**Introduction**

Therapeutic exercise is the systematic and planned performance of bodily movements, postures or physical activities intended to provide a patient or client with the means to

- Remediate or prevent impairments
- Improve, restores or enhance physical function
- Prevent or reduce health related risk factors
- Optimize overall health status, fitness or sense of well being.

Therapeutic exercise programs designed by physical therapists are individualized to the unique needs of each patient or client. A patient is an individual with impairments and functional limitations diagnosed by a physical therapist and is receiving physical therapy care to improve function and prevent dysfunction who engages in physical therapy services to promote health and wellness and to prevent dysfunction.

The following are the common physical impairments managed with Therapeutic exercise.

**Musculoskeletal**

- Pain
- Muscles weakness / reduced torque production
• Decreased muscular endurance
• Limited range of motion due to:
  • Restriction of the joint capsule
  • Restriction of periarticular connective tissue
  • Decreased muscle length
• Joint Hypermobility
• Faulty posture
• Muscle Imbalances

Neuromuscular
• Pain
• Impaired balance, postural stability or control
• Incoordination, faulty timing
• Delayed motor development
• Abnormal tone (hypotonia, dystonia)
• Ineffective / inefficient functional movement strategies

Cardiovascular / Pulmonary
• Decreased aerobic capacity (cardiopulmonary endurance)
• Impaired circulation (lymphatic, venous, arterial)
• Pain with sustained physical activity (intermittent claudication)

Integumentary
• Skin hypomobility (ex. immobile or adherent scarring)
1.0 Introduction

The postures from which movement is initiated are known as Starting Position and they may be either active or passive in character. There are five basic or fundamental starting position and all the others are derived from them, i.e. standing, kneeling, sitting, lying and hanging.

Equilibrium and stability is maintained in these positions by a balance of forces acting upon the body, and when the force of muscular contraction is used for this purpose the contraction is isometric. The strength and distribution of this contraction is normally controlled by a series of reflexes known collectively as the Postural Reflexes but, during the learning process of new patterns of posture, voluntary effort may be required.

1.1 Fundamental Positions

1. Standing

This is the most difficult of the fundamental positions to maintain, as the whole body must be balanced and stabilized in correct alignment on a small base by the coordinated work of many muscle groups. The position may be described as follows:
(i) The heels are together and on the same line, the toes slightly apart (so that the angle between the feet does not exceed 45°).

(ii) The knees are together and straight.

(iii) The hips are extended and laterally rotated slightly.

(iv) The pelvis is balanced on the femoral heads.

(v) The spine is stretched to its maximum length.

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

(vii) The shoulders are down and back.

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

It is usually preferable to modify the position of the legs to that in which the heels are slightly apart and the inner borders of the feet are parallel, as this is the natural functional position of the foot when it is used as a lever to propel the body forwards.

**Muscle Work**

The muscle groups involved are

a. The Intrinsic Muscles of the Feet working to stabilize the feet and to prevent curling of the toes so that the Flexors of the Interphalangeal Joints can press the balls of the toes to the ground.

b. The Plantaflexors of the Ankle, working to balance the lower leg on the foot.

c. The Dorsiflexors of the Ankle, working to counterbalance the action of the Plantaflexors and to support the medial longitudinal arch of the foot.

d. The Evertors, working to counterbalance the action of the Invertors (Tibialis Anterior and Posterior), and in the case of Peroneus Longus, to press the ball of the great toe to the ground.

The interaction of b, c and d may be likened to that of there guy ropes which support a flag pole, the tension in all three is reciprocal, an increase in the tension of one resulting in a slackening of the others. If the pole is perfectly balanced tension in all three is minimal.

e. The Extensors of the Knee may work slightly.
f. The Extensors of the Hip, working to maintain hip extension and to balance the pelvis on the femoral heads. Slight action of the Lateral Rotators of the Hip is associated with a bracing of the legs and of the arches of the foot.

g. The Extensors of the Spine, working to keep the trunk upright. Where their action over the lumbar and cervical regions would result in increased curvature and consequent shortening of the spine, they are counter balanced by the Flexors of these regions to ensure maximum lengthening.

h. The Flexors of the Lumbar Spine (Abdominal Muscles), working to prevent over-action of the Extensors of this region. They also assist in the maintenance of the correct angle of pelvic tilt, and support the abdominal viscera.

i. The Pre-vertebral Neck Muscles, working to control excessive extension of the neck and to straighten the cervical spine.

j. The Flexors and Extensors of the Atlanto-occipital Joint, working reciprocally to balance the head. The Elevators of the Mandible close the mouth.

k. The Retractors of the Scapulae, working to draw the scapulae backwards so that the glenoid cavity faces more or less laterally.

l. The arms are relaxed. Sometimes, however, it is necessary to use the Lateral Rotators of the Shoulder to keep them in the correct position.

All the muscle groups mentioned above stabilise the body in the anterior-posterior direction, in addition there must also be a balanced

Fig. 1.1 Standing
contraction of the lateral muscles to maintain equilibrium.

Effects and Uses. As the base is relatively small and the centre of gravity high, the state of equilibrium of the body is relatively less stable than in the other fundamental positions; therefore the standing position is only suitable as a starting position for exercise for those who can maintain it correctly. The muscle work is minimal when perfect balance is achieved, therefore practice in attaining and holding a satisfactory pattern of standing posture reduces fatigued and also conditions the postural reflex.

2. Kneeling (kn.)

The body is supported on the knees which may be together or slightly apart. The lower leg rests on the floor with the feet plantarflexed or, if a plinth is used, the feet may be in the mid-position over the edge. The rest of the body is held as in standing.

Muscle Work. The lower leg is relaxed; the body must be stabilized on the knees.

a. There is interplay between the Flexors and Extensors of the Knee, to balance, the femora vertically on the knees.

The muscle work of the rest of the body is as in standing, except that:

b. The Extensors of the Hip and the Flexors of the Lumbar Spine work strongly to maintain the correct angle of pelvic tilt. A decrease in this angle and consequent increase in extension of the lumbar spine tends to occur in this position, because of the tension of the Rectus Femoris, which is stretched across the front of both hip and knee joints.

Effects and Uses. Although the centre of gravity of the body is relatively lower than in standing, the position is only slightly more stable and is uncomfortable for most people. It is used as a starting position for backward movement in a sagittal plane and to train control of the hip joints and lower trunk in preparation for the standing position during which the feet are pressed to the floor by the Extensors of the Knees and Dorsiflexors, so that the lower leg acts as a bracket.

3. Sitting (sitt.)

The position is taken on a chair or stool, the height and width of which allow the thighs to the fully supported and the hips and knees to be flexed to a
right angle. The knees are apart sufficiently to allow the femora to be parallel and the feet rest on the floor with the heels vertically below the knees.

Muscle Work. There need be no muscle work to hold the position of the legs, as they are fully supported. The Flexors of the Hips work to maintain a right angle at these joints and to prevent the tendency to slump.

The muscle work of the rest of the body is the same as in standing.

Effects and Uses. This is a comfortable, natural and very stable position which is much used, and it particularly suitable for those who lack the necessary strength and control to maintain a more difficult position. Lateral and rotatory mobility of the pelvis is eliminated by the weight of the body and the position of the legs, so that lateral and rotatory movements can be localized to the spine. As none of the body weight is transmitted to the legs, many non-weight-bearing knee and foot exercises can be performed in the position, which is also suitable for training correct alignment of the upper part of the body in the habitual sitting position, which is used by the majority more than any other in everyday life.

4. Lying (ly.)

This is the easiest of the fundamental positions as the body can be completely supported in the supine position and is as stable as is possible.

Muscle Work. This is minimal. If the body is relaxed on a hard surface, such as the floor or the average plinth, the head rolls to one side, the lumbar spine is hollowed because of the tension of structures lying anterior to the hip joints and the latter fall into a position of lateral rotation. On a soft resilient surface, however, such as a spring mattress, which gives way to the contours of the body and supports it completely, this does not occur.

When the lying position is used as a starting position for exercise it is usually taken on a firm surface and the following muscle groups work slightly:
a. The Head Rotators of both sides work reciprocally to stabilise the position of the head.

b. The Extensors of the Hips and Flexors of the Lumbar Spine work to combat the tendency to hollow the back.

c. The Medial Rotators of the Hips work to keep the legs in the neutral position, so that the knees and inner borders of the feet are held together.

Effects and Uses. This is an easy position and as the trunk is relaxed and fixed by its own weight, it is a suitable position for many exercises. As the alignment of the body is the same as in standing, static posture training can be carried out in this position. The Spine is relieved of the burden of transmitting the weight of the head and shoulders when it is in the horizontal position, therefore it tends to elongate and straighten, and this is an advantage in the treatment of spinal deformities. Breathing is impeded slightly by pressure on the posterior aspect of the thorax and by increased pressure of the abdominal viscera on the under surface of the Diaphragm, often making the position unsuitable for those suffering from respiratory or heart conditions. The position hinders the return of blood from the head and so maybe unsuitable for the elderly, or those who suffer from high blood pressure.

5. Hanging (hg.)

The body is suspended by grasping over a horizontal bar, the fore-arms being pronated, the arms straight and at least shoulder width apart. The head is held high and the scapulae are drawn down and together, so that the neck appears as long as possible. The trunk and legs hang straight, with the heels together and the ankles plantaflexed.

Muscle Work

a. The Flexors of the Fingers work strongly to grasp the bar.

b. All the muscles round the wrist work strongly to reduce the strain on the joints and to act as synergists and fixators for the Flexors of the Fingers.

c. The Flexors of the Elbows work to reduce the strain on the joints.
d. The Adductors of the Shoulders work strongly to lift the body on the arms (especially Latissimus Dorsi posteriorly and Pectoralis Major anteriorly).

e. The Depressors, Retractors and Medial Rotators of the Scapulae work strongly to fix the scapulae work strongly to fix the scapulae and to brace the upper back.

f. The Pre-vertebral and Posterior Neck Muscles work reciprocally to maintain the position of the head and neck.

g. The Flexors of the Lumbar Spine and the Extensors of the Hips work to correct the tendency to arch the back as the result of the over-action of Latissimus Dorsi, working on the sacrum.

h. The Adductors of the Hips work to keep the legs together.

i. The Extensors of the Knees may work to maintain full extension.

j. The Plantaflexors work to point the toes to the floor.

Fig. 1.6 Measurement of the Angle of pelvic tilt

Effects and Uses. As the muscle work for the arms and upper back is extensive and strong the position is only suitable for those in whom muscular strength and body weight are well balanced. As the weight of the shoulders is taken off the spine and the weights of the legs exert traction upon it, it is straightened and elongated.

The thorax is fixed in the inspiratory position and breathing in difficult, therefore the position is unsuitable for weak patients and those suffering from
cardiac or respiratory conditions. The effect of attaching the body is stimulating and much enjoyed, especially by children.

**The Pelvic Tilt**

Movement in the vertebral column and at the hip joints makes it possible for the pelvis to be established in a variety of positions. It may be inclined or tilted in an antero-posterior direction, laterally or rotated.

a. Antero-posterior Tilt

In erect posture the angle of the pelvic tilt can be measured in a variety of ways.

1. The angle at which an imaginary line, drawn through the symphysis pubis and the lumbo-sacral angle, lies in relation to a horizontal line can be measured. The pelvic tilt is said to be normal in the standing position when this angle measures between $50^\circ$ and $60^\circ$.

2. The angle of pelvic tilt is said to be normal in the standing position when the anterior superior iliac spines and the symphysis pubis all lie in the same vertical plane.

3. The angle recorded by a pelvic inclinometer, one of the arms of which is placed over the symphysis and the other over one of the posterior superior iliac spines, is in the region of $30^\circ$ in the standing position when the pelvic tilt is normal.

**Maintenance of the Normal Angle of Antero-posterior.** Tile of the Pelvis tension

The angle of the pelvic tilt in stabilised either by the tension of the structures which lie anterior to the hip joint, which prevent the angle from being reduced, or by the action of the straight Abdominal Muscles and the Hip Extensors which prevent it from being increased.

**Alteration in the Angle Antero-posterior.** Tile of the pelvis

An increase in the angle of pelvic tilt may be called forward tilting of the pelvis, and a decrease in the angle of pelvic tilt may be called backward tilting of the pelvis.

Forward Tilting of the Pelvis. Movement of the pelvis on the femoral heads to produce a forward tilting is produced by the contraction of the Hip Flexor Muscles and the Extensors of the Lumbar Spine.
Backward Tilting of the Pelvis. The pelvis can be tilted backwards on the femoral heads by the contraction of the Hip Extensors and the straight Abdominal Muscles.

b. Lateral Tilting of the Pelvis

The pelvis may also be tilted laterally on one of the femoral heads. When the femur on which the pelvis is tilted is fixed as in standing on one leg, and the other leg is free move, the pelvis is tilted laterally to bring the centre of gravity over the base and so maintain balance by abduction or adduction in the hip joint of the leg which is fixed. An upward inclination of the pelvis from the point of support is produced and maintained by the contraction of the Abductors of the Hip of the supporting leg. When this occurs the Lumbar Side Flexors on the opposite side from the supporting leg work to keep the trunk erect.

When the weight of the body is transferred on to one leg and the Hip Abductors are relaxed or inefficient, the pelvis is inclined laterally and downwards towards the unsupported side by the force of gravity.

c. Rotation of the Pelvis

The pelvis can also be rotated so that the anterior superior iliac spine of one side is thrust forwards. This rotation is associated with separation of the legs in an antero-posterior direction providing it is more than a few inches and both legs are moved.

### Short Answer Type Questions

1. What are the different fundamental starting positions?
2. Explain about the sitting position.

### Long Answer Type Questions

1. What are the different posture movements? Explain in detail.
2. Write short notes on: (a) Pelvic tilt  (b) Lateral tilting of the pelvis.
Introduction to Exercise Therapy

Exercise Therapy is a means of accelerating the patient’s recovery from injuries and diseases which have altered his normal way of living. Loss or impairment of function prevents or modifies his ability to live independently, to carry on with his work and enjoy recreation. He may react to the demands of his environment either by rejecting them and remaining inactive or by meeting them to the best of his ability by altering his pattern of activity.

The aims of Exercise Therapy

The aims of treatment by exercise are:

1. To promote activity whenever and wherever it is possible to minimize the effects of inactivity.

2. To correct the inefficiency of specific muscles or muscle groups and regain normal range of joint movement without delay to achieve efficient functional movement.
3. To encourage the patient to use the ability he has regained in the performance of normal functional activities and so accelerate his rehabilitation.

### 2.1 The techniques of Exercise therapy

Movement used in treatment may be classified as follows:

**Active Movement**

1. Voluntary
   - Free.
   - Assisted.
   - Assisted-Resisted.
   - Resisted.

2. Involuntary
   - Reflex.

**Passive Movement**

1. Relaxed passive movements including accessory movements.

*Posture*. Movement begins and ends in posture which is classified as either active or inactive.

*Active Movement and Posture* is achieved by muscular contraction in response to a demand presented in a manner suitable to the patient’s ability to respond.

*Passive movement and Posture* result from the application of external forces when the muscles are unable to contract or when they relax voluntarily to permit movement or allow support.

The techniques which are most effective for obtaining the aims of treatment are those which (i) demand as much activity as possible and which (ii) are based on patterns of movement which are the same as those used by the patient for his normal functional activities.

(i) Muscles are as active as possible when all their available motor units are activated, i.e. contracting maximally. As the strength of contraction is proportional to the assistance which opposes it the application of the greatest degree of resistance possible, i.e. (*a maximal resistance*, elicits a maximal contraction).

(ii) Patterns of *mass movement* are used for most functional activities.
When activity is impossible or contra-indicated passive movement is used to maintain the extensibility of the muscles and the free range of movement in joints. In some cases forced passive movement are used to increase the free range of movement in joints.

### 2.2 Assessment of the patient condition

#### Some methods of testing

Record charts are dated and kept for use each time the test repeated. Some of the tests in common use are as follows:

**1. Functional Tests**

These are used to assess the patient’s needs and abilities with regard to functional activities, e.g. mobility (in bed, transfers, ambulation, etc.), personal care (eating, dressing, washing etc.), household or garden jobs (cooking, washing up, sweeping, lifting, etc.), work recreation.

**2. Tests of Joint Range**

Measurement of the limitation of joint range presents many difficulties in practice. A suitable position is selected for the patient so that he is stable, to make sure that any structures which would limit the normal range of movement are relaxed, e.g. calf muscles must be relaxed by flexing the knee to measure full range of ankle movement. As the normal range of movement varies considerably in individuals, the contralateral joint always be measured first when possible.

**3. Tests for Neuromuscular Efficiency**

These may be carried out electrically, manually or mechanically.

a. **Electrical Tests**: These may be carried out by the doctor with the use of the electro-myograph or by means of the strength-duration curve. They are particularly valuable for diagnostic purposes.

b. **Manual Muscle Testing**. To be accurate and efficient manual muscle testing requires a standardized technique and considerable experience. The classification of the findings at examination, however, are usually recorded according to the Oxford Classification, on a scale 0-5, i.e.,

No contraction

1. Flicker of contraction
2. Weak. Small movement with gravity counterbalanced.
3. Fair. Movement against gravity
4. Good. Movement against gravity and some resistance.

5. Normal.

c. Circumference Measurement. This test relies on the fact that there is a relationship between the development of power and that of hypertrophy. A tape measure made from some inextensible material is used to measure the circumference of the limb at a predetermined level. Experiment on normal limbs indicates that this method is unreliable even in experienced hands; although it is still used.

d. Static Power Test. The power of static or isometric contraction may be recorded by means of a spring balance capable of registering up to 50 to 100 lbs.

e. Dynamic Power Test. This is a method devised by de Lorme, and Watkins as a basis for Progressive Resistance Exercise. The maximum weight which can be lifted once only through a prescribed range is called the One Repetition Maximum (1 R.M.) and the maximum weight which can be lifted ten times at natural speed without rest between lifts is the Ten Repetition Maximum (10 R.M.). Experience in estimating the approximate weight which can be lifted is essential to avoid fatigue which results from continued trial and error and which rapidly reduces the poundage which can be lifted.

f. Endurance Test. Endurance maybe calculated by recording the drop in the maximal power of the muscles when their effort of contraction is repeated at given intervals for a specific period of time.

g. Speed Tests. The successful performance of functional activities can be timed by the use of a stop-watch, e.g. time taken to dress or walk a measured distance.

4. Tests for Co-ordination

Co-ordination of movement, or the lack of it, is observed in the patient’s gait, his performance of purposeful movements or during specific movement such as bringing the finger to the tip of the nose or moving the heel up and down along the opposite shin bone.

5. Tests for Sensation

These are described fully in any neurological network.
6. Measurement of Vital Capacity and Range of Respiratory Excursions

A spirometer is used to measure vital capacity. The patient is instructed to breath is as much as possible and then breath out through the mouthpiece of the spirometer which registers the volume in cubic centimeters.

7. Measurement of Leg Length

True shortening of the leg is measured from the anterior superior iliac spine or the upper margin of the great trochanter to the lateral malleolus, and apparent shortening from the umbilicus or xiphisternum to the level of the knee joint or the tip of the medial malleolus.

8. Measurement of the Angle of Pelvic Inclination

Antero-posterior inclination of the pelvis may be measured by means of a pelvic inclinometer.

2.3 Goniometry

Range of motion (ROM) is a basic technique used for examination of movement and for initiating movement into a program of therapeutic intervention. The full motion possible is called the range of motion. When moving a segment through its ROM, all structures in the region are affected: muscles, joint surfaces, capsules, ligaments, fasciae, vessels, and nerves. ROM activities are most easily described in terms of joint range and muscle range. To describe joint range, terms such as flexion, extension, abduction, adduction, and rotation are used. Ranges of available joint motion are usually measured with a goniometer and recorded in degrees. Muscle range is related to the functional excursion of muscles.

Short Answer Type Question

1. Define exercise therapy.

2. List the techniques of exercise therapy.

3. Define range of motion (ROM).

Long Answer Type Questions

1. What are the different aims of exercise therapy?

2. Explain in detail the methods of testing.
3.0 Introduction

These movements are produced by an external force during muscular inactivity or when muscular activity is voluntarily reduced as much as possible to permit movement.

Classification

a. Relaxed Passive Movements, including accessory movements.
b. Passive Manual Mobilisation Techniques
   (i) Mobilisations of joints
   (ii) Manipulations of joints
   (iii) Controlled sustained stretching of tightened structures.
Specific Definitions

a. (i) Relaxed Passive Movements

These are movements performed accurately and smoothly by the Physiotherapist. A knowledge of the anatomy of joints is required. The movements are performed in the same range and direction as active movements. The joint is moved through the existing free range and within the limits of pain.

(ii) Accessory movements

These occur as part of any normal joint movement but may be limited or absent in abnormal joint conditions. They consist of gliding or rotational movement which cannot be performed in isolation as a voluntary movement but can be isolated by the physiotherapist.

b. Passive Manual Mobilisation Techniques

(i) Mobilisations of joints

These are usually small repetitive rhythmical oscillatory, localized accessory, or functional movements performed by the physiotherapist in various amplitudes within the available range, and under the patient’s control. These can be done very gently or quite strongly, and are graded according to the part of the available range in which they are performed.

(ii) Manipulations of joints performed by

a. Physiotherapists

These are accurately localized, single, quick decisive movements of small amplitude and high velocity completed before the patient can stop it.

b. Surgeon/Physician

The movements are performed under anaesthesia by a surgeon, or physician to gain further range. The increase in movement must be maintained by the physiotherapist.

(iii) Controlled sustained stretching of tightened structures

Passive stretching of muscles and other soft tissues can be given to increase range of movement. Movement can be gained by stretching adhesions in these structures or by lengthening of muscle due to inhibition of the tendon protective reflex.
3.1 Principles of giving relaxed passive movements

**Relaxation.** A brief explanation of what is to happen is given to the patient, who is then taught to relax voluntarily, except in cases of flaccid paralysis when this is unnecessary. The selection of a suitable starting position ensures comfort and support, and the bearing of the physiotherapist will do much to inspire confidence and co-operation in maintaining relaxation through the movement.

