve and muscle tissue.
4. Some constitutional diseases.

Muscle power grading
The normal muscle strength present in the muscle can be graded; there are two types of muscle grading.

1. Medical research council grading (MRC).
2. Oxford classification for muscle grading.

MEDICAL RESEARCH GRADING

Grade 0 - No contraction.

Grade 1 - Flicker of contraction.

Grade 2 - contraction of the muscle sufficient to move the joint with reduce gravitational force or gravity eliminated that is in side lying position.

Grade 3 - contraction of the muscle in full range, against gravity.

Grade 4 - contraction of the muscle in full range, against gravity with minimal resistance.

Grade 5 - contraction of the muscle in full range, against gravity with maximal resistance.

EXAMPLE OF MEDICAL RESEARCH GRADING

Method

Muscle group : Quadriceps
Muscle action : Action (extension of knee joint).
Position of person : Side lying, while testing grade upto 0, 1 and 2. With the leg being tested is above (gravity eliminated position). Supine position while testing 3 & 4. Against gravity and sitting possion while testing 5.

Grade 0 - The muscle power of quadriceps is graded as **'0'**. If the person is not able to contract the muscle.

Grade 1 - If he produces slight contraction of the muscle in sidelying then the power of the muscle is graded as **1**.

Grade 2 - If he produces full range of extension of lower limb, in sidelying then the muscle power is graded as **2**.

Grade 3 - If he produces full range of extension of lower limb in supine lying then the muscle power is graded as **3**. (In supinelying the hip should be stabilized in 90^0 flexion and knee in full flexion at the starting point).

Grade 4 - If he produces full range of extension of lower limb in supine lying with minimal resistance, then the muscle power is graded as **4**.

Grade 5 - If person can do active knee extension in supine lying with maximal resistance then the muscle power can be graded as **5**.

Oxford classification for muscle grading

- Poor - contraction of the muscle is absent.
- Fair - contraction of the muscle in full range in gravity assisted position.
- Good - contraction of the muscle in full range against gravity.
- Normal - contraction of the muscle in full range against gravity with maximum resistance.

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CHAPTER 9

RANGE OF MOTION

Range of motion: The range of angular movement available at a joint. Each joint has specific, accurate and directed movement and is named according to the direction of movement, e.g. flexion means movement in a forward direction. Extension means opposite to that of flexion or movement in backward direction.

Movement : Movement means change in the joint position, from starting point to end point.

Passive range of motion: Unrestricted angular movement available at a joint, produced entirely by the external force.

Active range of motion: Unrestricted angular movement available at a joint, produced by an active contraction of the muscles.

Measurement of joint motion : This Normal Range of Motion is measured by means of goniometer and it is used to find out the joint stiffness. And to find out how many degrees joint Range of motion is restricted or limited. Accordingly therapy plan is being made and executed.

FACTORS LIMITING JOINT RANGE OF MOTION

The factors that commonly effect the joint range of motion are given below:

1. *Pain:* Restricts both active and passive range of motion
2. *Muscular weakness and inefficiency:* Weakness or flaccidity of the muscles limits active range of motion, as the power of the muscles is insufficient to overcome the resistance offered by the weight of the body.
3. *Tightness and spasticity of the muscles:* Tightness and spasticity of the muscles limit both active and passive range of motion as the antagonists to the movement are unable to relax and allow it to take place. Spastic muscles are weak muscles so there is limited in joint range of motion.
4. *Adhesion formation:* This limits both active and passive range of motion at a joint.
5. *Tight skin and scar tissue:* Limits both active and passive range of motion.
6. *Deformities:* Structural deformities (due to bony changes) also affect the range of motion.

Exercises to increase joint range of motion

1. Controlled, sustained lengthening of the tight or spastic muscles, increases the joint range of motion.
2. Passive movements are used to maintain the joint range of motion in weak or flaccid muscles.
3. Joint mobilizations and manipulations are used to increase joint range of motion in adherent joints.

Shoulder Joint

- Raising the arm in the forward direction towards the ceiling through flexion. Movement above 90^0 is called as elevation through flexion. It involves rotation of scapula.

  Flexion 90^0 and elevation 90^0 (elevation through flexion - 180^0).