**Fixation.** Where movement is to be limited to a specific joint, the bone which lies proximal to it is fixed by the physiotherapist as close to the joint line as possible to ensure that the movement is localised to that joint; otherwise any decrease in the normal range is readily masked by compensatory movement occurring at other joints in the vicinity.

**Support.** Full and comfortable support is given to the part to be moved, so that the patient has confidence and will remain relaxed. The physiotherapist grasps the part firmly but comfortably in her hand, or it may be supported by axial suspension in slings. The latter method is particularly useful for the trunk or heavy limbs, as it frees the physiotherapist’s stance must be firm and comfortable. When standing, her feet are apart and placed in the line of the movement.

**Traction.** Many joints allow the articular surfaces to be drawn apart by traction, which is always given in the long axis of a joint, the fixation of the bone proximal to the joint providing an opposing force to a sustained pull on the distal bone. Traction is thought to facilitate the movement by reducing interarticular friction.

**Range.** The range of movement is as full as the condition of the joints permits without eliciting pain or spasm in the surrounding muscles. In normal joints slight over pressure can be given to ensure full range, but in flail joints care is needed to avoid taking the movement beyond the normal anatomical limit.

As one reason for giving full-range movement is to maintain the extensibility of muscles which pass over the joint, special consideration must be given to muscles which pass over two or more joints. These muscles must be progressively extended over each point until they are finally extended to their normal length over all the joints simultaneously, e.g. the Quadriceps are fully extended when the hip joint is extended with the knee flexed.

**Speed and Duration.** As it is essential that relaxation be maintained throughout the movement, the speed must be uniform, fairly slow and rhythmical. The number of times the movement is performed depends on the purpose for which it is used.
A full description of the technique of giving relaxed passive movements to individual joints will be found.

**Effects and uses of Relaxed Passive Movement**

(i) Adhesion formation is prevented and the present free range of movement maintained. One passive movement, well given and at frequent intervals, is sufficient for this purpose, but the usual practice is to put the joint through two movement twice daily.

(ii) When active movement is impossible, because of muscular inefficiency, these movements may help to preserve the memory of movement patterns by stimulating the receptors of kinaesthetic sense.

(iii) When full-range active movement is impossible the extensibility of muscle is maintained, and adaptive shortening prevented.

(iv) The venous and lymphatic return may be assisted slightly by mechanical pressure and by stretching of the thin-walled vessels which pass across the joint moved. Relatively quick rhythmical and continued passive movements are required to produce the effect. They are used in conjunction with elevation of the part to relieve oedema when the patient is unable, or unwilling, to perform sufficient active exercise.

(v) The rhythm of continued passive movements can have a soothing effect and induce further relaxation and sleep. They may be tried in training relaxation and, if successful the movement is made imperceptibly and progressively slower as the patient relaxes.

**3.2 Principles of giving accessory movements**

The basic principles of relaxation and fixation apply to accessory movement as to relaxed passive movements. Full and comfortable support is given and the range of the movement is as full as the condition of the joint permits. They are comparatively small movements.

**Effects and Uses of Accessory Movements**

Accessory movements contribute to the normal function of the joint in which they take place or that of adjacent joints.

In abnormal joint conditions there may be limitation of these movements due to loss of full active range caused by stiffness of joints from contracture of soft tissue, adhesion formation or muscular inefficiency. Accessory movements are performed by the Physiotherapist to increase lost range of movement and to maintain joint mobility. Hence they form an important part of the treatment of a patient who is usable to perform normal active movement.
3.3 Principles of passive manual mobilisation and manipulations

These techniques, together with their effects and uses, cover a very wide field which is beyond the scope of this book. Specific reference to books by Maitland, Grieve, Kaltenborn and other authorities on the subject is given in the bibliography.

Manipulations performed by a surgeon or physician are usually given under a general or local anaesthetic which eliminates pain and protective spasm, and allows the use of greater force. Even well-established adhesions can be broken down; but when these are numerous, it is usual to regain full range progressively, by a series of manipulations, to avoid excessive trauma and marked exudation. Maximum effort on the part of the patient and the physiotherapist must be exerted after manipulations in maintain the range of movement gained at each session, otherwise fibrous deposits from the inevitable exudation will form new adhesions.

3.4 Principles of passive manual mobilisation and manipulations

The patient is comfortably supported and as relaxed as possible in an appropriate position. With suitable fixation the part is grasped by the physiotherapist and moved in such a way that a sustained stretch can be applied to the contracted structures for a period of time within a functional pattern of movement. Mechanical means can be used, e.g., turnbuckle plaster.

Effects and Uses of Controlled Sustained Stretching

(i) Steady and sustained stretching may be used to overcome spasticity patterns of limbs, e.g., a hemiplegic patient. The slow stretch produces a relaxation and lengthening of the muscle

(ii) A steady and prolonged passive stretch can overcome the resistance of shortened ligaments, fascia and fibrous sheaths of muscles as, for example, in controlled stretching and progressive spintage of talipes equinovarus.

Short Answer Type Questions

1. How are passive movement produced.

2. What are the uses of accessory movement?

Long Answer Type Questions

1. What are the principles of giving relaxed passive movement? Explain.
**Structure**

4.0 Introduction

4.1 Free exercise

4.2 Assisted exercise

4.3 Resisted exercise

4.4 Progressive resistance exercise

4.5 Involuntary movement

### 4.0 Introduction

**Definition**

Movement performed or controlled by the voluntary action of muscles, working in opposition to an external force.

**Classification**

**Free Exercise**: The working muscles are subject only to the forces of gravity acting upon the part moved or stabilised.

**Assisted Exercise**: When muscle strength or co-ordination is inadequate to perform a movement an external force is applied to compensate for the deficiency.
Assisted-resisted Exercise: Muscles may be strong enough to work against resistance in part of the range and not in others. This type of exercise ensures the external forces applied are adapted in every part of the range to the abilities of the muscles.

Related Exercise: The forces of resistance offered to the action of the working muscles are artificially and systematically increased to develop the power and endurance of the muscles.

4.1 Free Exercise

Free exercises are those which are performed by the patient’s own muscular efforts without the assistance or resistance of any external force, other than that of gravity. A degree of relaxation is induced by exercises which are rhythmical or pendular in character; muscle tone is maintained and power increased according to the speed, leverage and duration of the exercise, and the relationship of the part moved to gravity.

The great advantage of free exercises lies in the fact that once the patient has mastered the technique of their performance and it aware of their purpose, they are his own, to practice when and where he pleases.

Classification of Free Exercises

Free exercises may be classified according to the extent of the area involved; they may be:

a. Localised

b. General

a. Localised exercises are designed primarily to produce some local and specific effect, for example, to mobilise a particular joint or to strengthen particular muscle groups.

b. General exercises usually involve the use of many joints and muscles all over the body and the effect is widespread, for example, as in running.

The Technique of Free Exercises

1. The starting position is selected and taught with care to ensure the maximum postural efficiency as a basis for movement.

2. Instruction is given in a manner which will gain the interest and co-operation of the patient and lead him to understand both the pattern and the purpose of the exercise.
3. The speed at which the exercise is done depends on the effect required. It is usually slow during the period of learning and later the patient is either allowed to find his own natural rhythm, or the speed required is dictated by the physiotherapist.

4. The duration of the exercise depends very largely on the patient’s capacity.

The Effects and Uses of Free Exercise

The effect and consequent uses of any particular free exercise depend on the nature of the exercise, its extent and the intensity and duration of its performance.

Relaxation: Rhythmical swinging movements and those which are pendular in character assist the relaxation of hypertonic muscles in the region of the joint moved.

Joint Mobility: The normal range of joint movement is maintained by exercises performed in full range.

Muscle Power and Time: The power and endurance of the working muscles are maintained or increased in response to the tension created in them.

Normally, muscle power is maintained adequately by a minimum of everyday activities, most of which are performed in the middle range.

Neuromuscular Co-ordination: Co-ordination is improved by the repletion of an exercise.

Confidence: The achievement of coordinated and efficient movement assures the patient of his ability to maintain subjective control of his body, giving him confidence to attempt other and new activities, together with a feeling of exhilaration and satisfaction when they are accomplished, for example, jumping a rope, or shooting a goal. Objective exercises and activities are usually used for this purpose.

Circulatory and Respiratory Co-operation: During vigorous or prolonged exercise it is apparent that the speed and depth of respiration is increased, in light exercise these changes are so slight that they are not noticed.

a. The Needs of the Active Tissues. The active tissues involved during muscular exercise require a free supply of oxygenated blood and the removal of metabolic products to enable them to continue their activity.

b. Preparation for Activity. It is probable that the cerebral cortex, which initiates the muscular contraction also prepares the body to supply the needs of
the tissues concerned, by communicating with Respiratory, Cardiac and Vasomotor centre’s which form part of the Autonomic Nervous System.

c. Local Circulatory Changes in the Muscles. During active exercise the capillaries in the working muscles dilate and their permeability is increased. Many capillaries that were closed when the muscle was at rest become open and blood flows through them. In this way the capacity of the muscles to contain blood is markedly increased and the interchange of fuel and waste products between the blood and the tissue fluids is facilitated.

d. Regulation of Circulatory and Respiratory Function during Exercise. The venous return to the heart is increased during exercise and results in an increase in cardiac output. The increased venous return is caused partly by the pressure variations in the abdominal and thoracic cavities resulting from increased respiratory movements which exert a pumping action upon the large veins in the direction of the heart, and partly by the pressure of the contracting muscles on the thin walls of the peripheral veins. Values in these veins prevent regurgitation during relaxation of the pressure.

Muscular contraction increases both the carbon dioxide content and the temperature of the blood, and both these factors stimulate the circulatory and respiratory systems to further activity. The rise in temperature of the body is kept within normal limits by dilation of the skin capillaries and stimulation of the sweat glands, thus enabling heat to be lost from the surface.

Active exercise can therefore be used to increase Respiration, to increase both the local and the general Circulation, and to provide work for the Heart Muscle.

4.2 Assisted Exercise

The Principles of Assistance

When the force exerted on one of the body levers by muscular action is insufficient for the production or control of movement, an external force may be added to augment it. This external force must be applied in the direction of the muscle action but not necessarily at the same point. Mechanical advantage can be gained by increasing the leverage.

Technique

The inefficient muscles exert their maximum effort to produce movement under conditions designed to facilitate their action. The assisting force is applied only to augment this maximum effort and not to act as a substitute for it.
1. **Starting Position**: Stability for the body as a whole ensures that the patient’s whole attention is concentrated on the pattern of movement and the effort required to perform it.

2. **Pattern of Movement**: This must be well known and understood by the patient. It can be taught by passive movement or in the case of limb movements by active movement of the contralateral limb.

3. **Fixation**: Adequate fixation of the bone of origin of the prime movers improves their efficiency.

4. **Support**: The part of the body moved is supported throughout to reduce the load on the weakened muscles by counterbalancing the effects of the force of gravity. This support may be provided by the physiotherapist’s hands, suspension slings, a polished horizontal surface such as a re-education board, the buoyancy of water or ball bearing skates.

5. **The Antagonistic Muscles**: Every effort must be made to reduce tension in the muscles which are antagonistic to the movement.

6. **Traction**: Preliminary stretching of the weak muscles to elicit the myotatic (stretch) reflex provides a powerful stimulus to contraction.

7. **The Assisting Force**: The force used to augment the action of the muscles is supplied in the direction of the movement, preferably by means of the physiotherapist’s hands, which should be placed in such a way that they rest on the surface of the patient’s skin which is in the direction of the movement.

   The range of movement is as full as possible, but as the power of muscles varies in different parts of their range more assistance will be necessary in some parts than in others.

8. **The Character of the Movement**: The movement is essentially smooth as this is characteristic of efficient voluntary movement and it is performed in response to a forceful command which demands the patient’s full attention.

9. **Repetitions**: The number of times the movement is repeated depends on whether it is considered advisable or injurious to fatigue the muscles.

   10. The co-operation of the patient is essential during this type of exercise, the aim being for him to achieve controlled active movement without assistance.

**Effects and Uses of Assisted Exercise**

   (i) This type of exercise may be used in the early stages neuro-muscular re-education.
(ii) By frequent repetition of the correct pattern with decreasing assistance, the patient may relearn to control the movement himself as the conduction of impulses is facilitated in the neuromuscular pathways.

(iii) Confidence, in the ability to move is established when the patient observes the movement and the fact that has muscles co-operate in producing it.

(iv) The range of effective joint movement may be increased by assisted exercise; however, as both range and control are often dependent on the efficiency of the muscles working over that joint.

**Assisted - Resisted Exercise**

This type of exercise constitutes a combination of assistance and resistance during a single movement and whenever it is possible it is preferable to Assisted Exercise as it meets the needs of the muscles with greater accuracy.

**4.3 Resisted Exercise**

**The Principles of Resistance**

An external force may be applied to the body levers to oppose the force muscular contraction. Tension is increased within the muscles by the opposing force (or resistance) and the muscles respond by an increase in their power and hypertrophy. The resisting force applied to an isotonic contraction must be sufficient to increase intra-muscular tension to the maximum. There are five factors which contribute to the development of muscular efficiency, i.e. power, endurance, volume, speed of contraction and coordination.

Power develops in response to the application of the maximum resistance which is consistent with the ability of the muscles to overcome it, therefore power can be built up when they work against a progressively increasing resistance. As the essential factor in power development is the magnitude of the resistance the method used to promote it is called PROGRESSIVE RESISTANCE-LOW REPETITION EXERCISE, the number of times the movement is repeated being relatively few to allow the resistance to be as great as possible.

Endurance is a quality which develops in response to repetitive contraction, therefore as it is the number of contractions which is the essential factor, the method used in this case is called LOW RESISTANCE-HIGH REPETITION EXERCISE.

Volume, which can be observed or measured as an indication of hypertrophy, usually develops in proportion to power.
Technique of Resisted Exercises

1. **Starting Position**: Comfort and stability for the body as a whole ensures that the patient's whole attention can be concentrated on the pattern of movement and the effort required to overcome the resistance.

2. **The Pattern of Movement**: This must be well known by the patient and can be taught as passively or a free exercise.

3. **Stabilisation**: Stabilisation of the bone or bones of origin of the muscles to be resisted improves their efficiency. Manual pressure or a strap must be used to ensure movement at the required point.

4. **Traction**: Traction maintained throughout the range facilities joint movement and maintains tension on the muscles and so augments the effect of the resisting force.

5. **The Resisting Force**: A variety of means may be employed to supply the force used to resist the contraction of the working muscles, e.g. manual pressure, weights, springs, etc. The advantage of manual pressure is that it can be adjusted accurately to match the power of the muscles in all circumstances and in every part of the range, but it also has the disadvantage of not being easily measurable. Maximal resistance elicits maximal effort on the part of the muscles and is therefore used to develop power and hypertrophy.

6. **The Character of the Movement**: The movement is essentially smooth and controlled throughout, the effort involved commanding the patient's full attention. The range of movement is full whenever possible, but resistance can be applied in any part of the range.

7. **Repetitions**: The number of times the muscles are thrown into action against a resistance varies according to the condition to the condition and the individual patient.

   Low Resistance-High Repetition exercises appear to be more suitable for weak or elderly patients whose muscles are less resilient than those of the young and strong, and they have proved to be effective in such conditions as Osteo-arthritis. High Resistance-Low Repetition exercises on the other hand undoubtedly build up power and hypertrophy muscles suffering from disuse as the result of traumatic injury.

8. **The Co-operation of the Patient**: The effort exerted by the patient and his interest in the treatment undoubtedly play an important part in the development of his muscles by means of resisted exercise.
Resistances

A resisting force other than that provided by gravity and friction may be provided by:

1. The physiotherapist
2. The patient.
3. Weights
4. Weight and pulley circuits.
5. Springs and other elastic structures
6. Substances which are malleable
7. Water

Fig. 4.1

4.4 Progressive Resistance Exercise

The use of Progressive Resistance Exercise for the restoration of muscle power and volume after injury was first described by de Lorme in 1945 although this method of promoting muscle builders for a very long time.

Metal weights, which constitute the resisting force, are applied to the part of the body. The poundage is determined by testing the repetition maximum (R.M.) for a given number of repetition. Lifting of the weight may involve either static (isometric) or dynamic (isotonic) muscle work. It appears that the regime most suitable and successful in the treatment of an individual patient varies very much with his age, temperament and the condition from which he is suffering.

The following schema are all based on the test for a 10 R.M. and represents a power programmed. Imperial measures can be replaced by metric units.

De Lorme & Watkins                  Zinovieff (Oxford Technique)
10 lifts with 1/2 10 R.M.            10 lifts with 10 R.M.
10 lifts with 1/2 10 R.M.            10 lifts with 10 R.M. minus 1 lb.
Physiotherapy

10 lifts with 10 R.M. 10 lifts with 10 R.M. minus 2lbs.
10 lifts with 10 R.M. minus 3lbs.
10 lifts with 10 R.M. minus 4lbs.
10 lifts with 10 R.M. minus 5lbs.
10 lifts with 10 R.M. minus 6lbs.
10 lifts with 10 R.M. minus 7lbs.
10 lifts with 10 R.M. minus 8lbs.
10 lifts with 10 R.M. minus 9lbs.

30 lifts 4 times weekly. 100 lifts 5 times weekly.
Progress 10 R.M. once Progress 10 R.M. daily.
weekly.

MacQueen
10 lifts with 10 R.M.
10 lifts with 10 R.M.
10 lifts with 10 R.M.
10 lifts with 10 R.M.

40 lifts 3 times weekly.
Progress to R.M. every 1-2 weeks.

The endurance programme is based on the use of relatively low resistance and high repetition regime.

Progressive resistance exercise can be used in principle for the development of most muscle groups but it is at present more often used for the Knee Extensors than any other group.

Resistance by Weight and Pulley Circuits: The use of a rope and pulley allows the force exerted by a weight to act in any direction (see Pulleys) therefore the muscles need not be required to work against the resistance of both gravity and the weight. The effect of gravity can be counterbalanced if the movement takes place in a horizontal place. This provides a useful method of arranging resistance for weak muscles when the limb is heavy.
Example: In sitting the resistance of gravity to the Knee Extensors is approximately 5 kg. If these muscles are unable to straighten the knee against this resistance, they may still be able to perform the exercise adequately when, in side lying, the leg is supported horizontally and a resistance of, 4 kg, is applied.

![Fig. 4.2](image)

Two methods of giving Weight and Pulley Resistance for the Knee Extensor. The relaxation stop R is shown on the left.

Resistance by Springs and Other Elastic Substances. The resisting force of a spring increases progressively as it is stretched or compressed according to the type of spring used.

Resistance by Substances which are Malleable. Substances such as putty, clay, some kinds of wax, Plasticine and wet sand can be moulded into different shapes.

Resistance by Water. The resistance offered by water increases with the speed and the surface area of the part moved. When the movement is vertical, buoyancy adds to the resistance on the way down and cancels out much of the resistance on the way up.

Progression. As the power of the muscle increases, the resistance must be increased proportionately.

**Effects and Uses of Resisted Exercises**

(i) Muscle power can only be maintained or increased by contraction, and in these exercises the working muscles are strengthened and hypertrophied in response to the tension created in them by the resistance. Resisted exercises are used to build up weak muscles and so to restore the balance of muscle power which is essential for stability and co-ordinated movement.

(ii) The blood flow to the working muscles is increased in proportional to the amount of work. Flow is impeded during the actual contraction, the amount
of blood contained in the muscles immediately after contraction may be as much as ten times as great during strenuous exercise as the amount contained during rest. This increase in the blood flow to the muscles continues for some time after exercise, bringing oxygen and nutrition to the part and assisting the removal of metabolic products.

(iii) A general rise in blood pressure frequently anticipates exercise and may be increased by the mental effort required to perform these exercises correctly.

(iv) Heat, which is produced as the result of strenuous muscular activity, stimulates the heat-regulating centre causing vaso-dilatation in the skin.

### 4.5 Involuntary movement

**Reflex movement**

Reflex movement is involuntary and may be defined as the motor response to sensory stimulation. These reflex movements are protective in character or concerted with the repetition of movement patterns which have become automatic or habitual. Although the stimuli which give rise to reflex movements do not usually gain conscious recognition the patient is aware the reflex movements of the body have taken place.

The Reflex Arc

The reflex arc is the pathway of impulses which give rise to reflex activity. In its most simple form it consists of two neurones, an afferent neurone which leads from a sensory receptor organ to the C.N.S and an efferent neurone leading from the C.N.S. to the effector organ (muscle fibres). Few reflex arcs are as simple as this, most of them consisting of a chain of neurones in which one or several connecting neurones lie between the afferent and efferent neurones.
Reflex activity can be stimulated and used to improve or facilitate movement or the maintenance of posture.

The Stretch Reflex

This is a spinal reflex activated by stretching a muscle. When an innervated muscle is stretched it responds by contracting and developing tension to counteract the stretching force; this provides a means of promoting activity in muscles when voluntary effort is ineffective or too weak to do so. Quick stretching stimulates the muscle spindles which the proprioceptive receptors so that they discharge impulses which reach the A.H.C's by mono-synaptic pathways. Tension in a contracting muscle is increased by the application of a resisting force and the quality of the contraction is improved. Contraction of muscles in response to stretch is accompanied by a reciprocal inhibition of antagonistic muscles to permit movement.

The Righting Reflexes

These are a series of reflexes concerned with the maintenance and restoration of equilibrium. Pushing the patient off balance elicits a series of mass movements designed to restore balance and save him from falling.

The Postural Reflexes

The erect posture is maintained by a complex series of reflexes known collectively as the Postural Reflexes.

Effects and Uses of Reflex Movement

1. The initiation of reflex movement provides a means of promoting activity of the neuromuscular mechanism when voluntary efforts is ineffective or insufficient for the purpose. It is used in cases of flaccid paralysis and brain damage to facilitate the initiation of movement and to combat the effects of inactivity.

2. Normal joint movement and the extensibility of muscles is maintained by this type of movement when spastic paralysis makes voluntary movement impossible.

3. Circulation is improved by the contraction of muscles and movement of joints achieved during these movements.

4. Temporary relaxation of spastic muscles is obtained following repeated movements of this type by means of reciprocal innervation. This may provide the opportunity for the development of voluntary ability to perform movement in cases of specific paralysis.
5. Postural reflexes are conditioned to reproduce a satisfactory pattern of posture by repeated use of these patterns. This is the basis of postural re-education.

**Short Answer Type Questions**

1. Define active movement.
2. What is free exercise?
3. What is assisted exercise?
4. What is resisted exercise?

**Long Answer Type Questions**

1. Write down the classification of free exercise in detail.
2. What are the techniques, principles of assisted exercise?
3. What are the principles and techniques of resisted exercise?
Muscles which are relatively free from tension and at rest are said to be released. Tension develops in muscles as they work during the traction and this tension is reduced to a variable degree as the muscles come to rest during relaxation.

**Muscle Tone**

Living muscles are never completely free from tension, as they retain a quality of firmness known as muscle tone.

**Postural Tone**

The contraction which persists in the muscles connected with the maintenance of posture (chiefly the anti-gravity muscles) is called Postural Tone.

**5.1 Technique of general relaxation**

Support, comfort and a restful atmosphere are basic conditions for general relaxation and may prove effective without additional methods.
a. **Support**

Various forms and modifications of the lying position are used, to achieve full support of the body, the relative suitability of each one varying according to the condition of the patient and to individual preference. The weight of the body is thus effectively counterbalanced by the uniform upward pressure of a reciprocal surface, or by suspension, in a position of semi-flexion which obviates all mechanical tension on muscles of ligaments.

(i) *Lying Supine.* A firm surface is essential, and if resilient also, as in the case of a good spring mattress, it is ideal, as it will mould itself to the body contours and give even pressure and comfort. At all costs plinths or beds which sag are to be avoided as they cramp the thorax and so throw additional strain on the inspiratory muscles. A head pillow is required which is sufficiently soft to prevent the head from rolling to either side, and to be well moulded to support the neck posteriorly. A small pillow under the knees relieves tension on the Hamstrings and the ilio-femoral ligament, and consequently allows the pelvis to roll backwards so that the lumbar spine is straightened and supported. The feet are held in the mid-position by a sandbag or similar device, and each arm, slightly abducted at the shoulder and flexed at the elbow, rests on a pillow.

![Fig. 5.1 Lying supine for relaxation](image1)

(ii) *Half Lying.* This is similar to the previous position but breathing is easier as there is less weight on the back and abdominal pressure on the under surface of the Diaphragm is reduced. An armchair makes quite a good substitute for a plinth or bed, the thighs are fully supported and the feet rest on the floor, or a footstool, of a T-shaped footrest.

![Fig. 5.2 Half lying adapted for relaxation](image2)
(iii) Prone Lying. The head is turned to one side and may rest on a small pillow, if more comfortable. A firm pillow under the hips and the lower abdomen prevents hollowing of the back, and for women it should extend higher to avoid too much pressure on the breasts; the lower leg is elevated so that the knees are slightly bent and toes free. A degree of medial rotation at the hips, causing the heels to fall apart, still further induces relaxation of the legs. Many find this position comfortable and use it for sleeping; others dislike it because of the rotated position of the head.

Fig. 5.3 Prone lying as for relaxation

(iv) Side Lying. The measure of relaxation obtained is governed by the efficiency with which the shoulder and pelvic girdles are stabilized. The arm and leg which are uppermost may be rested on the supporting surface instead of a pillows, but some of the weight then falls on the trunk and this impedes respiration. The head pillow supports the neck and head in alignment with the body, and must not be too high. The majority of people sleep on the side, but few are conscious of the part suitable positioning for relaxation plays in promoting it.

Fig. 5.4 Side lying for relaxation

b. Comfort

In addition to support and individual preference in positioning, for which some suggestions have already been made, the ingredients of comfort include freedom to breathe deeply, warmth, abdominal quiescence and a mild degree of physical fatigue. Removal of constrictive clothing, such as corsets and belts, is essential and any garters, buttons or suspenders liable to cause pressure must be removed. The room should be warm, but should have a free supply of fresh air; in winter additional warmth can be supplied by light but warm blankets, a covered hot-water bottle at the feet, an electric blanket or by non-luminous
infra-red irradiation, but care being taken to avoid overheating, as this leads to restlessness. For home use a warm bath gives the most even and pleasing type of heat, but its soothing effect must not be ruined subsequently by vigorous rubbing with a towel. A light well-balanced meal, rhythmical physical activity of short duration, such a brisk walk in the open air, and attention to emptying the bladder before treatment are all conductive to general relaxation.

c. Restful Atmosphere

As physical and mental relaxation are interdependent, an effort must be made to secure a state of mental rest. The treatment-room should be as quiet as possible, as many people for whom training in relaxation is prescribed are highly susceptible to the disturbing influence of noise.

d. Additional Methods of promoting Relaxation

Tension may persist in spite of the provision of conditions conductive to relaxation, in which case additional methods to help the patient may be employed.

Consciousness of Breathing. Under conditions of quiet and comfort the patient’s mind may remain active and turn to mundane problems and anxieties, with associated physical tension; in this case it may help him to concentrate on his own rhythm of breathing, which must be deep with a slight pause at the end of expiration. Expiration is a phase of relaxation and should be accompanied by a feeling of ‘letting go’ in the whole body.

Progressive Relaxation. A method by which relaxation may be achieved progressively was devised and practiced by Jacobson of Chicago, and something similar appears in modern literature on the Yoga System as the ‘Savasana’ or ‘Still Pose.’

![Fig. 5.5 Savasana - The Still pose](image)

Positive Movement. Rhythmical passive movements of the limbs and head may assist the degree of general relaxation in some cases. These movements are generally given as a sequel to massage. Group movements of joints, e.g. flexion and extension of hip, knee ankle, are preferable. The rhythm of small pendular movements pleases some patients.

The ability to promote a state of relaxation depends very largely on the individual physiotherapist. General relaxation can sometimes be carried our
effectively in groups, as in the case of pregnant women, who tend to relax easily, and with some asthmatic and bronchitic sufferers who have had previous individual instruction.

**5.2 Local Relaxation**

General relaxation takes time and is not always essential or desirable. Methods of obtaining local relaxation depend to some extent on the cause and distribution of the tension.

Preparatory to Massage and Passive Movement

Massage and passive movement both presuppose relaxation of the area under treatment. Relaxation is obtained of a specific area by the application to that area of the general principles already described for the whole body.

*For the Relief of Spam*

Spasm due to pain is protective and is most effectively reduced by the relief of a pain which caused it. However, if it persists because of fear of pain, techniques which ensure pain-free movement are often successful. Hold-relax is applicable in these circumstances, or pendular movements which start in the free range and gradually increase in amplitude may restore confidence and achieve relaxation.

*In preventing and combating Adaptive Shortening*

Persistent tension or hypertonicity of muscles acting upon one aspect of a joint produces a state of muscular imbalance which leads to adaptive shortening of the tense muscles and progressive lengthening and weakening of the antagonists on the opposing aspect of the joint. Both agonistic and antagonistic muscles are inefficient when this situation develops. Relaxation techniques for the shortened muscles and strengthening techniques for their antagonists are followed by integration of their reciprocal action to establish the increase in the range of movement.

**Short Answer Type Questions**

1. Define muscle tone and pastural tone.

2. Why is local relaxation technique used.

**Long Answer Type Questions**

1. What are the techniques of general relaxation?

2. What are the methods of local relaxation?
Structure

6.0 Introduction
6.1 Limitation of the range of joint movement
6.2 The prevention of joint stiffness
6.3 Mobilizing methods
6.4 Relaxed passive movement of the foot
6.5 Accessories movement of the foot
6.6 The knee joint
6.7 The hip joint

6.0 Introduction

Skeletal movement occurs at the joints, the type and range of movement possible depending on the precise anatomical structure of the joint and the position of the muscles controlling it.

The slightly movable or cartilaginous joints all lie in the median plane and permit a limited degree of movement by compression of a fibro-cartilaginous disc interposed between the bony surfaces, e.g. the pubic symphysis and joint of the vertebral bodies.
The free movable or synovial joints predominate in the body and, with one exception, include all the joints of the limbs.

**Classification**

Joints may be classified according to the movement they permit.

*Uni-axial.* Movement takes place about one axis: in a hinge joint it is flexion and extension (e.g. inter-phalangeal joints), in a pivot joint it is rotatory (e.g. atlanto-axial joint).

*Bi-axial.* Movement takes place about two axes: an ellipsoid joint allows the four angular movements, flexion, extension, abduction and adduction, and a combination of these four called circumduction (e.g. wrist), and a saddle joint such as the carpo-metacarpal joint of the thumb is similar.

*Poly-axial.* Movement about many axes occur in ball and socket joints: they are four angular movements, circumduction and rotation (e.g. hip).

*Plane.* Small gliding movement only are allowed, probably being more or less poly-axial in character (e.g. acromio-clavicular joint).

Some points permit small accessory movements in certain positions which cannot be performed voluntarily.

Under normal conditions joint movements are usually limited by tension of the opposing muscles, contact of soft tissues or tension of ligaments. For example, abduction of the hip is limited by the tension of the Adductor Muscles, flexion of the hip with the knee bent is limited by contact of the thigh with the abdomen, and extension is limited by the tension of the Flexor Muscles and the ilio-femoral ligament. The active range is usually greater than the passive range of movement owing to the reciprocal relaxation of the antagonistic group of muscles.

### 6.1 Limitation of the range of joint movement

Injury or disease may affect each or all the structural components of a joint and lead to a reduction in the normal range of movement. The factors which commonly cause limitation are:

(i) Tightness of skin, superficial fascia or scar tissue. This limits both the active and passive range.

(ii) Muscular weakness or inefficiency: Weakness or flaccidity of muscles limits active range if the power of the muscles is insufficient to overcome the resistance offered by the weight of the part moved. Tightness or spasticity of
muscles limits or prevents both active or passive movement, as the muscles antagonistic to the movement are unable to relax and allow it to take place.

(iii) The formation of adhesions: These limit both active and passive movement. Adhesion formation occurs following the output of a sero-fibrinous exudate into the region of the joint or into the joint itself. The joint structures become soaked in this exudate and if it is not speedily removed the fibrinous constituents of the exudate ‘glue’ the collagenous fibres of the ligaments and tendons together. The fibrinous ‘glue’ constitutes the adhesion, which is relatively soft at first and easily broken, but later, when the adhesions are consolidated, they contract to form scars. In this way the limitation of movement may be progressive. In the case of the shoulder joint, for example, adhesion formation may limit movement considerably, the capsule being ‘glued’ in folds, if the joint is allowed to remain in the same position for too long.

(iv) Displacement or tearing of an intracapsular fibrocartilage or the presence of a foreign body in the joint. Limitation of both passive and active movement may be present in this case, when either are accompanied by intense pain as the result of which the joint becomes locked by muscular spasm.

(v) Cartilaginous or bony destruction. The pain which arises may limit both active or passive movement and the articular surfaces will not slide easily upon one another. Bony of fibrous ankylosis limits movement altogether. Bony obstruction, such as in myositis ossificans, limits range in the direction of the obstruction.

(vi) Sometimes no organic cause can be found when the patient is unable to move a joint.

6.2 The prevention of joint stiffness

Whenever possible it is the physiotherapist’s duty to prevent a joint from suffering, and thereby save the patient pain and the possibility of a permanent disability. The period of rehabilitation can be considerably reduced in many cases and a return to work made possible. The motto that ‘Prevention is better than cure’ was never more apt than when applied to stiff joints.

Methods of prevention vary to some extent with the cause of the potential stiffness. Tightness of skin, fascia and scars must be combated by hot pack, soaking or massage. Muscular efficiency must be maintained by resisted exercise in prevent atrophy from disuse. Suitable strong muscles working against maximal resistance can be utilized to secure overflow of effort and ensure contraction of muscles working across immobilized joints, e.g. after knee injury or surgery. Quadriceps and Hamstrings can be activated by strong contraction of hip and
foot muscles of either leg. In addition the patient must be taught to initiate and practice voluntarily static contractions of these muscles at frequent intervals. “Five minutes in every hour” is the slogan. Coarse muscles such as Quadriceps, Deltoid, Gastrocnemius and glutei waste very rapidly without sufficient resistance to their contraction. In case of flaccid paralysis passive movement maintains joint range and the extensibility of muscles one or two full range movements, within physiological limits, performed twice daily being sufficient for the purpose. Where muscular imbalance is present splintage may be required. Joint range can be maintained in spastic paralysis by initiating reflex movement. Any forcing of passive movement or strong resistance is contra-indicated following recent injury to the elbow region because of the danger of myositis ossificans.

The formation of adhesions in the collagenous tissues of tendons, ligaments and fascia must be prevented by attempting to control the level of serofibrinous exudate. This may be achieved by reducing circulation in the area, by removing the cause of the increased exudation, or by increasing the removal of exudate. From bandages, rest, chemotherapy, cold packs or cooling lotions are effective means of treatment. The position of rest is of some importance, as it is designed to ensure an equal degree of tension of all fibres of the capsule. If a portion of the capsule is slack and prone to fall into folds, adhesions form very readily and glue these folds into tucks, therefore the knee joint is rested for example in 20 degrees of flexion and the shoulder joint is partially abducted.

Except in cases of bacterial infection, persistent effort must be made to assist the removal of the exudate or swelling before adhesions become organized, even if the affected joint has to be rested for a time to prevent further exudation. Elevation of the part, elastic bandaging and rhythmical active exercise of muscles and joints in the vicinity assist the venous return and ensure the free movement of tendons passing over the affected joint. Other methods of improving the circulation, such as contrast, baths, massage and heat, may also be employed if required. Careful active movements of the affected joint are begun as soon as possible and should progress rapidly. These movements maintain the power of the working muscles, ensure the freedom of tendons, and enable the pattern of movement to be remembered. Passive movements can also be used but they are more likely to give rise to minor trauma of the affected joint with consequent further output of exudation, and their effect on the circulation is minimal.

6.3 Mobilising methods

Limitations of the range of movement impairs the function of a joint and the muscles that move it. Measures which increase the range of the movement must, therefore, go hand in hand with those which build up sufficient muscle power to stabilise and control that movement. As instability and lack of control lead directly
to further injury, it is absolutely essential to ensure that every degree of mobility gained can be controlled by muscular action. Active exercise, which leads to an increase in range, works the muscles and reminds the patient of the pattern of movement, is the treatment of choice; in some cases, however, relaxation and passive or manipulative methods precede or assist its performance.

1. Relaxation

Where spasm causes limitation of movement relaxation leads to an increase in range.

2. Relaxed Passive Movement, including accessory movements

Relaxed passive movement maintains but does not increase mobility. It is used when active exercise in the same range is impossible or contraindicated. Freedom of accessory movement is necessary to maintain or regain full joint function.


(i) Mobilisations of joints.

(ii) Manipulations performed by the physiotherapists or surgeon/physician.

(iii) Controlled Sustained Stretchings.

These techniques increase mobility in joints and are followed by active exercise to maintain the increase. When the manipulations are carried out by a surgeon or physician, it is an advantage to the physiotherapist to be present so that she sees the range of movement to be maintained, and can treat the patient as soon as possible after he comes round from the anaesthetic.

4. Active Exercise

**Assisted Exercise.** Rhythmical movement, in which muscular contraction and assistance combine at the limit of the free range against the resistance of the limiting structures, is often successful in increasing the range. The patient’s cooperation and strict supervision by the physiotherapist are essential to achieve results.

**Free Exercise.** This is a valuable method as the exercises can be learnt and carried out at frequent intervals by a co-operative patient. This co-operation, and accurate instruction to ensure the correct movement, are essential. Pendular movement is used with an attempt to increase the amplitude, or a series of contractions of ‘pressing movements’ are performed at the limit of the range. Circulation is also increased.
**Resisted Exercise**: Techniques of Proprioceptive Neuromuscular Facilitation are most effective for rapid mobilization of stiff joints. Relaxation techniques are used to obtain a lengthening reaction of tight muscles and strengthening techniques for their antagonists. Control of the newly gained range of movement is established by slow reversal techniques. In some cases rhythmic stabilization followed by contraction into the range which has previously been limited may be more suitable.

**Technique of mobilising point**

The aim of mobilisation may be either to maintain the present range of a movement in a joint or to increase it. Relaxation, Relaxed Passive movements including accessory movement, Passive Manual Mobilisation Techniques, Assisted, Free, Assisted-Resisted and Resisted Exercises or General Activities all have a part to play in the mobilisation of joints in one case or another. The technique of Relaxation has already been considered, Manipulations under an anaesthetic are the province of the doctor or surgeon and the techniques of Proprioceptive Neuromuscular Facilitation which are recommended as the most effective method of using resisted exercise. With regard to all Free Exercises it is important to emphasize that a mobilising effect results not so much from the choice of a particular exercise but depends very largely on the manner in which it is performed. Full-range movement at natural speed with emphasis at the limit of the range and repeated many times and at frequent intervals seems to be most effective, but sometimes a more rapid movement or a sustained contraction are also used.

**Assessment of Progress**

Measurement of the present range of joint movement is essential before treatment begins and at specified intervals afterwards to permit assessment of progress. If progress is unsatisfactory the method of treatment must be modified or changed, and if it is still ineffective further investigation of the cause of the limitation must be made.

**Joints of the foot**

The many joints of the foot all contribute to its ability to adapt itself for walking on uneven surfaces, and to its resilience. With the exception of the transverse tarsal and subtaloid joints the range of movement at the intertarsal, tarsometatarsal and intermetatarsal joints is very small and cannot be localised to a single joint.
6.4 Relaxed passive movements of the foot

**Interphalangeal Joints of the Toes**

Each of these joints can be moved separately with the patient sitting or lying with the foot relaxed. The bone proximal to the joint moved is fixed, traction is given in the long axis of the joint and the full free range of flexion and extension is performed with a slight pause for overpressure at the end of each movement. Extension usually requires emphasis, as curling of the toes frequently limits this movement.

**Metatarsophalangeal Joints of the Toes**

Passive movements of each joint may be done separately or all five joints may be moved simultaneously, in which case the fingers of the physiotherapist’s fixing hand lie under the arching shafts of the metatarsal bones and her thumb rests on the dorsum of the foot. Her other hand grasps the proximal phalanges, gives traction and then performs the movement. Alternatively the distal phalanges may be grasped, and, while the toes are kept straight by traction, the movements are performed at the metatarsophalangeal joints, usually with emphasis on flexion. This alternative method is preferable as it more nearly approaches the correct functional movement of the toes in gripping the floor. For abduction and adduction all the toes are moved together either medially with regard to the body, or laterally. The great toe may need special attention.

**The Transverse Tarsal Joints**

½ ly.; 1F, inv. And ev. (pass.)

One of the physiotherapist’s hands fixes the patient’s ankle in dorsiflexion to prevent the lateral movement which may take place in this joint during plantarflexion. The other hand grasps round the distal row of the tarsus and the bases of the metatarsal bones from the lateral border of the foot and then inverts and everts the forefoot. Traction and overpressure are given in the usual way.

**Ankel Joint**

Tension on the Calf Muscles must be slackened to avoid limitation of dorsiflexion, therefore some position in which the knee is bend must be selected. Half Lying with the patient’s knee bent over a firm pillow or across the physiotherapist’s knee, leaving the heel unsupported, is a suitable starting position. The physiotherapist’s fixing hand grasps immediately above the joint while her other hand grasps round the foot at the level of tarsal joints to perform the movement. Overpressure during dorsiflexion may be given with this hand in the
same position or by means of traction on the heel with forearm on the sole of the foot. The plantar structures must not be strained by pressure on the forefoot.

6.5 Accessory movements of the foot

Metatarsophalangeal Joints of the Toes

Some accessory rotation, side to side, and anteroposterior gliding movements are possible when the joints are distracted.

Intermetatarsal Joints of the Foot

These movements cannot be performed actively except in conjunction with other movements. Gliding movements between the distal ends of the bones performed passively help to keep the foot resilient. Upward pressure of the physiotherapist’s fingers bunched behind the heads of the metatarsal bones on the sole of the foot, in combination with a stroking movement performed with her thumbs on the dorsum, moulds the anterior transverse arch of the foot into what should be its normal non-weight-bearing position.

The Subtaloid Joint

Movement here usually accompanies inversion and eversion so that the heel falls in the same plane as the forefoot. With the leg resting horizontally the heel is grasped with both hands, as in a clamp, and while traction is maintained on the tendo-calcaneum a side-to-side gliding movement on a vertical axis is performed. Fixation of the talus by means of pressure on the lateral malleolus with the fingers, and on the medial aspect of the talus with the thumb, while the calcaneum is moved on it by the other hand, is another method which may be used.

Controlled sustained stretching of the foot

Stretching of tightened structure is required for deformities such as talipes equino-varus. For this condition the baby’s knee is bent and protected by the mother while the ankle and heel are grasped so that the physiotherapist’s thumb rests on the talus. Using this as a fulcrum for the movement the forefoot is then drawn into abduction and eversion. When this movement is relatively free it is followed by that of dorsiflexion, during which traction is given on the calcaneum in an attempt to approximately the little toe and the anterior aspect of the tibia.

Assisted exercises for the foot

Manual assistance can be given to all the muscle groups which move the joints of the foot by using the same grasps as those used for giving passive movements of the joints.
Self-assistance given by means of a rope and pulley or a treadle machine is most useful for home practice.

**Exercises of free exercises for the foot**

Rhythmical exercises which are performed at a speed which allows time for additional pressure at the limit of the free range are used for group treatment and for home practice. A special effort on every 2nd or 3rd beat provides variety and reduces fatigue.

**Non-weight-bearing Exercises**

1. For the Ankel Joint

   a. *Legs crossed sitting*; I Foot dorsiflexion and plantaflexion.

   
   
   ![Fig. 6.1](image)

   
   
   b. *inclined long sitting; alternate* Foot dorsiflexion and plantaflexion (Treadle Movement)

   c. *sitting; alternate* Heel and Toe raising.