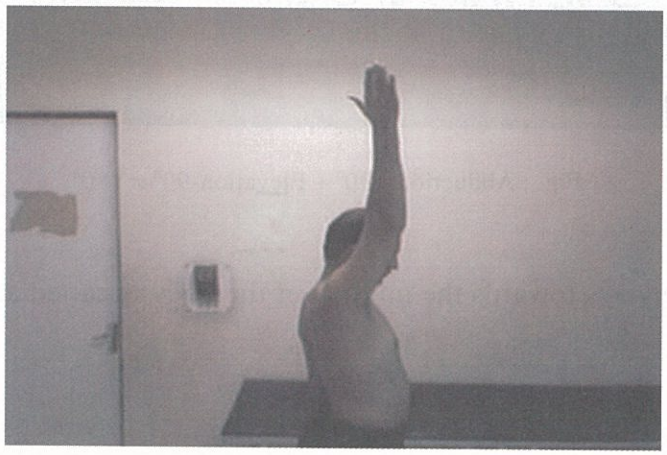

Fig: Flexion - 90^0 + Elevation - 90^0 = 180^0

- Moving the arm in the backward direction is called extension (opposite of flexion).
  Range of motion, extension - 45^0 - 50^0

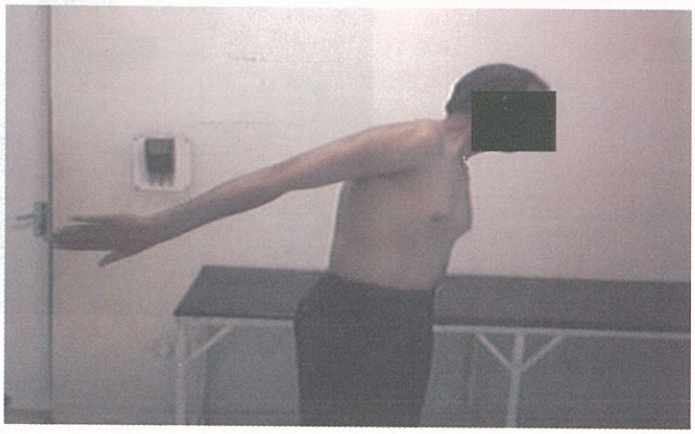

Fig. : Extension - 45^0 - 50^0

- Moving the arm sideways, from the body through 180^0. Movement above 90^0 is called elevation through abduction. It involves rotation of scapula.

  Elevation through abduction is 180^0.
  Abduction 90^0 - Elevation 90^0. (movement away from midline)

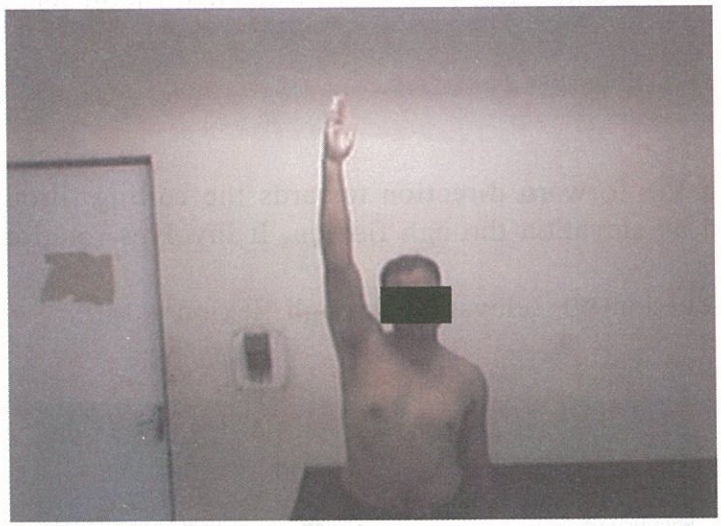

Fig. : Abduction - 90^0 + Elevation-90^0 = 180^0

- Moving the arm side ways towards the midline of the body is called adduction.

  Adduction - 70^0
  Range of motion - 70^0

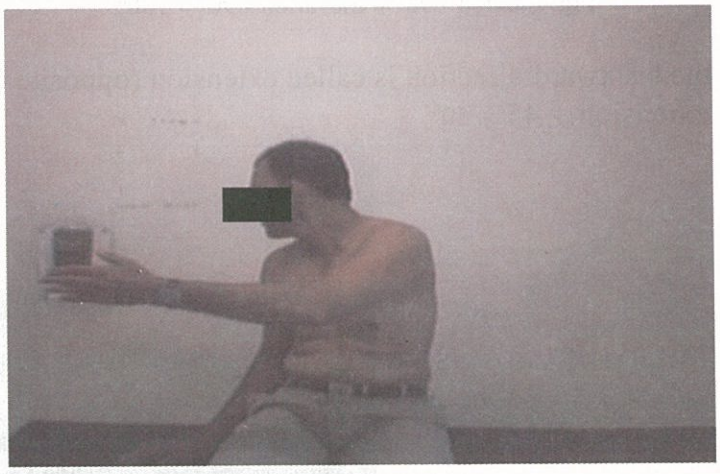

Fig. :Adduction - 70^0