2. For the Transverse Tarsal and Subtaloid Joints

   d. *Legs crossed sitting (Foot dorsiflexed)*; Foot inversion and eversion.

   e. *close sitting*; Foot inversion and eversion (inner and outer border raising).

   f. *Ankles crossed sitting*; foot inversion and eversion (sweeping movement)

3. For the Metatarsophalangeal Joints.

   g. *sitting (Toes resting on book)*; Toe flexion and extension at these joints, with pressure on balls of toe.
h. sitting; foot shortening by flexion at the metatarsophalangeal joints. (Draw up stocking under medial longitudinal arch.)

i. sitting; Toe parting and closing. (This may be done in water or sand).

**Weight bearing Exercises**

j. reach grasp high toe sanding (wall bars); Heel raising and lowering.

k. reach grasp standing (on rocking board); Foot inversion and eversion. (see-saw movement of board.)

l. High standing; walk up inclined form.

**Activities to increase mobility of joints of the foot**

Common activities such as walking, running, and later, skipping, dancing, and hiking are also good mobilizing exercises when the feet are used correctly. Walking and running on uneven ground are specially recommended, as the feet are constantly required to adapt themselves to a varying surface and this requires movement at most or all of the many joints.

**6.6 The Knee joint**

The joints between the femoral and tibial condyles permit flexion, extension, and rotation in semi-flexion. The latter is possible in this position only when the lateral and medical ligaments, which lie somewhat posterior to the joint, are slackened as the knee is bent. Gliding movements in all directions are possible at the patello femoral joint when the Quadriceps Femoris is relaxed, and this movement must be free to allow the knee to bend.

**Accessory movements at the patello-femoral joint**

Whenever freedom of movement of the patella cannot be maintained by means of repeated contractions of the quadriceps muscles the bone must be moved passively. With the knee fully extended and the muscles relaxed, the patella is grasped between the first finger and thumb of both hands and glided up and down and from side to side.

**Relaxed passive movements of the knee joint**

*Between all the Articular Surfaces of the Knee Joint*


With the patient in lying and relaxed the physiotherapist in walk standing gives support under the thigh with one hand and with the other hand grasps round the ankle and gives traction. The hip and the knee joints are then moved.
into full flexion during which the physiotherapist’s hand, which is under the thigh, glides to a position in front of the knee to give overpressure at the end of the movement. As the hip and knee are extended, this hand is again moved to its original position to prevent any jarring of the knee at the conclusion of the movement.

\[ b. \ s.ly.; \ Hip \ and \ K.\ flex. \ and \ ext.(pass). \]

Either the leg which rests on the plinth or the one which is uppermost may be moved. In the latter case the leg must be fully supported throughout the movement in the hands, in suspension, on a re-education board or in water.

\[ c. \ 2 \ crk. \ Ly.; \ 1 \ K. \ rot. \ (pass.) \]

For rotation at the knee the thigh is supported vertically with the knee flexed to a right angle. The physiotherapist supports the thigh with one arm and grasps round the heel with the other hand so that the sole of the foot on her forearm, or, she may grasp round the lower leg just above the ankle.

To localise movement to the knee joint either side lying or prone lying are the most suitable starting positions for the patient.

**Assisted and resisted exercise for the knee point**

\[ (i) \ s. \ ly.; \ 1 \ K. \ flex. \ and \ ext. \ (ass.) \]

Manual assistance may be given for the Flexors or Extensors of the Knee from side lying with the limb supported in the hands on the surface of a plinth. In the latter case it is convenient to support the other leg in slings, but when the hands are used for support the leg remaining on the plinth is bent up to increase the stability of the trunk. The pattern of movement used should be that of withdrawal of the leg followed by thrust, as in this way the stabilization of the origins of the muscles working over the knee is adapted progressively to the circumstances of the movement.

During the thrusting movement the physiotherapist’s hand is placed under the ball of the great toe in order to gain advantage from the proprioceptive stimulation of pressure on this area. The movement is repeated rhythmically many times and, whenever times and, whenever possible, resistance to the movement is gradually introduced to encourage greater activity on the part of the muscles.

\[ (ii) \ pr. \ ly.; \ alt. \ K. \ flex. \ And \ ext. \ (auto-ass.) \]

Auto-assistance can be arranged in the prone position, and is particularly suitable when the hip is arthodesed. A pillow under the pelvis to get a degree of flexion will, however, help the movement if the hip is free.
A rope is attached to the heel of the stiff leg by some suitable device and passed over a pulley on the wall facing the patient, the other end of the rope being attached to the other leg. The rope is kept taut throughout by the reciprocal movement of the lower legs, the assisting leg being near full extension when the other reaches the limit of flexion. Alternatively the patient may operate the assistance by hand. Maximum assistance and overpressure are given at the limit of flexion by a right-angled pull on the rope at this point.

Except in special circumstances, these assisted exercises are only of use when movement is very limited or the patient is not allowed to bear weight.

**Free exercise for the knee joint**

There may be non-weight-bearing, partial weight-bearing or full-weight-bearing according to the condition and the stage of treatment at which they are used. Rhythmical movements with active overpressure at the limit of the range are essential. In full-weight-bearing exercises, when the body weight is used to assist flexion the power and control of the Extensor Muscles must be sufficient to restore the joint to full extension.

**Non-weight-bearing Exercises**

- a. lying; *One Hip and Knee flexion and extension.*
- b. side lying; *One Hip and Knee flexion and extension.*
- c. prone lying; alternate *Knee flexion and extension*
- d. high sitting; alternate *Knee flexion and extension*

**Partial Weight-bearing Exercises**

- e. *Bicycling on free or stationary bicycle.*
Activities to increase Mobility of Knee Joint

Correct movement in walking must be learnt and practiced as soon as possible, and later, walking up- and downstairs and uphill and downhill,
6.7 The hip joint

The joint between the spherical head of the femur and the acetabulum is poly-axial and very stable. The range of movement can become limited in any or all directions but the most usual deformity is a combination of flexion, adduction and lateral rotation.

Relaxed Passive movements of the hip joint

ly.; I Hip abd, and odd., med. And lat. Rot., flex. and ext. (pass.)

The leg which is not to be moved is fully abducted and fixed, either by a sandbag or by bending the knee over the side of the plinth, and the patient relaxes. With the forearm supinated, one of the physiotherapist’s hands supports under the thigh, and with the other pronated she supports the lower leg at the ankle point. Traction is given and the leg is moved into abduction (30° from the median plane) and adduction. Medial and lateral rotation can be performed by giving traction on the heel and rolling the knee inwards and outwards with a stroking movement (as in using a rolling pin).

Support under the thigh and round the ankle or foot is given for flexion, the hand under the thigh moving as the knee is bent into a position in which the fingers support the knee laterally and the thumb gives overpressure on the front of the knee. This pressure is directed towards the patient’s shoulder. The leg is then extended by allowing the heel to come to the plinth first and then straightening the lower leg. Extension is still incomplete in this position and the patient must be move to side lying or prone lying for the additional 15° which is possible.

A combination of abduction and lateral rotation, adduction and medial rotation can be done in both hips simultaneously from crook lying, and the four angular movements can be combined as a hip rolling, in which case the knee is held in flexion.

Assisted exercises for the hip joint

Grasps similar to those used for relaxed passive movements enable the physiotherapist to assist the patient’s own efforts to move.

As the limb to be moved is heavy, suspension and the use of roller skates are valuable means of assistance. Suspension for flexion, extension, abduction and adduction may be either axial with manual assistance, or pendular, and the use of tension springs gives a feeling of buoyancy and prevents any jerking as
the direction of the movement is reversed. In acute cases, where movement is very limited, vertical suspension at the knee and foot helps relaxation and avoids the centripetal pull of the rope, which presses the joint, surfaces against each other, in the axial method. The point of suspension should be high in this case, to flatten the plane of movement as much as possible.

Extension is emphasized in side lying, the stationery leg being bent up to fix the pelvis by the tension of the Hamstrings.

For abduction one or both legs can work in lying or prone lying, the legs being as nearly in alignment with the body as possible to get pure abduction.

Skates can be used in a similar way either on the floor or on hinged and sloping boards.

Rotation is most effective when combined with angular movements, medial rotation with abduction, lateral with adduction. In flexion, the leg can be suspended so that the thigh is vertical and the lower leg horizontal and a rotatory movement assisted manually with traction. In extension, traction can be given and movement assisted manually.

**Examples of free mobility exercises for the hip joint**

Movement in these joints is usually associated with movement in the spine and in the knees. A combination of hip and knee flexion with lumbar flexion and backward tilt of the pelvis provides a fixed origin for the Hip Flexors and relief of tension on the antagonistic muscles (the Hamstrings), whereas extension of
the hip and knee with lumbar extension and a pelvic the forwards provides for maximum efficiency of both the Gluteus Maxims and the Hamstrings and a release of tension on the Hip Flexors (including Rectus Femoris).

To increase mobility, full-range movement performed with active overpressure and frequent repetitions is required. In non-weight-bearing exercises resistance to the movement can be added to increase the effect.

**Non-weight-bearing Exercises**

- **a.** *side lying; one Hip and Knee bending, stretching and Leg carrying backwards.*
- **b.** *Grasp high half standing; Leg swining forwards and backwards.*
- **c.** *prone lying (Knees straight, Toes tucked under); Leg medial and lateral rotation.*

![Fig. 6.5](image)

- **d.** *prone kneeling; one Hip and Knee bending and stretching.*
- **e.** *Reach grasp high half standing; one Leg swinging across and sideways.*

**Partial Weight-bearing Exercises**

- **f.** *heave grasp high half standing; one Leg swining across and Knee bending.*
- **g.** *Crouch position; step or spring to stride prone falling.*

**Weight-bearing Exercises**

- **h.** *grasp standing; change to fallout sideways position.*
i. half kneeling, or step standing; forward pressing.

j. crouch position; change to stretch standing.

k. Stride standing; Pelvis and Trunk rotation.

l. Standing; step and hop with one Leg swing sideways.

Fig. 6.6

Activities suitable for increasing Hip Mobility

Examples of these are walking, running, climbing, stairs, cycling, rowing, breast-stroke swimming and golfing.

**Short Answer Type Questions**

1. What are different mobilising method. ? Name them.

2. List out various measures to prevent joint stiffness.

3. What are the activities to increase mobility of joints of the foot.

**Long Answer Type Questions**

1. Classify joints and explain each of them in detail.

2. What are the different relaxed passive movements of the knee point?

3. What are free, assisted and resisted exercise for the knee point?
Active movement of the skeleton is brought about by the contraction of voluntary muscle. This muscle tissue has contractile properties which are activated by nerve impulses, to supply the effort required to move or stabilise the body levers.

Muscle work involves an increase in intra-muscular tension; when this is accompanied by a change in the length of the muscle the contraction is said to be isotonic. When intra-muscular tension is increased without a change in the length of the muscle work is isometric.

There is a change in the length of a muscle when it works to produce movement in opposition to an external force, and when it works to resist movement produced by an external force which gradually overcomes it. When
the attachments of a working muscle are drawn towards the centre of that muscle, it works concentrically, i.e. towards the centre, or ‘in shortening’. When the attachments are drawn away from the centre, as its resistance is overcome by the external force, the muscle works eccentrically i.e. away from the centre, or ‘in lengthening’.

There is no attention in the length of a muscle which works to stabilise a joint, the power of its contraction being exactly equal and opposite to the forces which oppose it. In this case the attachments of the muscle remain stationary and it is said to work statically.

1. **Isotomic**
   a. **Concentric Muscle Work**

   Muscles working concentrically become shorter and thicker as their attachments are drawn closer together and joint movement results. A patient doing concentric muscle work performs a movement, and in so doing overcomes some force which offers resistance, such as friction, gravity, manual pressure by the physiotherapist, or some form of mechanical resistance.

   The physiological cost of this type of work is high, as only about a quarter of the energy liberated during contraction is available as mechanical work. Some is used to overcome the initial inertia and some is converted into heat. Concentric muscle work is used to build up muscle power, and although most everyday movements involve the use of all types of muscle work, it seems to be more natural, and to require least concentration, to use the concentric type.

   b. **Eccentric Muscle work**

   Muscle working eccentrically become longer and thinner as they pay out and allow their attachments to be drawn apart by the force producing the movement.

   The physiological cost of this type of muscle work is low, probably only about a quarter of that required for concentric work, therefore a muscle recovering from paralysis may sometimes be persuaded to contract to resist before it will attempt to produce movement. Considerable concentration is required during exercises designed to work the muscles in this way. This is probably to control the speed of the movement, as eccentric work in natural movements is usually fairly rapid.

2. **Isometric or Static ‘Work’**

   The length of the muscle remains the same throughout the muscle work and no movements results.
Static muscle work is more economical than either of the previous types, but it is fatiguing if sustained, probably because of hindrance to the circulation through the muscle, as the result of an increase in the intramuscular tension. Static muscle work against maximal resistance provides the most rapid method for gaining hypertrophy of muscles at a particular point of the range because the resistance demands the greatest possible increase in intra-muscular tension.

Static work of the postural muscles is used to train the pattern of good posture. Posture is maintained by muscle work which is somewhat similar, but is not fatiguing because of the low metabolic rate at which the muscle fibres work, and the special nature of their reflex control.

### 7.2 Ranges of muscle work

The range of muscle work is the extent of the muscular contraction which results in joint movement.

**Full Range**

The joint is moved as the muscles work from the position in which they are fully stretched, to the position in which they are fully contracted, concentrically, or, from the position of full contraction, to the position of maximum extension, if they are working eccentrically.

Under ordinary circumstances muscles are rarely required to work in full range, but in emergencies they may have to do so. Active full range exercise are used for patients as they maintain joint mobility, increase the circulation and ensure that the emergency reserve of power of mobility is preserved.

**Inner Range**

The muscles work either concentrically from a position in which it is partially contracted (approximately half-way between the limits of full range) to a position of full contraction, or vice versa if it works eccentrically.

![Fig. 7.1](image-url)
Exercise in inner range is used to gain or maintain movement of a joint in the direction of the muscle pull, and to train some extensor muscles movement responsible for stabilizing joints.

FIGURE

*Outer Range*

The muscles work concentrically from the position in which they are fully stretched to a position in which they are partially (half) contracted, or vice versa if working eccentrically.

The outer range of muscle work is used extensively in muscle reeducation as a contraction is initiated more easily from stretch in most muscles.

*Middle Range*

The muscles are never either fully stretched or fully contracted. This is the range in which muscles are most often used in everyday life and in which, generally speaking, they are most efficient. Exercises in this range maintain muscle tone and normal power, but full joint movement is never achieved.

7.3 Group action of muscles

Muscles do not work singly, but in groups, and it is the harmonious working together of several groups which results in coordinated movement.

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. They may alter the direction of pull or, in the case of prime movers which pass over more than one joint, they fix or move the joint in which the main action is not required into the position which is most advantage.

4. the fixators are muscles which work to study the origin of the prime movers or the synergists.

**Example:** In flexion of the fingers as, in making a fist, the flexors of the fingers work as prime movers to perform the movement the antagonist, the extensors of the fingers, relax. The extensors of the wrist work as synergist to fix or move the wrist into full extension so that the power of the flexors of the fingers, which can also flex this joint, is not diverted to this purpose, but increased as extended wrist joint acts as a fulcrum for their action.
The appropriate impulses for contraction or relaxation are concerned to the muscles concerned in any particular movement, from the Central Nervous System. As, it is movements and not individuals muscle or even muscle groups, which are represented in the cerebral cortex. The importance of concentrating on the movement rather than on the contraction of the specific muscle or muscle group in re-education cannot be over emphasised. Furthermore, as the movements which are represented are those to which the patient is accustomed, i.e. Natural movements, these are of prime importance.

Two-joint Muscles

Most groups of muscles include at least one which extends across more than one joint. These muscles are most effective in moving one joint when they are stretched over the others, as under these conditions the latter joint is used as a fulcrum and the stretching of the muscle acts as an additional stimulus to contraction.

Example: To work the Hamstrings as Flexors of the Knees, the hip joint must flex or be flexed by synergic action; alternatively, to work the Hamstrings as Extensors of the Hip, the Knee must extend or be extended during the movement of hip extension.

7.4 Group movement of joints

Most natural movements involve the use of a series of joints controlled by the integrated action of many muscle groups. The control of these movements may be voluntary and conscious, but in many instances it is unconscious and reflex in character and controlled from the basal ganglia or reflex centres in the spinal cord. The basic patterns seem to be those of thrust, withdrawal, swing and strike.

Example: In walking, plantaflexion of the ankle joint and extension the knee and hip result progressively in response to firm pressure on the ball of the foot, but should there be pain in the foot as the result of injury or ill-fitting shoes, a flexion reaction is often imperfectly inhibited to produce a sagging posture and a limping gait.

Muscular Weakness and Paralysis

Weakness or paralysis in any muscle or group of muscles not only results in loss of movement or stability of a particular joint, but creates a state of muscular imbalance which affects all the groups concerned in the production of co-ordinated movement. If the weakened muscles are to recover their full function, they must be protected while they are ineffective and encouraged by re-education, until
they are able finally to take their place once more as effective members of the
team of muscles, which work together to perform natural and skilled movements.

\[\text{Fig. 7.2 Thrust and withdrawal swing and strike}\]

**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. Complete loss ability to contract is known as paralysis, partial
loss as paresis, or a muscle may be merely weak or sub-page.

*Lesions affecting the Anterior Horn Cells*

Destruction of the Anterior Horn Cells results in permanent inactivity of the
motor unit, i.e. flaccid paralysis. Damage to these cells, short of their destruction,
may increase their threshold to such an extent that they remain dormant.

*Lesions affecting the Motor Pathways*

Interference with the passage of impulses along motor pathways causes
paralysis. Spastic paralysis results from upper motor neurone lesions and flaccid
paralysis from lower motor neurone lesions.

*Lesions affecting the Muscle Tissue*

Degeneration of the muscle tissue results in loss of strength which is usually
progressive, i.e. muscular dystrophy. Ischaemia causes structural changes, i.e.
Volkmann’s ischaemic contracture, and extensive scar tissue may replace contractile tissue as the result of deep flesh injuries.

**Disuse of Normal Nerve and Muscle Tissue**

Loss of strength and wasting from disuse is by no means uncommon. A patient may not use his muscles—

a. Because he cannot; as contraction is inhibited by pain or protective spasm of antagonistic muscles.

b. Because he does not need to; joints fixed by splintage are stable and unable to move, therefore there is no necessity for the patient to contract his muscles unless he is compelled to by strong resistance offered to other strong muscles in the same series or by his own voluntary effort. Static muscle work is essential to maintain circulation, muscle power and the movement of tendons passing over the temporarily immobilised joints, which are essential for recovery of function when splintage is removed.

c. Because he will not; some patients resist all efforts to make them do sufficient muscular contraction to prevent disuse atrophy.

**Some Constitutional Diseases**

A marked degree of muscle wasting, which cannot be put down entirely to disuse, occurs in some diseases, notably in rheumatoid arthritis.

**Functional**

There is no organic cause, but the muscles do not function, although they may be made to contract by electrical stimulation of the nerve or by methods of facilitation.

**The Prevention of Muscle wasting**

**In Flaccid Paralysis**

Muscles deprived of their motor nerve supply are limp, hypotonic and unable to contract. Rapid wasting takes place and cannot be prevented, although it is thought that it can be arrested by improving the blood supply to the area by stimulation of the muscle fibres by electrical means. Although little can be done to prevent wasting in these cases measures are taken to keep both muscles and the joint structures in as good a condition as possible in preparation for a return to normal function.

**Principles of Treatment during Flaccid Paralysis**
1. **The Affected Muscles must be protected from prolonged Overstretching by adequate Support and Splintage.**

Normal muscles protect themselves from overstretching by a reflex contraction, but those suffering from flaccid paralysis are unable to do so, as they are incapable of contraction; consequently, they may become stretched beyond their physiological limit and injured by the force of gravity or the unopposed action of healthy antagonist muscles.

Example: A lesion affecting the Anterior Tibial Nerve results in a dropped foot, as gravity and the unopposed action of the Calf Muscles plantaflex the foot. To prevent injury to the Anterior Tibial Muscles a splint or toe-spring must be worn until their power of contraction is sufficient to restore muscle balance.

2. **The Circulation to the Area must be maintained to ensure Adequate Nutrition to the Paralysed Muscles by Active Exercise for Other Normal Muscles in the Area, Contrast Baths etc.**

Paralysis leads to coldness and blueness of the area, indicating poor circulation. The arterial blood flow to muscles is much increased during active work to supply the oxygen and nutrition essential for repair and, at the same time, the local venous return is assisted by the intermittent pressure exerted on the vessels, by the contracting muscles, and by the movement of joints.

3. **The Range of Movement in Joints Immobilised by the Paralysis and the Extensibility of the Affected Muscles must be Maintained by Passive Movements**

The fibrous tissue which constitutes the sheaths of muscles, ligaments of joints and fascia, undergo adaptive shortening if subjected to prolonged immobilization. One full-range movement at frequent intervals is sufficient to prevent this and, in practice, two full-range passive movements performed twice daily are found to be adequate.

Where muscles work over more than one joint they must be stretched over these joints at the same time. Example – wrist and finger flexors: wrist and fingers must be fully extended in one movement.

4. **Remembrance of the Pattern of Movement must be stimulated and kept alive by Passive Movement while Active Movement is impossible.**

Movement is associated in the brain with numerous sensory impulses from the joints, muscles, skin and eyes. In the absence of voluntary movement, stimulation of these sensory impulses by passive movement may remind the brain of the pattern of movement, in preparation for the time when the motor
pathway will once more be intact. In this way co-ordinated movement, made possible again by the return of power to the affected muscles, is remembered and does not require to be re-learnt or re-developed.

The passive movements used this purpose must obviously follow the natural pattern of movement with regard to the group movement of joints.

5. **The Strength and Use of Normal Muscles in the Area must be maintained by Resisted Exercise**

Unless the limb is flail (all muscles paralysed) all possible activity is encouraged. Thus wasting from disuse is prevented and circulation to the part is improved.

**Example :** A man with Anterior Tibial paralysis is able to walk about provided he wears a toe-spring, and the advantage of his being able to work is obvious.

**In Spastic Paralysis**

Muscles which receive a motor nerve supply only by means of a spinal reflex, since they are cut off from the higher centres by a lesion affecting the upper motor neurone, are tense, hypertonic and incapable of voluntary contraction or relaxation. This condition is known as spastic paralysis and wasting is not marked.

When a limb or segment of the body is ‘locked’ in spasm circulation is impeded and muscle and joint contractures may develop over a period of time. The aim of treatment is to initiate movement to maintain normal joint range and muscle extensibility and at the same time improve the circulation. While the limb remains immobile any potential for voluntary control is masked by the spasm. Reflex movement initiated by means of Neuromuscular Facilitiation techniques, i.e. the stretch stimulus coupled with a command for voluntary effort, develop any voluntary control which remains and may lead to a permanent reduction in spasm. Controlled sustained passive stretching also inhibits spasm sufficiently to permit movement. Active or passive mobilization may be preceded by massage or packing with ice to reduce spasm and make movement easier.

**In Primary Lesions of the Muscle Tissue**

In this case loss of power cannot be arrested, although a temporary improvement often follows light exercise in cases which have not previously received treatment. This is probably the result of making the best use of fibres which still function.
In Disuse Atrophy

Provided there is no constitutional disease, e.g. Rheumatoid Disease, muscle atrophy from disease can be prevented or controlled by strong and frequent contraction against resistance as wasting occurs because an insufficient demand is made to elicit a strong enough contraction. Exercise must be carried out within the limits of the disability but with skill and imagination this can be organized. Any type of active work is suitable provided the right muscles are activated sufficiently to maintain or improve their normal strength and endurance. Exercises with manual resistance is advisable in the early stages to make sure that the contraction is pain-free and satisfactory and to give the physiotherapist the opportunity to assess the patient’s capacity for activity and to give instruction in those activities he must practice on his own. It is important that the patient should fully understand and appreciate the need for his own effort to ensure his cooperation in carrying out a regime of free exercise, the slogan for which is, ‘Five minutes in every hour’. If his cooperation is doubtful or his ability to exert voluntary effort is reduced he will require constant supervision or individual treatment. Whenever possible the patient should continue with his normal work, when this is impossible other occupational activities suited to his abilities can be substituted. Suitable games and sports of a competitive nature supply a demand for activity but need careful supervision and control to avoid development of ‘trick’ movement, e.g. development of a faulty pattern of walking in order to move rapidly.

The wasting of muscle in Rheumatoid Disease is not entirely due to disease. Isometric muscle work in the pain-free range helps to prevent atrophy and often leads to increased pain-free movement which can be used for functional activities.

The Initiation of Muscular contraction

(Early Re-education)

Denervated muscles are incapable of contraction except by direct stimulation of the muscle fibres by suitable electrical means.

Innervated muscles contract in response to a demand for activity provided the demand is sufficient. As contraction is the only means by which muscles regain their normal function it is essential that a response is obtained its seen as possible from muscles affected by paralysis.

The lesion causing paralysis and the inactivity which follows both increase the threshold of excitability of the anterior horn cells (A.H.C.). Once the acute phase of the lesion has passed reactivation of the motor unit is possible except
when there has been permanent damage, e.g. death of the cell or lack of continuity of its axon. The A.H.C. is much more difficult to stimulate, when its threshold is increased therefore it fails to react to the normal level of stimulation, in which case the patient’s maximal voluntary effort of contraction is insufficient to gain a response. An increase in the demand is required and supplied by stimulation of sensory receptors, e.g. proprioceptors and exteroceptors, which discharge impulses to the A.H.C.s to increase central excitation and lower the threshold of the cells. With a lower threshold the A.H.C.s are more easily stimulated and the arrival of repeated stimuli reduces the threshold still more and facilitates the passage of impulses along all the nervous pathways used. When stimulated the A.H.C.s discharge impulses results in a muscle twitch but discharges repeated sufficiently frequently lead to summation and a sustained contraction.

**Measures Used to Obtain Initiation of Contraction**

1. **Warmth**: The area affected must be warm, as moderate warmth improves the quality of the contraction. Any method designed to improve the circulation in the area is effective; active exercise of unaffected muscles against strong resistance is the method of choice.

2. **Stabilisation**: Stabilisation of the bones of origin of the affected muscles and a joints distal to those over which those muscles work, improves their efficiency. Whenever possible stabilization should be achieved by isometric contraction of strong synergic muscles working against maximal resistance as their effort re-inforces that of the muscles in question, e.g. for initiating elbow flexors the shoulder and wrist are stabilized by their flexors working against resistance applied by the physiotherapist’s hands.

3. **Grip of Manual Contact**: The physiotherapist’s hands give pressure only in the direction of the movement, to direct the patient’s effort and give sensory stimulation.

4. **Stretch**: Stimulation of the muscle spindles elicits reflex contraction of that muscle provided the reflex arc is intact. Sharp but controlled stretching of the affected muscle at the limit of its extended range is followed immediately by the patient’s maximum effort of contraction thus:

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NOW (Stretch)—PULL! (Let is move)
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The muscles must be stretched in all their components of action and the more accurate the stretch the greater its effect for producing a contraction. Prolonged stretching or failure to allow the muscle to shorten inhibits the contraction.
The command for voluntary effort must be brief, forceful and timed to coincide with the stretch reflex. The stretch reflex is applied several times in quick succession and then repeated after a short rest for as long as a satisfactory response is obtained.

Some muscles do not respond to the stretch reflex applied from the lengthened range its well as others, e.g. triceps. Once the ability to initiate contraction is established muscle strengthening continues until normal function is restored.

5. Irradiation.

(i) The use of resistance to functional movements of the opposite limbs which normally produces fixator action on the other side can assist initiation of contraction in the affected muscle. For example, resistance to the extension-abduction pattern of one arm results in extension and abduction of the other arm to prevent the body rolling towards the moving arm.

(ii) The use of strong groups which normally work with the affected muscle also encourages contraction of that muscle. For example, the eating pattern involves flexion of the shoulder, elbow, wrist and fingers. Therefore, strong resistance given to the shoulder, wrist and fingers flexors will stimulate the flexors of the elbow to contract.

**Strengthening methods**

(Re-education)

The art of training or strengthening muscles lies in creating the conditions under which they are called upon to work to full capacity against an ever-increasing resistance. Increase in strength and hypertrophy occur in response to an increase in intra-muscular tension set up by the factors which oppose their contraction. It is, therefore, essential that these opposing factors, which constitute the resistance, must be increased as the strength of the muscles improves.

An increase in resistance which is too rapid results in overloading, which prevents contraction and maybe sufficient to prevent wasting of muscles.

At the beginning of treatment, assessment of the strength of the muscles is essential. A suitable resistance is then selected, which includes consideration of the poundage of the resisting force, the leverage, the speed, and the duration of the movement. As treatment continues, progression of one or all of these factors in made as muscle strength develops. Accounts must be taken of all work the muscles in question are called upon to do, whether it be Exercises in the
Physiotherapy Department, Occupational Therapy, Specific Home Exercises, Work, or the ordinary activities of everyday life.

Re-education may be regarded as a continuous process which begins, while the muscles are still paralysed, in the form of an attempted initiation of contraction, and extends until maximum function is achieved.

The exact stage in this re-education process at which any particular muscle group beings is determined by the findings at the assessment made when treatment begins.

**Treatment to increase muscular strength and function**

Once the power of contraction has been regained, the muscles are strengthened progressively until maximum function is obtained. Passive movements support, and artificial methods of assisting the circulation are discontinued gradually and are replaced by active exercise.

**Principles of Treatment to Increase Strength and Function**

1. **The Affected Muscles must be Strengthened Progressively by Resisted Exercises, which are Specific for the Group to which the Muscles belong**
   a. **Range.** The range of movement is increased.
   b. **Type of Muscle Work.** Concentric, eccentric and static muscle work are elicited.
   c. **Resistance.** The resistance is increased by:
      (i) Increasing the poundage of the resistance;
      (ii) Increasing the leverage of the resistance.
   d. **Speed.** Increase or decrease in the speed of movement is a progression for concentric work. Decrease in speed is a progression for eccentric work. Lengthening of the contraction period is a progression for static holding.
   e. **Duration.** Increase in the number of times an exercise is performed or decrease in the rest period between each series of exercises, or a combination of both according to circumstances, makes more work for the muscles.

2. **Full Function of the Affected Muscles as Members of the Teams of Muscles which Work to produce Skilled and Co-ordinated Movement, must be restored by Free Activities, Natural and Skilled Movements.**

   Progression of these exercises follows on lines similar to those stated above for resisted exercises. Pendular movements requiring relatively little power are
used at first to assist in the restoration of muscle balance, progressing to slow sustained or rapid movement requiring more power. Small-range movements in which many joints must be controlled are the most highly skilled.

**Types of Exercises used to strengthen muscles and restore function**

All active exercises maintain or increase muscle strength providing intramuscular tension is increased sufficiently by the demands of the resisting forces. Weak muscles are provided with work suitable to their capacity by the use of Assisted-Resisted, Free, or Resisted Exercises, while Objective, Recreational or Occupational Activities ensure their return to functional use.

It cannot be over-emphasised that the choice of a particular exercise does not necessarily ensure the desired effect: it is the manner an speed with which the exercise is performed which determines the effect it produces. In general, strengthening exercises are slow and precise.

**Assisted-Resisted Exercises**

These are rarely used to strengthen muscles except in cases of marked weakness when strength is insufficient to complete the range of movement.

**Free Exercises**

Free exercises are valuable as they can be practiced at regular and frequent intervals and at home. Careful selection of the starting positions and accurate teaching ensure the use of the muscles in question an grade the exercise to match their capacity for work.

**Resisted Exercises**

These exercises create the tension in muscles essential for increase in power and hypertrophy. Emphases on the activity of the affected group restores the balance of muscle strength rapidly and so prevents trick movement and strain elsewhere.

Proprioceptive neuromuscular facilitation is most effective in this context. Repeated contractions, slow reversals and rhythmic stabilizations are all suitable techniques.

**Activities**

These are essential to ensure integrated action of muscle groups in the production of movement. They also restore confidence and general health.
Assessment of Progress

Re-assessment of the patient’s abilities made at frequent intervals to guide progression of activities and estimates progress.

Short Answer Type Questions

1. Define how muscle works.

2. List different types of muscle works.


Long Answer Type Questions

1. What are the types of exercises used to strengthen muscles?

2. What are the different causes of paralysis?

3. What are the group movements of muscles and joints?
8.0 Introduction

The ability of an individual to initiate, control, or sustain active movements of the body to perform simple to complex motor skills. Stretching is general term used to describe any therapeutic maneuver designed to increase mobility of soft tissues and subsequently improve ROM by elongating (lengthening) structures that have adaptively shortened and have become hypomobile over time.

8.1 Definition of Terms Related to Mobility and Stretching

Flexibility is the ability to move a single joint or series of joints smoothly and easily through an unrestricted, pain-free ROM. Dynamic flexibility refers to the active ROM of a joint. This aspect of flexibility is dependent upon the degree to which a joint can be moved by a muscle contraction and the amount of tissue resistance met during the active movement. Passive flexibility is the degree to which a joint can be passively moved through the available ROM and is dependent upon the extensibility of muscles and connective flexibility is a prerequisite for but does not tenure dynamic flexibility.
Hypomobility

Hypomobility refers to decreased mobility or restricted motion.

Contracture

Contracture is defined as the adaptive shortening of the muscle-tendon unit and other soft tissues that cross or surround a joint, which results in significant resistance to passive or active stretch and limitation of ROM.

Indications

- When ROM is limited because soft tissues have lost their extensibility as the result of adhesions, contractures, and scar tissue formation, causing functional limitations or disabilities.
- When restricted motion may lead to structural deformities otherwise preventable.
- When there is muscle weakness and shortening of opposing tissue.
- As a part of a total fitness program designed to prevent musculoskeletal injuries.
- Prior to and after vigorous exercise to potentially minimize postexercise muscle soreness.

Contraindications

- When a bony block limits joint motion.
- After a recent fracture before bony union is complete.
- Whenever there is evidence of an acute inflammatory or infectious process (heat and swelling) or when soft tissue healing could be disrupted in the tight tissues and surrounding region.
- Whenever a hematoma or other indication of tissue trauma is observed.
- When hypermobility already exists.
- When contractures or shortened soft tissues are providing increased joint stability in lieu of normal structural stability or neuromuscular control.
- When contractures of shortened soft tissues are the basis for increased functional abilities, particularly in patient with paralysis or severe muscle weakness.
8.2 Classification

Manual or Mechanical Passive or Assisted Stretching

A sustained or intermittent external, end-range stretch force, applied with overpressure and by manual contact or by a mechanical device, elongates a shortened muscle-tendon unit and periarticular connective tissues by moving a restricted joint just past the available ROM. If the patient is as relaxed as possible, it is passive stretching. If the patient assists in moving the joint through a greater range, it is called assisted stretching.

Self-Stretching

Any stretching exercise that is carried out independently by a patient after instruction and supervision by a therapist is referred to as self-stretching. The terms self-stretching, active stretching, and flexibility exercises are often used interchangeably.

Neuromuscular Inhibition Techniques

These procedures reflexively relax tension in shortened muscles prior to or during stretching. Because the use of inhibition techniques to assist with muscle elongation was originally developed as a component of proprioceptive neuromuscular facilitation.

Joint Mobilization/Manipulation

These are stretching techniques specifically applied to joint structure and are used to stretch capsular restrictions or dislocated joint.

Soft Tissue Mobilization and Manipulation

Various techniques, including friction massage, myofascial release, acupressure, and trigger point therapy, are designed to improve tissue mobility by mobilizing and manipulating connective tissue that binds down soft tissues.

Neutral Tissue Mobilization

After trauma or surgical procedures, adhesions or scar tissue may form around the meninges and nerve roots or at the site of injury at the plexus or peripheral nerves. Tension placed on the adhesions or scar tissue leads to pain or neurologic symptoms.

Selective Stretching

It is a process whereby the over-all function of patient may be improved by applying stretching techniques selectively to some muscles and joints not allowing limitation of motion to develop in other muscles or joints. When determining
which muscles to stretch and which to allow becoming slightly tight, the therapist must always keep in mind the functional needs of the patient and the importance of maintaining a balance between mobility and stability for maximum functional performance.

- For example, in the patient with spinal cord injury, stability of the trunk is necessary for independence in sitting. With thoracic and cervical lesions, the patient will not have active control of the back extensors. If the hamstrings are routinely stretched to improve or maintain their extensibility and moderate hypomobility is allowed to develop in the extensors of the low back, the patient will be able to lean into the slightly shortened structures and will have some trunk stability in lying-sitting. The patient must still have enough flexibility for independence in dressing and transfers. Too much limitation of motion in the low back can decrease function.

- Allowing slight hypomobility to develop in the long flexors of the fingers while maintaining flexibility of the wrist will enable the patient with spinal cord injury who lacks innervation of the intrinsic finger muscle to develop grasp through a tenodesis action.

**Overstretching and Hypermobility**

Overstretching is a stretch well beyond the normal ROM of a joint and the surrounding soft tissues, resulting in hypermobility.

- Creating elective hypermobility by overstretching may be necessary for certain healthy individuals with normal strength and stability participating in sports that require extensive flexibility.

- Overstretching becomes detrimental and creates joint instability when the supporting structures of a joint and the strength of the muscles around a joint are insufficient and cannot hold a joint in a stable, functional position during activities. Instability of a joint often causes pain and may predispose a person to musculoskeletal injury.

**Short Answer Type Questions**

1. Define stretching.
2. Define mobility.
3. What is Contracture?
4. What is Contraindications?

**Long Answer Type Questions**

1. Write in detail about the classification of stretching.
9.1 Co-ordinated movement

Co-ordinated movement, which is smooth, accurate and purposeful, is brought about by the integrated action of many muscles, superimpose upon a basis of efficient postural activity. The muscles concerned are grouped together as prime movers, antagonists, synergists and fixators, according to the particular function they are called upon to perform.

Group action of muscles

The contraction of the prime movers results in the movement of a joint, while the reciprocal relaxation of the opposing group, the antagonists, controls their action without impeding it. Other muscles may work as synergists, either to alter the direction of the pull of the prime movers, or, where the latter pass across more than one joint, to stabilise the joint in which movement is not required. Efficiency is still further ensured by muscular fixation of the bone, or bones, from which the prime movers take origin (or alternatively, into which they are inserted, should they work with reversed origin and insertion). These fixator muscles
may be in the immediate vicinity of the movement, but when strong resistance is offered, muscles all over the body are frequently involved.

Nervous control

The motor pathways. The action of each muscle group is determined by the afferent impulses which reach it by the motor pathway.

The cerebral cortex. Voluntary movement is usually, if not invariably, initiated in response to some sensory stimulus. It is now thought that an initiation centre exists in the brain stem which alerts the cerebral cortex, which then is responsible for planning the pattern of movement. This plan is based on memories of patterns used on previous occasions.

The cerebellum. The cerebellum is a receiving station of information which reaches it by the afferent pathways conveying impulses of kinaesthetic sensation from the periphery and from other parts of the brain including the cerebral cortex and the vestibular nucleus. In the light of this information, the delicate adjustments, which ensure harmonious interaction of the various groups of muscles concerned in the pattern of movement, are made and conveyed to the anterior horn cells by either the extra-pyramidal tracts or other descending pathways of the spinal cord.

Kinaesthetic sensation. The afferent impulses of kinaesthetic sensation arise from proprioceptors situated in muscles, tendons and joints and they record contraction or stretching of muscle and the knowledge of movement and position of the limbs. Some of these impulses reach the level of consciousness but many end in the spinal cord and cerebellum.

9.2 Incordination

Interference with the function of any of the factors which contribute to the production of a co-ordinated movement will result in jerky, arrhythmic or inaccurate movement, which is said to be in disturbed. The type of incoordination, and the exercises designed to help in overcoming it, vary according to the location of the lesion which causes it. Four main types usually benefit from the suitable exercise therapy.

Causation

1. Inco-ordination associated with the weakness or flaccidity of a particular muscle group.

In this case, either some lesion of the lower motor neurones prevents the appropriate impulses from reaching the muscles, or the condition of the muscle modifies their normal reaction to these impulses.
2. Inco-ordination associated with spasticity of the muscles.

Lesions affecting the motor area of the cerebral cortex, or the upper motor neurones, result in spasticity of the muscles, therefore, even when some appropriate impulses are able to reach them, the condition of the muscles is such that their response to them is abnormal.

3. Inco-ordination resulting from cerebellar lesions.

This is generally known as ‘ataxia’, the prefix ‘a’ meaning ‘without’ and the greek word ‘taxis’ meaning ‘order’. There is marked hypotonicity of the muscles, which tire easily, and inadequate fixator action, not only of the muscles directly concerned with the group action, but of the body generally. Movement is irregular and swaying, with a marked intension tremor.

4. Inco-ordination resulting from loss of kinaesthetic sensation.

‘sensory ataxia’, or in the case of tabes dorsalis, ‘tabetic ataxia’, describe this type. Without using his eyes to gain the information, the patient with this condition is completely unaware of the position of the joints. The muscles are hypotonic and tire easily, but they are unaware of this as the sensation of fatigue is not recorded.

Involuntary movements, sometimes associated with these conditions, or a state of abnormal general tension superimposed on an otherwise normal pattern of group action, may interfere with movement and reduces its efficiency.

**Frenkels exercises**

Dr. H. S. Frenkel was medical superintendent of the sanatorium ‘freihof’ in Switzerland towards the end of the last century. He made a special study of tabes dorsalis and devised a method of treating the ataxia, which is a prominent symptom of the diseases, by means of systematic and graduated exercises. Since then his methods have been used to treat the inco-ordination which results from many other diseases, e.g. Disseminated sclerosis.

He aimed at establishing voluntary control of movements by the use of any part of the sensory mechanism which remained intact, notably sight, sound and touch, to compensate for the loss of kinaesthetic sensation. The process of learning this alternative method is similar to that required to learn any new exercise, the essentials being.

A. Concentration of the attention.

B. Precision.
C. Repetition

The ultimate aim is to establish control of movement so that the patient is able and confident in his ability to carry out those activities which are essential for independence in everyday life.

Technique

1. The patient is positioned and suitably clothed so that he can see the limbs throughout the exercise.

2. A concise explanation and demonstration of the exercise is given before movement is attempted, to give the patient a clear mental picture of it.

3. The patient must give his full attention to the performance of the exercise to make the movement smooth and accurate.

4. The speed of movement is dictated by the physiotherapist by means of rhythmic counting, movement of her hand, or the use of suitable music.

5. The range of movements is indicated by the marking the spot on which foot or hand is to be placed.

6. The exercise must be repeated many times until it is perfect and easy. It is then discarded and a more difficult one is substituted.

7. As the exercises are very tiring at first, frequent rest periods must be allowed. The patient retains little or no ability to recognize fatigue. But it is usually indicated by a deterioration in the quality of the movements, or by a rise in the pulse rate.

Progression

Progression is made by altering the speed range and complexity of the exercise. Fairly quick movements require control than slow ones. Later, alteration in the speed of consecutive movements and interruptions which involve stopping and starting to command, are introduced. Wide range and primitive movement, in which large joints are used, gradually give way to those involving the use of small joints, limited range and a more frequent alteration of direction. Finally simple movements are built up into sequences to form specific actions which require the use and control of a number of joints and more than one limb, e.g. Walking.

According to the degree of disability, re-education exercises start in lying with the head propped up and with the limbs fully supported and progress is made to exercise in sitting, and then in standing.
Examples of Frenkel’s exercises

Exercise for the legs in lying

a. Lying (head raised); hip abduction and adduction.

The leg is fully supported throughout on the smooth surface of a plinth or on a re-education board.

b. Lying (head raised); one hip and knee flexion and extension.

The heel is supported throughout and slides on the plinth to a position indicated by the physiotherapist.

c. Lying (head raised); one leg to place heel on specified mark.

The mark may be made on the plinth, on the patient’s other foot or shin, or the heel may be placed in the palm of the physiotherapist’s hand.

Fig. 9.1

d. Lying (head raised); hip and knee flexion and extension, abduction and adduction.

The legs may work alternatively or in oppositional to each other. Stopping and starting during the course of the movement may be introduced to increase the control to perform any of these exercises.

Exercise for the legs in sitting

e. Sitting; one leg stretching, to slide heel to a position indicated by a mark on the floor.

f. Sitting; alternate leg stretching and lifting to place heel or toe on specified mark.

g. Stride sitting; change to standing and then sit down again.

The feet are drawn back and the trunk inclined forwards from the hips to get the centre of gravity over the base. The patient then extends the legs and
draws himself with the help of his hands grasping the wall-bars or other suitable apparatus.

Exercise for the legs in standing.

h. Stride standing; transference of weight from foot to foot.

i. Stride standing; walking sideways placing feet on marks on the floor.

Some support may be necessary, but the patient must be able to see his feet.

j. Standing; walking placing feet on marks.

The length of the stride can be varied by the physiotherapist according to the patient’s capacity.

k. Standing; turn round.

l. Standing; walking and changing direction to avoid obstacles.
Group work is of great value as control improves, as it teaches the patient to concentrate on his own efforts without being distracted by those of other people. In walking, he gains confidence and becomes accustomed to moving about with others, to altering direction and stopping if he wishes, to avoid bumping into them. The ability to climb stairs and to step on and off a kerb helps to independence.

Exercise for the arms

m. Sitting (one arm supported on a table or in lings); shoulder flexion or extension to place hand on a specified mark.

n. Sitting; one arm stretching, to thread it through small hoop or ring.

o. Sitting; picking up objects and putting them down on specified marks.

Diversional activities such as plaiting, building with toy bricks, or drawing on a blackboard, lead to more useful movements such as using a knife and fork, doing up buttons and doing the hair.

Exercises to promote movement and rhythm

All exercises are repeated continuously to a rhythmic count, or to suitable music.

a. Sitting; one hip flexion and adduction (cross one thigh over the other), the movement is then reversed and repeated.

b. Half lying; one leg abduction to bring the knee to side of plinth, followed by one knee bending to put foot on floor; the movement is then reversed and repeated.

Fig. 9.4
c. Sitting: lean forward and take weight on feet (as if to stand), then sit down again. Later this can be done progressing along the seat as if moving up to make room for someone else to sit.

d. Standing: arm swing forwards and backwards (with partner, holding two sticks).

e. Standing or walking: bounce and catch, or throw and catch a ball.

**Short Answer Type Questions**

1. What is infoordination movement?

2. What is re-education?

**Long Answer Type Questions**

1. What are the principles of Re-education?

2. Write in detail about the Frenkel’s Exercise.
It is an approach to therapeutic exercise that combines functionally based diagonal patterns of movement with techniques of neuromuscular facilitation to evoke motor responses and improve neuromuscular control and function. PNF techniques also have widespread application for rehabilitation of patients with musculoskeletal conditions that result in altered neuromuscular control of the extremities, neck, and trunk.

PNF techniques can be used to develop muscular strength and endurance; facilitate stability, mobility, neuromuscular control, and coordinated movements; and lay a foundation for the restoration of function. PNF techniques are useful throughout the continuum of rehabilitation from the early phase of tissue healing when isometric techniques are appropriate to the final phase of rehabilitation when high-speed, diagonal movements can be performed against maximum resistance.

The use of PNF techniques, specifically contract-relax or hold-relax technique or other variations, to increase flexibility are described. As noted in
PNF patterns can be also be used for passive and active ROM. Additional application of PNF techniques for the extremities and trunk, some using resistance equipment, are described in the regional chapters later in this text.

The techniques of Proprioceptive Neuromuscular Facilitation rely mainly on stimulation of the proprioceptors for increasing the demand made on the neuromuscular mechanism to obtain and facilitate its response.

The techniques are suitable for use in the treatment of many conditions and provide an effective means of obtaining and accelerating patient’s rehabilitation.

10.1 Classification

Treatments by these techniques aim to summate the effects of facilitation to increase the response of the neuromuscular mechanism. Proprioceptive stimulation is the principle means used to increase the demand made by voluntary effort, the initiation of some reflex reactions and physiological principles concerned with the interaction of antagonistic muscles are also used in some techniques. Maximum resistance is considered to be the most important means of stimulating the proprioceptors and techniques concerned with its application to patterns of mass movement are basic. Techniques of emphasis are designed to correct imbalances.

Basic Techniques

1. Patterns of facilitation

Mass movement patterns are used as the basis upon which all the techniques of proprioceptive neuromuscular facilitation are superimposed because mass movement is characteristic of all motor activity. The patterns of movements are spiral and diagonal and they are closely allied to those of normal functional movements; they may be observed in everyday use, e.g. in taking the hand to the mouth, and in work or sports e.g. chopping wood or kicking a football. They are two pathways of movements for each major part of the body, i.e. Head-neck, lower Trunk, upper Trunk, Arm, Leg, and as movement can take place in either direction, each pathway provides two antagonistic patterns.

Component of Movement

Each pattern of movements has three components, the pathway is specific and in the line of action of the main muscle components responsible for the movements. Two components of the movements are angular and the third is rotatory, the latter being of major importance because it gives direction to the movement as a whole. Each pattern is named according to the movements which take place at the proximal joints or joints of the parts moved, e.g. Flexion adduction with lateral rotation of the Leg, or Extension with rotation to
the Right of the lower Trunk. Movement in distal joints follows the direction of that proximal joints but intermediate joints may move in either direction, e.g. in Flexion-adduction with lateral rotation of the Leg the foot dorsiflexes, adducts and inverts, the knee either flexes (with knee flexion) or extends (with knee extension) during the movement or it can remain locked in extension.

Movement in Pattern

Fig. 10.1 Various leg pattern

The pattern of movements starts with the muscle components at the limit of their extended range and is completed when they are as shortened as possible.
The range of the rotatory components is only partial but essential, rotation starts the movement and gives its direction.

Effects and Uses

As these patterns of movements are specific and closely allied to those of functional movements they can be repeated to facilitate movements which the patient’s requires more urgently. They are more effective for facilitation than so-called movements as they are in the line of action of the muscles which work to produce them and the latter are more efficient in these ways than in any others. By applying maximal resistance and adjusting the sequence of movements during the performance of these patterns the action of weaker muscle components can be re-informed by that of stronger groups which are their normal synergists.

The preceding diagrams indicate the position at the end of the movement assuming that intermediate joints remain still with the exception which shows lower flexion with hip and knee flexion and movement is pivoted at proximal joints. The limbs or area moved is shown in heavy type.

Manual Contacts

Pressure of the physiotherapist’s manual contacts with the patients provides a means of facilitation and is only the satisfactory way of applying maximal resistance to movement in patterns of facilitation.

The Application of Manual Contacts

Touch contributes to facilitation by stimulating the exteroceptors. Manual contacts must be (i) purposeful (ii) directional (iii) comfortable

(i) Purposeful. Pressure must be firm, so that the patient is aware of it, and applied directly to the patient’s skin whenever possible. Pressure is given with the palm of the hand to ensure the even contact with a wide area of skin, preferably over muscles and tendons taking part in the movements.

(ii) Directional: Manual pressure is applied only in the direction of the movement to resist the action of muscles taking part and to give direction to the patient’s effort. When there is loss of skin sensation the position of the hands may have to be adjusted.

(iii) Comfortable: Manual contacts which are uncomfortable or which produce painful stimuli must be avoided as they inhibit contraction and may lead to the initiation of unwanted movements.

The stretch stimulus and stretch reflex
Proprioceptors situated in the muscles (muscle spindles) are stimulated by stretching which increases the intra muscular tension. Stimulation of the muscle spindle elicits a reflex contraction of the muscle provided the stimulus is of threshold value and the reflex arc is intact. Bombardment of dormant A.H.C.s by impulses initiated from the spindles increases central excitation and facilitates stimulation of these cells.

The Application of the Stretch Stimulus

The muscles to be worked are put on full stretch, all components of the pattern being considered, so that tension is felt in all muscle groups.

The Application of the Stretch reflex

A sharp but controlled stretch of the muscles at the limit of heir extended range is given and synchronized with a dynamic command for the patient’s maximum voluntary effort to perform the movement. In this way the patient’s efforts adds all it can to the stimulus of stretching.

Now (stretch)……… PULL!

Summation of the stimuli initiated by the spindles in response to stretching of the muscles and of those initiated by voluntary effort is obtained by rhythmical repetition of this technique until the maximum response obtainable is achieved. Use of this technique in patterns of facilitation makes it possible to stretch the muscles effectively in all their components of action.

Effects and Uses

Provides the reflex arc is intact and the stretch stimulus and stretch reflex are applied correctly and with sufficient frequency, a response is assured except in cases of spinal shock. Stretch is therefore a valuable means of initiating contraction and, when applied to weak muscles, increases their responses and so accelerates the strengthening process.

Traction and Approximation

Traction and approximation (compression) may be effective in stimulating proprioceptive impulses arising from joint structures.

(1) Traction : Manual contacts make it possible to maintain traction throughout the range of movement. It is most effective when used in flexion probably because any weight lifted would normally exert traction in proportion to its weight.
(2) Approximation: Compression of joint surfaces against each other stimulates the normal circumstances which arise during weight bearing or pushing, it is therefore more effective for facilitating extension movements.

Commands to the Patients

The physiotherapist’s voice is used as a verbal stimulus to demand the patient’s maximum voluntary effort. Brief, simple, accurate and well timed instructions suitable for his age, character and ability to cooperate demand the patient’s attention and effort at the right time and indicate the type of reaction required from him, even if he is does not understand the language! Accuracy in commanding is essential.

HOLD! . . . for isometric contractions

PULL OR PUSH! . . ,, ISOTONIC ,, Relax . . . ,, relaxation

The physiotherapist must make sure that her commands are carried out to the maximum of the patient’s ability.

Normal Timing

Timing is defined as the sequence of muscle contraction occurring in motor activity, and the production of co-ordinated movements pre-supposes the ability to achieve normal timing. In functional movement timing usually proceeds from distal to proximal because it is the stimuli for activity. Proximal control develops first, then, during the process of learning co-ordination and purposeful movements distal control is established.

Normal timings in patterns of facilitation is from distal to proximal and, provided rotation begins the movement it proceeds in this direction in the normal subject. The movement as a whole progresses smoothly so that if each joint is blended with that at others, it is completed first in distal, then intermediate and finally in proximal joints. As movement is completed in each joint the muscles which have produced it (by their isotonic contraction) continue to contract isometrically until the movement as a whole is completed.

When normal timings cannot be achieved timings for emphasis is used as a means of correcting imbalances. Normal timings may be defeated by the application of too much resistance to a particular component of the movement with the result that its efficiency is decreased, e.g. much resistance given to the foot in leg movements.
Physiotherapy

Maximal Resistance

Maximal resistance is defined as the greatest amount or degree of resistance which can be given to muscular contraction. Maximal resistance to an isometric contraction is the greatest amount of resistance which can be applied without breaking the hold. Maximal resistance to an isometric contraction is the greatest amount of resistance against which the patient can perform a smooth co-ordinated movement through full range.

The Application of Maximal Resistance

In facilitation technique maximal resistance is applied manually to movements and holding in patterns of facilitation. All three components of the movements are resisted maximally at every stage of the movement. Variations in the strength of each component and in different parts of the range must be taken into account.

Effects and Uses

Maximal resistance demands ‘all the muscles can do’, i.e. all their available motor units are activated throughout the range of movements. Stimulation if the muscles spindle and a maximal increase in intra-muscular tensions leads to a spread of excitation to adjacent muscle groups by means of irradiation. The demands of the resistance determines the extent of this spread of excitation and the patterns of movements the particular muscles affected by it. Maximal resistance is used in all techniques of Proprioceptive Neuromuscular Facilitation to increase excitation, to strengthen muscles, to build up endurance, to demand relaxation and to improve co-ordination.

Re-inforcement

Innumerable combination of movements are required and utilized in everyday life and when great effort is required movement of one part of the body is associated and re-inforced by those of other parts. This can be observed in heavy work and sporting activities when strength or concentrations are required.

Muscle components of a pattern of movement re-inforce each other automatically according to the demands of the resistance and when this is maximal re-inforcements extends beyond the muscle components of the pattern to other segments of the body, e.g. from arm to trunk or from one leg to the other.

The proprioceptive stimulation which results from tension in shortly contracting muscles leads to a spread or overflow of excitation in the C.N.S by the process of irradiation, the purpose of which is to recruit the co-operation of allied muscles which, by contracting as synergist, increase the energy of the movements.
The use of Re-inforcement

The maximal contraction of strong muscles is used to re-inforce the action of weaker allied muscles. Re-inforcement always takes place from strength, therefore strong muscle components of a pattern are used to re-inforce weaker components, of the same pattern and strong patterns re-inforce weaker patterns provided they are related. Re-inforcement is used with timing for emphasis as a means of obtaining or emphasizing the contraction of ineffective or weak muscles to correct imbalances.

10.2 Techniques of Emphasis

Techniques of emphasis use the means of facilitation to correct muscles imbalances and restore the patient’s ability to perform effected co-ordinated movement.

1. Repeated Contractions

Repetition of activity against resistance is essential for the development of muscle strength and endurance. The contraction of specific weak muscles or weaker components of a pattern is repeated in this technique while they are being re-inforced by maximal isotonic or isometric contraction of stronger allied muscles.

Application of Repeated Contractions

(a) Normal timing—isotonic muscle work: A maximal isotonic contraction is obtained in the desired pattern and when the patient can go further the stretch reflex is repeated in order to facilitate contraction of the weaker muscle groups. This enabled the patient to move through range. Two or three repetitions of the stretch reflex may be used; thus: PULL UP!—NOW (stretch) PULL UP!—NOW (stretch) PULL UP! Etc.

(b) Normal Timing—isotonic and isometric muscle work: This is a more advanced form of repeated contractions. A maximal isotonic contraction is obtained in the desired pattern and the muscles are then held in an isometric contraction. This contraction is held against maximal resistance to obtain a build-up of excitation (by a gradual increase in resistance without breaking the hold). Then, without relaxing, the resistance is repeatedly applied to facilitate movement throughout the remainder of the range; thus:

PULL UP!—HOLD! . . . PULL UP!—NOW (stretch) PULL UP!—NOW (stretch) PULL UP! Etc.
The stretch reflex must be short and sharp, and contraction of the reinforcing muscles must be maintained throughout. The performance of the technique as a whole should be unhurried to give time for excitation to take place.

(c) Timing for Emphasis—isotonic and isometric muscle work: The sequence of muscle contraction in the performance of movement is adjusted to provide the means of reinforcing the action of weaker components of a pattern or of a weaker pattern. The maximal contraction of strong muscle groups for use in reinforcement is obtained first, then movement is pivoted to the joint over which the weaker muscles in question are effective. Three factors are essential:

(a) the stabilizing part is the area which is proximal to the joint or joints usually over which the weak muscles work.

(b) the pivot is the joint or joints over which the weak muscles work and in which movement is repeated to emphasise their activity.

(c) the handle is the part of the body which is distal to the pivot.

Movement proceeds through pattern against maximal resistance until it is completed in joints of the handle and reaches the strongest part of the range of muscles working in the stabilizing part. The muscles used to produce these movements then work isometrically against maximal resistance, those of the stabilizing part to maintain stability, those of the handle to ‘lock in’ the joints so that it moves as a single unit. While this isometric contraction is maintained by maximal resistance, movement is initiated at the pivot to obtain or emphasise the contraction of the weaker muscles. Weak distal components may be strengthened by irradiation from strong proximal components and weak proximal components may be strengthened by irradiation from strong distal components.

Effects and Uses

Repetition of activity of weaker muscles, reinforcement and timing for emphasis are used together in this technique. Repeated contractions build up strength and endurance of weaker components of a pattern and co-ordinate their activity with those of stronger components of the same pattern. They are used to correct imbalances of muscle strength, to demand relaxation of antagonistic muscles and to gain range of movement in the treatment of stiff joints.

Slow and Reversals

This technique is based on Sherrington’s principle of successive induction, i.e. that immediately after the flexor reflex is elicited the excitability of the extensor
reflex is increased. This principle is application to voluntary movement and to the interaction of antagonistic groups in the performance of movement. The contraction of strong agonistic muscles or patterns is used as a source of proprioceptive stimulation for weaker antagonistic muscles or patterns.

Application of Slow Reversals

Movement in a strong agonistic pattern against maximal resistance is followed immediately and without relaxation by a reversal of the movement into the antagonistic pattern, which is also resisted maximally. The reversal of the movement takes place smoothly with normal timing and no relaxation is allowed as the physiotherapist changes the position of her hands. A sequence of slow reversals follows; movement always beginning in the stronger pattern and ending in the weaker.

Effects and Uses

The contraction of muscles of the weaker antagonistic pattern is facilitated by that of the stronger muscles of the agonistic pattern working against maximal resistance. Repetition of the movement with normal timing integrates the action of these weaker muscles with those of their normal antagonists and facilitates the process of learning. The technique is used to strengthen and build up endurance of weaker muscles or of two antagonistic patterns, to develop co-ordination and establish the normal reversal of antagonistic muscles in the performance of movement.

Rhythmic Stabilisation

Isometric contraction of antagonistic muscles is used in this technique to stabilise joints. Stability is maintained against resistance by a co-ordination of antagonistic muscles.

Application of Rhythmic Stabilisation

Rhythmic Stabilisation can take place at any point on the pathway of the pattern of movement. The patient is instructed to ‘HOLD!’ while the physiotherapist applies maximal resistance alternating rhythmically from one direction to the other. The rotatory component of the pattern is particularly important. For ‘locking in’ the joint, and is therefore given special attention and the direction of the resistance must be changed smoothly to hold in the simultaneous contraction (or co-contraction) of all the muscles. The patient is commanded to ‘HOLD’ (against resistance in any direction) for if his effort is directional an isometric reversal of antagonists takes place and not a co-contraction.
Effects and Uses

Maintenance of a co-contraction of antagonistic muscles against maximal resistance builds up excitation; the response of the muscles is facilitated and their strength increased. Circulation is improved following Rhythmic Stabilisations, the energy of the contraction being released as heat as there is no movement.

Any part of the range of movement can be used for this technique, the part selected varies according to the circumstances, e.g. to increase excitation the strongest part of the range of the muscles’ action is used, when pain is a problem any pain-free part is suitable; when there is joint stiffness the joint at which movement is limited is selected and Rhythmic Stabilisation is followed by an attempt to increase the free range. All parts of the range are used successively when postural inco-ordination is present and the technique is repeated at each point to improve stability.

Hold - Relax

This is a relaxation technique designed to obtain a lengthening reaction of muscles whose action is antagonistic to the movement limited in range. It is effective, simple and pain-free.

Application of Hold-Relax

a. Isometric contraction of the hypertonic muscles: Movement in pattern in the direction of limitation takes place either passively or actively. When movement is active it is resisted maximally with normal timing but, whether active or passive, it continues to the point at which it is limited either by tension or pain. Having made sure that the position is pain-free, the physiotherapist changes the position of her hands and commands the patient is ‘HOLD!’ while she applies maximal resistance to the hypertonic muscles. This isometric contraction is held to obtain a build-up of excitation and then followed by the patient’s voluntary relaxation of all the muscles, ‘Let go’ and ‘Relax’. Time allowed for relaxation to take place, then an attempt is made to move in the direction of limitation to gain an increase in range. Special attention is given to the rotatory component of often as required and is usually followed by Repeated Contraction to consolidate any increase is range.

b. Isometric contraction of the reciprocal muscles. The technique is applied in a similar way to (a) but the muscles working antagonistically to the hypertonic group are made isometrically, in order to gain reciprocal relaxation of the hypertonic group.
Effects and Uses

Immediately following the isometric contraction of the hypertonic muscles the activity of their antagonists is facilitated (successive induction). When the antagonists are facilitated, the lengthening reaction of the hypertonic muscles is increased (reciprocal innervation). Hold-relax is used as a means of increasing the range of movement in joints or of obtaining pain-free movement when pain is a limiting factor.

Rhythmic Initiation

This is a relaxation technique for specific application to the rigidity of Parkinson’s Disease.

Application of Rhythmic Initiation

The limb is taken passively and rhythmically through the range of a pattern and when some relaxation has occurred the patient is instructed to assist in the movement. Several repetitions of active-assisted movement are carried out and progression is made to resisted movement. Finally the therapist’s hands are removed and the patient is encouraged to maintain a free active movement. The rhythm must not be lost during the changes from passive to active-assisted to resisted and finally free active movement.

Effects and Uses

Guidance as to the use of these techniques produces relaxation and thus helps the Parkinson patient’s to improve their ability to initiate movement.

Short Answer Type Questions

1. What are the techniques of proprioceptive neuromuscular facilitation?

2. Define manual contact and its application.

Long Answer Type Questions

1. Write in detail about the stretch stimulus and the stretch reflex therapy. Mention its applications.

2. What is repeated contraction. Explain the application of it?
11.0 Introduction

It refers to the use of multidepth immersion pools or tanks that facilitate the application of various established therapeutic interventions including stretching, strengthening, joint mobilization, balance and gait training, and endurance training.

11.1 Indications

The specific purpose of aquatic exercise is to facilitate functional recovery by providing an environment that augments a patient’s and /or practitioner’s ability to perform various therapeutic interventions.

The specific goals include:

- Facilitate range of motion (ROM) exercise
- Initiate resistance training
- Facilitate weight-bearing activities
- Enhance delivery of manual techniques
- Provide three-dimensional access to the patient
- Facilitate cardiovascular exercise.
- Initiate functional activity replication
- Minimize risk of injury or reinjury during rehabilitation.
- Enhance patient relaxation

### 11.2 Contraindications

- Incipient cardiac failure and unstable angina.
- Respiratory dysfunction; vital capacity of less than 1 liter.
- Serve peripheral vascular disease.
- Danger of bleeding or hemorrhage.
- Severe kidney disease: Patients will be unable to adjust to fluid loss during immersion.
- Open wound, colostomy, and skin infections such as tinea pedis and ringworm.
- Uncontrolled bowel or bladder: Bowel accidents will require pool evacuation, chemical treatment, and possibly drainage.
- Water and airborne infections or diseases: examples include influenza, gastrointestinal infections, typhoid, cholera, and poliomyelitis.
- Uncontrolled seizures: Uncontrolled seizures create a safety issue for both the clinician and patient if immediate removal from the pool is necessary.

### 11.3 Precautions Aquatic Exercise

Although most patients will easily tolerate aquatic exercise, the practitioner must consider several physiologic and psychological aspects of immersion that will affect the selection of an aquatic environment.

**Precautions**

**Fear of Water**

Fear of water can limit the effectiveness of any immersed activity. Fearful patients often experience increased symptoms during and after immersion because
of muscle guarding, stress response, and improper form with exercise. Often patients require an orientation period designed to provide instruction regarding the effects of immersion on balance, control of the immersed body, and proper use of flotation devices.

**Neurologic Disorders**

Ataxic patients may experience increased difficulty controlling purposeful movements. Patients with heat intolerant multiple sclerosis may fatigue with immersion in temperatures greater than 33 C.

**Seizures**

Patients with controlled epilepsy require close monitoring during immersed treatment and must be complaint with medication prior to treatment.

**Cardiac Dysfunction**

Patient with angina and abnormal blood pressure also require close monitoring. For patient with cardiac disease, low-intensity aquatic exercise may result in lower cardiac demand than similar land exercise.

**Small Open Wounds and Lines**

Small, open wounds and tracheotomies may be covered by waterproof dressings. Patients with intravenous lines, Hickman lines and other open lines will require clamping and fixation.

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**Short Answer Type Questions**

1. Define Hydrotherapy.

2. Write about indications for hydrotherapy.

3. Write about contraindications for hydrotherapy.

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**Long Answer Type Questions**

1. What are the precautions to hydrotherapy exercises?
Breathing exercises and ventilatory training are fundamental interventions for the prevention or comprehensive management of acute or chronic pulmonary disorders. For example, these interventions are frequently advocated in the literature for patients with chronic obstructive pulmonary diseases (chronic bronchitis, emphysema, asthma, and cystic fibrosis), for patients with a high spinal cord lesion, for patients who have undergone thoracic or abdominal surgery and are at high risk for acute pulmonary complications, or for patients who must remain in bed for an extended period of time.

Breathing exercises and ventilatory training can take on many forms including diaphragmatic breathing, segmental breathing, ventilatory muscle training, inspiratory resistance training, incentive spirometry, and breathing techniques for the relief of dyspnea with exertion.
Although breathing exercises or ventilatory muscle training may affect and possibly alter a patient’s rate and depth of ventilation, these interventions may not necessarily have any impact on gas exchange at the alveolar level or on oxygenation. Therefore, breathing exercise or ventilatory training should be only one aspect of management of improve pulmonary status and to increase a patient’s overall endurance and function in daily living activities.

### 12.1 Guidelines for Teaching Breathing Exercises

1. Explain to the patient the aims and rationale of breathing exercises or ventilatory training specific to his or her particular impairments and functional limitations.

2. Have the patient assume a comfortable, relaxed position and loosen restrictive clothing. Initially a semi-fowler’s position with the head and trunk elevated approximately 45 degrees is desirable. By totally supporting the head and trunk and b flexing the hips and knees and supporting and the legs with a pillow, the abdominal muscles remain relaxed. Other positions such as supine, sitting or standing may be used initially or as the patient progress in treatment.

3. Observe and assess the patient’s spontaneous breathing pattern while at rest and later with activity.

4. Determine whether or not ventilatory training is indicated.

5. If necessary, teach the patient relaxation techniques. This will relax the muscles of the upper thorax, neck, and shoulders to minimize the use of the accessory muscles of ventilation. Pay particular attentions to relaxation of the sternocleidomastoids. Upper trapezius, and levator scapulae muscles.

6. Depending on the patient’s underlying pathology and impairments determining whether to emphasize the inspiratory or expiratory phase of ventilation.

7. Demonstrate the desired breathing pattern to the patient.

8. Have the patient practice the correct breathing pattern in a variety of positions at rest and with activity.

**Precautions**

- Never allow a patient to force expiration, expiration should be relaxed and passive or controlled. Forced expiration only increases turbulence in the airway, which can lead to bronchospasm and increased airway restriction.
· Do not allow a patient to take a very prolonged expiration. This causes the patient to gasp with the next inspiration. The patient’s breathing pattern then becomes irregular and inefficient.

· Do not allow the patient to initiate inspiration with the accessory muscles and the upper chest. Advice the patient that the upper chest should be relatively quiet during breathing.

· Allow the patient to perform deep breathing for only three or four inspirations and expirations at a time to avoid hyperventilation.

**12.2 Diaphragmatic Breathing**

When the diaphragm is functioning effectively in its role as the primary muscle of inspiration, ventilation is efficient and the oxygen consumption of the muscles of ventilation is very low during quiet relaxed breathing. When a patient substantially relies on the accessory muscle of inspiration, the work of breathing increases. Although the diaphragm controls breathing at an involuntary level, a patient with primary pulmonary disease such as COPD, can be taught breathing control by optimal use of the diaphragm and relaxation of accessory muscles. Controlled breathing techniques, which emphasize diaphragmatic breathing, are designed to improve the efficiency of ventilation, decrease the work of breathing, increase the excursion (ascent or descent) at the diaphragm, and improve gas exchange and oxygenation. Diaphragmatic breathing exercise are also used to mobilize lung secretions during postural drainage.

**Procedure**

· Prepare the patient in a relaxed and comfortable position in which gravity assists the diaphragm, such as a semi-flower’s position.

· If you have noted in the examination that the patient initiates the breathing pattern with the accessory muscles of inspiration, start instruction by teaching the patient how to relax those muscles (shoulder rolls or shoulder shrugs coupled with relaxation).

· Place your hand on the rectus abdominis just below the anterior costal margin. Ask the patient to breathe in slowly and deeply through the nose. Here the patients keep the shoulders relaxed and upper chest quiet, allowing the abdomen to rise. Then tell the patient to slowly let all the air out using controlled expiration.

· Have the patient practice his three or four times and then rest. Do not allow the patient to hyperventilate.
Fig. 12.1 The semireclining and semi flower’s positions are comfortable, relaxed positions in which to teach diaphragmatic breathing.

If the patient is having difficulty using the diaphragm during inspiration, have the patient inhale several times in succession through the nose by using a sniffing action. This action usually facilitates the diaphragm.

- To learn how to self-monitor this sequence, have the patient place his or her own hand below the anterior costal margin and feel the movement the patient’s hand should rise during inspiration and fall during expiration. By placing one hand on the abdomen, the patient can also feel the contraction of the abdominal muscle, which occurs with controlled expiration or coughing.

- After the patient understands and is able to control breathing using a diaphragmatic pattern keeping the shoulders relaxed, practice diaphragmatic breathing in a variety of positions (supine, sitting, standing) and during activity (walking and climbing stairs).

12.3 Segmental Breathing

It is questionable whether a patient can be taught to expand localized areas of the lung while keeping other areas quiet. It is known, however, that hypoventilation does occur in certain areas of the lungs because of chest wall fibrosis, pain, and muscle guarding after surgery, atelectasis, and pneumonia. Therefore, there are certain instances such as during postural drainage of following thoracic surgery.
when it is important to emphasize expansion of problem areas of the ling and chest wall.

**Lateral Costal Expansion**

This is sometimes called lateral basal expansion and may be done unilaterally or bilaterally. Emphasizing deep breathing with a focus of movement of this portion of the lower rib cage is thought to facilitate diaphragmatic excursion it is a particularly useful technique for those patient with a stiff lower rib cage, as is often seen in the patient with chronic bronchitis, emphysema, or asthma.

**Procedures**: The patient may be sitting or in a hook-lying position. Place your hands along the lateral aspect of the lower ribs to fix the patient’s attention to the areas at which movement is to occur.

- Ask the patient to breathe out, and feel the rib cage move downward and inward. As the patient breathes out, place pressure into the ribs with the palms of your hands.
- Just prior to inspiration, apply a quick downward and inward stretch to the chest. This places a quick stretch on the external intercostals to facilitate their contraction.
- Apply gentle manual resistance to the lower rib area to increase sensory awareness as the patient breathes in deeply and the chest expands and ribs flare.
- Then, again, as the patient breathes out, assist by gently squeezing the rib cage in a downward and inward direction.

![Fig. 12.2 Bilateral lateral costal expansion - supine](image-url)
The patient may then be taught to perform the maneuver independently. He or she may place the hand(s) over the ribs or apply resistance using a towel or belt.

**Posterior Basal Expansion**

This form of segmental breathing is important for the postsurgical patient who is confined to bed in a semi-reclining position for an extended period of time. Secretions often accumulate in the posterior segment of the lower lobes.

**Procedure:** Have the patient sit and lean forward on a pillow, slightly bending the hips. Place your hands over the posterior aspect of the lower ribs. Follow the same procedure just described for lateral costal expansion.

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**Right Middle Lobe or Lingula Expansion**

*Procedure.* While the patient is sitting, place your hands at either the right or the left side of the patient’s chest, just below the axilla. Follow the same procedure as described for lateral basal expansion.

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**12.4 Pursed-Lip Breathing**

Whether it is appropriate to teach pursed-lip breathing to a patient is debatable. Most therapists feel that gentle pursed-lip breathing with controlled expiration is a useful procedure, if it is performed appropriately. It is thought to
keep airways open by creating a backpressure in the airways. It is taught to help a patient with chronic obstructive pulmonary disease.

Fig. 12.4 Belt exercise reinforce lateral costal breathing (A) by applying resistance during inspiration and (B) by assisting with pressure along the rib cage during expiration

Deal with episodes of dyspnea. Studies suggest that pursed-lip breathing decreases the respiratory rate, increases the tidal volume, and improves exercise tolerance. Some patients spontaneously develop this pattern of breathing. If so, they should not be discouraged from using it.

Procedure

Have the patient assume a comfortable position and relax as much as possible. Explain to the patient that expiration must be relaxed and that contraction of the abdominals must be avoided. Place your hand over the patient’s abdominal muscles to detect any contraction of abdominals. Instruct the patient to breathe in slowly and deeply. Then have the patient loosely purse the lips and exhale.

12.5 Postural Drainage

Postural drainage, another intervention for airway clearance, is a means of mobilizing secretions in one or more lung segments to the central airways by placing the patient in various positions so that gravity assists in the drainage process. When secretions are moved to the larger airways, they are then cleared by coughing or endotracheal suctioning. Postural drainage therapy also includes the use of manual techniques, such as percussion, shaking, and vibration, as well as voluntary coughing.
Manual Techniques Used During Postural Drainage Therapy

In addition to the use of body positioning, deep breathing, and an effective cough to facilitate airway clearance, a variety of manual techniques are used in conjunction with postural drainage to maximize the effectiveness of the mucociliary transport system. They include percussion, vibration, shaking, and rib springing. Findings from studies that have been implemented to evaluate the effectiveness of these manual techniques are inconsistent.

**Percussion**

This airway clearance technique is used to further mobilize secretions by mechanically dislodging viscous or adherent mucus from the lungs. Percussion is performed with cupped hands over the lung segment being drained. The therapist’s cupped hands alternately strike the patient’s chest wall in a rhythmic fashion. The therapist should try to keep shoulders, elbows, and wrists loose and mobile during the maneuver. Mechanical percussion is an alternative to manual percussion techniques. Percussion is continued for several minutes or until the patient needs to alter position to cough. This procedure should not be painful or uncomfortable. To prevent irritation to sensitive skin, have the patient wear a lightweight gown or shirt. Avoid percussion over breast tissue in women and over bony prominences.

**Goals of Postural Drainage**

- Patients with pulmonary diseases that are associated with increased production or viscosity of mucus, such as chronic bronchitis and cystic fibrosis
- Patients who are on prolonged bed rest
- Patients who have received general anesthesia and who may have painful incisions that restrict deep breathing and coughing postoperatively

![Fig. 12.5 A hand position for applying percussion (B) The therapist alternately percusses over the lung segment being drained.](image-url)
· Any patient who is on a ventilator if he or she is stable enough to tolerate the treatment

**Remove Accumulated Secretions from the Lungs**

· Patients with acute or chronic lung disease, such as pneumonia, atelectasis, acute lung infections, and COPD
  · Patients who are generally very weak or are elderly
  · Patients with artificial airways

**Relative Contraindications to Postural Drainage**

Severe Hemoptysis

**Untreated Acute Conditions**

· Severe pulmonary edema
· Congestive heart failure
· Large pleural effusion
· Pulmonary embolism
· pneumothorax

**Cardiovascular Instability**

· Cardiac arrhythmia
· Severe hypertension or hypotension
· Recent myocardial infarction
· Unstable angina

**Recent Neurosurgery**

· Head-down positioning may cause increased intracranial pressure; if PD is required, modified position can be used.

**Vibration**

This airway clearance technique is used in conjunction with percussion is postural drainage. It is applied only during expiration as the patient is deep breathing to move the secretions to the larger airways. Vibration is applied by placing both hands directly on the skin and over the chest wall (or one hand on top of the other) and gently compressing and rapidly vibrating the chest wall as the patient breathes out. Pressure is applied in the same direction as that in
which the chest is moving. The vibrating action is achieved by the therapist isometrically contracting the muscles of the upper extremities from shoulders to hands.

**Shaking**

Shaking is a more vigorous form of vibration applied during exhalation using an intermittent bouncing maneuver coupled with wide movements of the therapist’s hands. The therapist’s thumbs are locked together, the open hands are placed directly on the patient’s skin, and fingers are wrapped around the chest wall. The therapist simultaneously compresses and shakes the chest wall.

**Postural Drainage Positions**

Positions are based on the anatomy of the lungs and the tracheobronchial tree. Each segment of each lobe is drained using the positions depicted in figures as shown. The shaped area in each illustration indicates the area of the chest wall where percussion or vibration is applied.

The patient may be positioned on a postural drainage table that can be elevated at one end, a tilt table, a reinforced padded table with a lift, or a hospital bed. A small child can be positioned on a therapist’s or parent’s lap.

![Fig. 12.6 Percussion is applied above the scapulae. Your finger curve over the top of the shoulders](image)

**Guidelines for Implementation for Postural Drainage**

**General Considerations**
**Time of day.** Consider the following when scheduling postural drainage into a patient’s day:

- Never administer postural drainage directly after a meal
- Coordinate treatment with aerosol therapy. Some therapists feel that aerosol therapy combined with humidification prior to postural drainage will help loosen secretions and increase the likelihood of productivity. Others believe that aerosol therapy is best after postural drainage when the patient’s lungs are clearer and maximal benefit can be gained from medication administered through aerosol therapy.

- Choose a time of a day that will be of most benefit to the patient. A patient’s cough tends to be very productive in the early morning because of accumulation of secretions from the night before. Postural drainage in the early evening will clear the lung prior to sleeping and help the patient rest more easily.

**Frequency of treatments:** Frequency on a daily or weekly basis depends upon the pathology of the patient’s condition. If secretions are thick and copious, two to four times per day is usually necessary until lungs are clear if the patient is on a maintenance program, the frequency may be decreased.

**Prepare the Patient**

- Loosen tight or bulky clothing. It is not necessary to expose the skin. The patient may wear a light weight shirt or gown.
- Have a sputum cup or tissues available
- Have sufficient pillows for positioning and comfort.
- Explain the treatment procedure to the patient.
- Teach the patient deep breathing and an effective cough prior to beginning postural drainage.
- If the patient is producing copious amounts of sputum, instruct the patient to cough a few times or have the patient suctioned prior to positioning.
- Make any adjustment of tubes and wires, such as hest tubes, ECG wires, or catheters, so they remain clear during positioning.

**Modified Postural Drainage**

Some patients who require postural drainage cannot assume or cannot tolerate the positions that are optimal for treatment. For example, the patient with congestive heart failure may develop orthopnea (shortness or breath caused
by lying flat). After neurosurgery a patient may not be allowed to assume a head-down (trendelenburg) position because this position causes increased intracranial pressure. After thoracic surgery a patient may have chest tubes and monitoring wires that may limit positioning. Under these circumstances, as well as many others, positioning during postural drainage must be modified. The positions in which postural drainage is undertaken are modified consistent with the patient’s medical or surgical problems. Their compromise, although not ideal, is better than not administering postural drainage at all.

**Home Drainage of Postural Drainage**

Postural drainage may have to be carried out on a regular basis at home for patients with chronic lung disease. Patients need to be shown how to position themselves using inexpensive aids. An adult may place pillows over a hard wedge or stacks of news papers to achieve the desired head-down positions in bed. A patient may also lean the chest over the edge of the bed, resting with the arms on a chair or stool. A child may be positioned on an ironing board propped up against a couch. A family member should be instructed in positioning and percussion to assist the patient when needed. Guidelines and precautions, previously discussed, should be followed.

**Short Answer Type Questions**

1. List any two breathing exercises.

2. Define postural drainage.

**Long Answer Type Questions**

1. What are the different Guidelines for Teaching Breathing Exercises?

2. Explain in detail about diaphragmatic breathing.

3. Explain in detail about segmental breathing.
13.1 Inactive postures

These are attitudes adopted for resting or sleeping, and they are most suitable for this purpose when all the essential muscular activity required to maintain life is reduced to a minimum. Those postures which make minimal demands upon the muscles responsible for the maintenance of essential body function, such as respiration and circulation, are preferable. The postures or positions used for training general relaxation fulfil these conditions by allowing freedom for respiratory movement and at least possible work for the heart muscle.

13.2 Active postures

The integrated action of many muscles is required to maintain active postures, which may be either static or dynamic.

Static Postures: A constant pattern of posture is maintained by the interaction of groups of muscles which work more or less statically to stabilise the
joints, and in opposition to gravity or other forces. In the erect postures they preserve a state of equilibrium.

**Dynamic Postures**: This type of active posture is required to form an efficient basis for movement. The pattern of the posture is constantly modified and adjusted to meet the changing circumstances which arise as the result of movement.

### 13.3 The Postural mechanism

#### The Muscles

The intensity and distribution of the muscle work which is required for both static and dynamic postures when varies considerably with the pattern of the posture, and the physical characteristics of the individual who assumes it. The groups of muscles most frequently employed are those which are used to maintain the erect position of the body, by working to counteract the effects of gravity. They are consequently known as the anti-gravity muscles and their action with regard to joints is usually that of extension.

These anti-gravity muscles present certain structural characteristics which enable them to perform function with efficiency and the minimum of effort. The form of the muscles is multi-pennate and fan-shaped, an arrangement which signifies powerful action is opposed to the ability to produce a wide range of movement at high speed. Many of the constituent fibres are ‘red’, indicating their capability of sustained contraction without fatigue, due to their low metabolic rate of action.

#### Nervous Control

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

The Postural Reflexes. A reflex, by definition, an efferent response to an afferent stimulus. The efferent response in this instance is a motor one, the anti-gravity muscles being the principal effector organs. Afferent stimuli arise from a variety of sources all over the body, the most important receptors being situated in the muscles themselves, the eyes and the ears.

(i) **The Muscles**: Neuromuscular and neurotendinous spindles within the muscles record changing tension. Increased tension causes stimulation and results in a reflex contraction of the muscle, and so appears to be a manifestation of the myotatic, or stretch, reflex.
(ii) The Eyes: Visual sensation records any alteration in the position of the body with regard to its surroundings, and the eyes from one of the receptors for the 'righting' reflexes which enable the head and body to restore themselves to the erect position from other less usual attitudes.

(iii) The Ears: Stimulation of the receptors of the vestibular nerve results from the movement of fluid contained in the semicircular canals of the internal ear. Each canal lies in a different plane, which is at right angles to both others, and any movement of the head disturbs the fluid they contain, and thus knowledge of the movement and the direction in which it take place are recorded.

(iv) Joint Structures: In the weight-bearing position approximately of bones stimulates receptors in joint structures and elicits reflex reactions to maintain the position.

Skin sensation also plays a part especially that of the soles of the feet, when the body is in standing positions.

Impulses from all these receptors are conveyed and co-ordinated in the Central Nervous System, the chief centres involved being the cerebral cortex, the cerebellum, the red nucleus and the vestibular nucleus.

A very elementary summary of the chief components of the complex series of reflexes which together constitute the Postural Reflex is given in the diagram opposite.

13.4 The pattern of posture

Patterns of posture, both static and dynamic, are gradually built up by the integration of the many reflexes which together make up the Postural Reflex. Some of these component reflexes are inborn and some are conditioned, being developed as the result of constant repetition of postures maintained by voluntary control.

Good Posture

Posture is said to be good when it fulfils the purpose for which it is used with maximum efficiency and minimum effort.

As the physical characteristics of no two people are identical, the precise pattern of good posture must vary with the individual. It is possible, however, to generalize to some extent. For example, in the erect postures the alignment of specific parts of the body usually leads to perfect balance of one segment upon another, a state which can be maintained with the minimum of muscular effort and which is aesthetically pleasing to the eye.
As dynamic postures involve constant readjustment to maintain the efficiency of the postural background throughout the progress of the movement, they are much more difficult to assess. In many activities, however, the same alignment of the various segments of the body which is satisfactory in the erect static postures forms the basis from which these adjustments are made; for example, in walking or sitting and writing. In the erect positions the plane of this alignment is vertical, but in many dynamic postures it is inclined or even horizontal, in which case the effect of gravity on the various body segments is altered and the muscle work required to maintain the alignment is adjusted accordingly.

**Development of Good Posture**

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

The chief factors which predispose to the health and development of the muscles and the postural reflex are

(i) A stable psychological background,

(ii) Good hygienic conditions,

(iii) Opportunity for plenty of natural free movement.

Emotion and mental attitude have a profound effect upon the nervous system as a whole, and this is reflected in the posture of the individual. Joy, happiness and confidence are stimulating and are reflected by an alert posture in which positions of extension predominate. Conversely unhappiness, conflict and a feeling of inferiority have just the opposite effect and result in postures in which positions of flexion are most conspicuous.

This connection between mental and physical attitudes has always been recognized and used in dancing and on the stage. It is certain that the mental attitude affects the physical, either temporarily or permanently. Is it not possible that this can also happen in reverse? In other words, cannot a physical attitude adopted consciously affect the mental attitude?

Good hygienic conditions, particularly with regard to nutrition and sleep, are essential for a healthy nervous system and for the growth and development of bones and muscles. In addition, the opportunity for plenty of natural free movements also encourages the harmonious development of the skeletal muscles. Activities which are much enjoyed by the normal healthy child at play, for example, running, jumping, and climbing, are those in which movements of active extension predominate.
Poor Posture

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

Faulty alignment of the body segments in the erect positions may lead to the necessary for additional muscle work to maintain balance. On the other hand, efficient compensation may take place, in which case no additional muscular effort is required, but the attendant ligamentous strain or cramping of thoracic movement are disadvantages which cannot be ignored. In addition, postures which involve a marked increase in any or all of the curves of the spine are aesthetically displeasing, clothes do not fit these subjects well and this may in itself have an unwelcome psychological reaction.

The purpose of dynamic posture is to serve as an efficient and adaptable background to movement. Posture patterns which do not fulfil this function impede and reduce the efficiency of the movement and therefore must be considered poor, e.g. standing square to the net while making a forehand drive at tennis.

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

Factors which predispose to Poor Posture

The causes of poor posture are often very obscure, and, even if they are known, are difficult to remove.

The factors which most often contribute to the establishment of an inefficient postural pattern are the mental attitude of the patient and poor hygienic conditions. General debility after a constitutional illness and prolonged fatigue are also contributory causes, as they reduce the efficiency of the nervous system as a whole.

Local factors such as localised pain, muscular weakness, occupation stresses, or localised tension which serves no useful purpose, lead to muscular disbalance and alter the postural pattern, but do not necessarily reduce its efficiency under the circumstances. If, however, this altered pattern of posture is continued after the cause for it is removed, it must be regarded as a postural defect.

A faulty idea of what constitutes good posture may also lead to the establishment of an inefficient pattern by repeated voluntary effort.
13.5 Technique of Re-Education

The atmosphere in which instruction is given to the patient is of the greatest importance in postural re-education, and the physiotherapist can do much to gain co-operation by her manner and approach. The patient must be made to feel that the acquisition of good posture is worth while, and that any efforts he makes to attain will be noticed and appreciated, while his difficulties and shortcomings will be understood. Individual instruction is essential as no two patients have identical difficulties, but they have also much in common to learn and for this group instruction is valuable. The inclusion of group activities in any programme of re-education is conductive to an atmosphere of enjoyment and the patient is usually stimulated by working with others.

Relaxation

The ability to relax is an important factor in re-education, as some degree of useless and unnecessary tension is nearly always associated with poor posture. To begin with general relaxation with the body in horizontal positions reduces muscular tension and gives a feeling of alignment. Voluntary relaxation of specific muscle groups can then be taught and practice so that the patient learns to recognize tension and able to relax at will, if and when it develops during the maintenance of either static or dynamic postures.

Because of the excessive use of the arms in front of the body and the necessity to lean forwards which many occupations demands as in washing clothes or writing at a desk, these tensions usually occur in muscles, round the shoulder girdle and in the neck extensors. Local and voluntary relaxation of these groups can be taught in lying and the erect positions, first by the contrast methods and later by learning to recognize a state of tension and then ‘letting go’.

Example of Relaxation Methods
a. Crook lying, lying or prone lying; general relaxation.

b. Crook lying; relax Shoulders to supporting surface, with expiration.

c. Forehead support prone lying; Head raising and lowering with relaxation.

d. Sitting; Shoulder shrugging and retraction followed by relaxation.

Physiological relaxation can also be used in the treatment of occupation-induced tensions.
Mobility

The maintenance of normal mobility is essential to enable a wide variety of postures of postures to be assumed. Abnormal activity, however, is a liability rather than an asset, as additional muscular effort is required to control it, and in some cases it may be contributory factor in the development of poor posture.

Normal mobility is maintained by general free exercises which are rhythmical in character and include full-range movement of all joints. Emphasis is laid on full extension as this is the movement which is most liable to limitation, except in the case of the lumbar spine and the shoulder joints, where flexion and lateral rotation respectively are more likely to be limited. If joint stiffness has developed, specific mobility measures for the joint affected are used to make sure that the loss of range in one joint is not masked by a compensatory increase in the mobility of the adjacent joints. For example, stiff shoulders which will not permit full elevation of the arm are readily compensated by hyperextension in the lumbar spine.

Exercises and agilities which increase the respiratory excursions are of great importance and should on no account be omitted, and those which involve hanging positions give good alignment of the body and are much enjoyed by children.

Muscle Power

General muscular weakness is rarely if ever the root cause of poor posture, but the opportunity for free movement and harmonious muscular development helps to maintain their tone and efficiency, and so to withstand any strain which may be imposed by occupational stresses. The use of the anti-gravity muscles is of special importance as these are the groups which are most frequently called upon a act in a postural capacity.

If and when joint sufficient is present, exercise for the muscles which have been stretched are essential to ensure relaxation of their antagonists and to restore muscular balance. For example, work for the upper Back Extensors and Scapula Retractors is required during re-education of a stooping posture.

Presentation of a Good Posture

There is no one method of teaching any one patient to assume and experience the feeling of good posture. The method and the technique selected for a particular patient must depend on the patient and the physiotherapist, but one thing appears to be essential and that is that the physiotherapist must have faith in the method she adopts.

Those who have habitual poor posture often feel uncomfortable and unnatural in any position other than the one to which they have become
accustomed. This is not surprising, but emphasizes the importance of convincing the patient that good posture ‘looks’ right, and will prove efficient in the long run. In other words, the physiotherapist must ‘sell’ the pattern of good posture.

A mirror, posture recorder of photographs may be useful for this purpose, so that the image can be compared with pictures of experts which demonstrate a good general pattern of alignment. Video-tapes may also be used. This is particularly impressive in training dynamic posture in activities such as tennis, diving and lifting where faulty posture can have such a marked effect on the efficiency of the movement.

Training of static postures in the erect position is basic, partly because most people, with the exception of very small children, are compelled to spend most of their working hours in upright positions which are relatively static, for example, standing and sitting. Even in walking the alignment of the trunk remains more or less the same, and incidentally the ability to remain still without undue effort, when the occasion demands it, is a habit well worth acquiring.

In the erect postures, the control of each segment of the body in relation to the rest is by no means a simple thing to learn. The position of the whole is profoundly influenced by the position of the head, of the pelvic tilt, and by the state of comfort and position of the feet. Different authorities stress the importance of one or other of these factors but in fact they are all important and any one may prove to be the dominant factor.

Establishment of a new and satisfactory pattern of posture is accelerated by strong and prolonged holding against maximal resistance in a satisfactory pattern of posture. This resistance is applied manually in directions which are at first known to the patient with a dynamic command to ‘HOLD!’ to focus his attention. Later resistance is applied is quick succession from a variety of directions unknown to the patient.

**The Head**

An upward thrust of the vertex in the erect positions may be sufficient to achieve satisfactory alignment of the whole body, provided no unnecessary tension is allowed to develop elsewhere.

To prevent tension in the initial stages this thrust may be practiced in the horizontal and inclined positions, e.g.

a. **Crook lying or lying with Feet support**: Body lengthening

b. **Half lying, sitting or standing**: Head stretching upwards.
The Pelvic Tilt

Voluntary control of the pelvic tilt teaches the patient to recognize any deviation from the normal, and trains him to be able to adjust and correct it at will. In crook lying the trunk is supported in a position of alignment and the pelvis is free to move in an antero-posterior direction, therefore this position is selected to start with. Contraction of the Hip Extensors, as if to lift the hips off the floor, and of the straight Abdominal Muscles, tilts the pelvis backwards and the reverse movement is achieved by the hollowing of the lumbar spine.

Once the ability to adjust the pelvic tilt has been learnt it can be performed in a variety of positions which include sitting and standing, and it can be controlled at the angle of tilt required.

c. **Crook lying**: Gluteal and Abdominal contraction (to flatten lower Back to floor), followed by relaxation, then hollowing of Back.

d. **Low wing sitting**: Pelvis tilting and adjustment.

e. **Low wing standing**: Pelvis tilting and adjustment.

The movement may be felt and appreciated by placing the hands over the anterior superior iliac spines.

The Feet

Painless, mobile and strong feet form a stable base on which the weight of the body is balanced and supported. The arches are braced, and the weight of the body adjusted so that if falls through the summit of the arch and is distributed evenly to the areas of the feet which are designed for weight-bearing. In walking, the weight is transferred progressively from one part of the weight-bearing area to the next. Bracing of the arches can be practiced with or without weight-bearing, but in every case the weight-bearing areas must be in contact with the floor or other supporting surface, otherwise the sensory stimulation of pressure on the soles of the feet is lost and the surfaces are unlikely to remain on the same plane.

f. **Sitting**: bracing of the longitudinal arch and pressing the Toes to the floor. (All weight-bearing areas must be kept in contact with the floor.)

g. **Standing (Feet turned forwards and slightly apart)**: Hip rotation outwards (to make patellae look laterally).
The Complete Picture

Where the complete pattern of good posture does not emerge as the result of the adjustment of any one of the areas which have been already mentioned, it must be built up gradually and progressively from complete relaxation. A state of balanced tension and much concentration is required at first, but the effort and tension are progressively reduced by repetition. Every new poise or movement requires effort at first, but this is reduced as the pattern on which it is based is simplified and becomes more efficient and the passage of the coordinating impulses on the neuromuscular pathways is facilitated. Provided there is sufficient repetition and precision, the new and satisfactory pattern of posture becomes habitual and therefore no longer requires voluntary control, as it is maintained by a conditional reflex which is part of the postural reflex.

Short Answer Type Questions

1. What are inactive postures?
2. What are active postures?
3. What are the features of good posture?

Long Answer Type Questions

1. What are the different postural mechanism? Explain in detail.
2. What are the characteristic features of good posture?
3. What are the techniques of reeducation?
There are a number of aids to assist people who have difficulty in walking or who cannot walk independently without one. These external aids are crutches, sticks and frames. Braces and splints which can be used to assist walking are not described in this book.

14.1 Crutches

There are three basic types of crutches and they are used to reduce weight bearing on one or both legs, or to give additional support where balance is impaired and strength is inadequate.

1. Auxiliary Crutches

They are made of wood with an axillary pad, a hand piece and a rubber ferrule. The position of the hand piece and the total length are usually adjustable (fig. 186).
Fig. 14.1 Axillary crutches

The auxiliary pad should rest against the chest wall approximately 5 cm below the apex of the axilla and the hand grip should be adjusted to allow the elbow to be slightly flexed when weight is not being taken. Weight is transmitted down the arm to the hand piece. The elbow is extended. On no account should weight be taken through the axillary pad as this could lead to a neuropraxia of the Radial Nerve or Brachial Plexus.

**Measurement of length:** There is variety of ways measuring the patient for crutches. It is usually carried out with the patient in lying.

a. With shoes off - measure from the apex of the axilla to the lower margin of the medial malleolus. This is an easy measurement and is reasonably reliable.

b. With shoes on - 5 cm vertically down from the apex of the axilla to a point 20 cm lateral to the heel of the shoe. This tends to be less accurate than the first method.

The measurement from the auxiliary pad to the hand grip should be taken with the elbow slightly flexed (approximately 15°) from a point 5 cm below the apex of the axilla to the ulnar styloid. Once the patient is standing with the support of the crutches, the physiotherapist must the correct way to use the crutches and to see that they do not allow the axillary pad to press into the axilla.

**2. Elbow crutches**

They are made of metal and have a metal or plastic forearm band. They are usually adjustable in length by means of a press clip or metal button and have a rubber ferrule. These crutches are particularly suitable for patients with good
balance and strong arms. Weight is transmitted in exactly the same way as for axillary crutches.

Measurement of length. The measurement is usually taken with the patient in the lying position with the shoes on. The elbow is slightly flexed (approximately 15°) and the measurement is taken from the ulnar styloid to a point 20 cm lateral to the heel of the shoe. Once the patient is standing with the support, the length must be checked.

3. Gutter Crutches. (Adjustable arthritic crutches; forearm support crutches)

They are made of metal with a padded forearm support and strap, an adjustable hand piece and a rubber ferrule.

These are used for patient’s with Rheumatoid Disease, who require some form of support but cannot take weight through hands, wrists and elbows because of deformity and/or pain. The crutch is adjustable in length in the same way as the elbow crutch. It should also be adjustable in the length of forearm support and in the angle of the hand piece to allow for deformities.

Measurement of length

(a) If the patient is able to stand, it is better to assess the required length in this position from elbow to the floor.

(b) Measurement can be carried out with the patient lying with shoes on, and is taken from the point of the flexed elbow to 20 cm lateral to the heel.

A patient with Rheumatoid Disease may allow the hips and knees to flex in the weight-bearing position because of muscle weakness and/or pain, but with gutter crutches for support he may be able to obtain more extension. This must be taken into account in any adjustment.

14.2 Preparation for Crutch Walking

a. Arms

The power of the extensors and adductors of the shoulder and the extensors of the elbow must be assessed and if necessary strengthened before the patient starts walking. The hand grip must also be tested to see that the patient has sufficient power and mobility to grasp the hand piece. The results of this assessment will determine the type of crutch chosen.
b. Legs

(i) Non-weight-bearing: The mobility and strength of the unaffected leg should be assessed, paying particular attention to the hip abductors and extensors, the knee extensors and the plantar flexors of the ankle. These muscles must be sufficiently strong to take weight. The patient is taught hip-hitching on the non-weight-bearing side if it is required.

(ii) Partial weight-bearing: The mobility and strength of both legs should be assessed and muscles strengthened where necessary.

c. Balance

Sitting and standing balance must be tested and trained if necessary.

Demonstration

The physiotherapist should demonstrates the appropriate crutch walking to the patient, emphasizing the important points.

Crutch Walking

The physiotherapist should have an assistant when the patient is to stand and walk for the first time. This person may be another physiotherapist, a nurse, another health care worker or a relative. The physiotherapist must instruct the assistant on how to support the patient to the upright position and then how to transfer the patient on to the crutches.

(i) Non-weight-bearing: The patient should always stand with a triangular base, i.e. crutches in front or behind the weight-bearing leg.

Fig. 14.3

To walk, the patient first moves the crutches a little further forward, takes weight down through the crutches and lifts the foot forward to a position just behind the line of the crutches. Once this is mastered the patient may progress to lifting the foot forward to a position just in front of the line of the crutches.
It is important in certain cases for the patient to progress to 'shadow walking', where the affected leg is moved in sequence simulating walking but taking no weight.

(ii) Partial weight-bearing: There are two methods of partial weight-bearing.

a. This is a progression from shadow walking, where no weight in taken through the affected leg, to permit a gradual increase of weight to be taken. The crutches and the affected leg are taken forward and put down together. Weight is then taken through the crutches and the affected leg while the unaffected leg is brought through.

b. This method simulates normal walking and more weight is taken through the affected leg. The right crutch is moved forward followed by the left leg, then the left crutch is moved forward followed by the right leg. This can be progressed to moving the right crutch with left leg and vice versa.

Sticks

Sticks may be either of wood or metal with curved or straight hand places. The metal ‘ones are adjustable and therefore suitable for assessment purposes. The wooden ones are cut to the required length.
**Measurement:** The measurement can usually be taken with the patient in the standing position. The elbow is slightly flexed and the measurement is taken from the ulnar styloid to the floor approximately 15 cm from the heel.

**Use of sticks:** The patient may use two sticks in the same way as the methods described for partial weight-bearing walking with crutches. Sticks allow more weight to be taken through the leg than do crutches. One stick may be used on the unaffected side so that the stick and the affected leg are placed forward together, taking some of the weight through the stick.

![Fig. 14.6 Tripod or Quadrapod Frames](image1)

The commonest type is the lightweight frame with four feet which may be adjustable in height. The patient lifts the frame forward, then leans on it and takes two steps. The patient should take even steps, keeping the frame well forward. A bag can be attached to the front of the frame to carry small items.
Ataxic patients who are too unsteady to lift a frame forward may be able to use a rollator frame which can be pushed or a reciprocal frame where each side moves independently.

Fig. 14.8

Safety: The physiotherapist must check the safety of all working aids not only when giving them to a patient, but regularly throughout a treatment programme. The patient must be taught to inspect his walking aids and know where to obtain replacement parts. Ferrules, which are made of rubber or plastic, should be rough to give a high co-efficient of friction. The general structure including screws, metal clips, press buttons, hand grips and axillary pads must all be in good condition.

Short Answer Type Questions

1. What are axillary crutches?
2. What are elbow crutches?
3. What are gutter crutches?

Long Answer Type Questions

1. Explain in detail how various crutch walking equipments are prepared.
Suspension Therapy

Structure

15.1 Definition

15.2 Types of suspension

15.3 Continuous passive motion

15.1 Definition

Suspension is defined as suspending a part of the body with the supported slings and pulleys.

Principles

It is working under the principle of 1) friction 2) pendulum, and 3) eliminating gravity movement.

Friction

It occurs during a particular surface moves on another. it is the force which restricts the movements of an object if the surface are more smooth and slippery will have more friction and in that surface the movement will be more and will cause slippery. if the surface are hard and rough results in more friction and the movements are opposed by the friction force. the same feature is used in the suspension which has less friction causes the smooth and easy movement.

Pendulum: Pendulum is heavy suspended by the weightless thread. if the force is applied on the pendulum it results it to and fro movements.
complete swing is called oscillation the oscillation will be continued until the
force comes down .in human body the pendulum motion occurs mainly in the
shoulders and hip forward leg movements and the arm swing movements while
walk .the simple muscular contraction is necessary to imitate the oscillation the
same mechanism is used in suspension therapy to maintain the muscle properly
.increase the range of movements and strengthening the muscles.

Eliminating gravity movement:

If the person has the muscle power 2 can go for the suspension exercises.
the muscle is less than 2 it is difficult to perform the suspension exercises if the
power is 3 or above 3 the patient can go for against the gravity exercises instead
of suspension therapy.

Advantages

· It reduces the burden for the therapist.
· Easy to lift the limbs.
· Active movements can be performed easily with minimum friction.

Suspension instruments:

1. Suspension frame
2. Supporting ropes
3. Pulleys
4. Slings
5. S-hooks and dog clips
6. Wooden chart.

15.1 Types of Suspensions

1. Axial suspension
2. Vertical suspension
3. Pendular suspension

1. Axial suspension

Joint axis is taken as the point of the suspension .the limb is supported by the
slings above the axis of the joint if the movement is initiated the limb moves
both sides and the base of the swings show the segment of the base of the cone
shape.
The part moves parallel to the floor.

**Uses**

1. Relaxation
2. maintain muscular properly
3. Increase the blood circulation
4. Increase the venous drainage
5. Increase the lymphatic drainage.

**Vertical suspension**

The centre of gravity of the body part or the body is taken as the point of suspension. The body parts can be supported in these type of suspensions rather than the strengthening or performing pendular movements of the limbs.

**Uses**

1. To support the body part
2. To reduce the pressure sore.

**Pendular Suspension**

Here at first the axis of the joint is taken as the point of suspension then depends on the strengthening of the muscle group, this axis is changing towards medially or laterally, anteriorly or posteriorly. The muscles will be getting resistance while movement if the axis is shifting opposite to that movement. if the axis is shifted towards the abducted side the adducted muscles will be getting resistance during movement.

**Uses**

1. To strengthen the muscles.
2. To increase the muscle power.
3. To increase the enduring.

**Swiss ball**

The swiss ball is used to give balanced exercise training, to strengthen the central core and also for coordination and general motor skills, anybody of any age or fitness level, even if injured can perform a program of exercises on the ball.
Using the ball porter’s core strength, which is vital for spinal health and daily activity.

When used properly and with a devised program, it can help to prevent injuries.

Using a swiss ball encourages movements in all 3 planes (horizontal, vertical and diagonal) in this way joints are used as they are in everyday life. The nervous system is also stimulated by the slightly unpredictable and unstable movements of the swiss balls which improves alertness and reaction times.

**Introduction**

The ball is made from a plastic based material so, it is sensitive to extreme temperature and sunlight.

When used properly and regularly a swiss ball exercise enhances the muscular endurance, muscular strength and mobility or flexibility.

1. **Parallel bars**

This training begins on parallel bars and then progresses to walking with mobility aids such as walkers, crutches or walking caves.

- Those who have sustained a lower body injury or are suffering from a neurologic or muscular disorder as well as brain and spinal cord injury and stroke patients may find difficulty in walking.

- Relearning to walk may be long. Re-education of walking will be taught by using these parallel bars.

**Effects and uses**

- To refrain strength, range of motion, balance, independent walking and co-ordination.

2. **Finger ladder**

It is a physical therapy technique that helps to restore range of motion to the shoulders after the injury. It is a single vertical unit with 36 steps and offers progressive mobility of arm at shoulders, elbows, wrist joints and finger re-habitations.

3. **Equilibrium board**

The board encourages rhythm, balance and vertibular responses. as children develop confidence, they can use it in kneeling or standing position. the recessed
side provide hand holds to eliminate pinched fingers, rexine cover cushioned platform size is 45cms*15cms high.

4. Shoulder wheel

Also called a mariners wheel. It is 16g tube contracted, 100cms dia wheel revolve smoothly with c.i drum and is fitted with calibrated sensitive resistance mechanism, resistance is controllable from 0 to maximum 360 degree mounted on three laminated hardwood wallboards.

The position of the patient should be opposite to the shoulder wheel and position also can be changed to side the patient’s shoulder should be opposite to the shoulder wheel. Then the patient has to rotate the wheel in clockwise direction and anti clockwise direction.

This movements will give the shoulders full range of motion and all the movements of the shoulder will be covered.

Effects and causes

- The patient can increase or decrease the resistance according to the patients condition.
- If the patient is achieved full range of motion then the therapist can increase the resistance. Resistance will strengthen the muscles that are around the shoulders.

5. Medicine balls

Medicine ball made out of five leather, securely stitched with strong leather cord, for arm and leg exercises, comes in different sizes and weight ie 1kg, 2kg, 3kg, 4kg, 5kg.

These balls are used in training of trunk or the spine.

15.3 Continuous Passive motion

It refers to passive motion that is performed by a mechanical device that moves a joint slowly and continuously through a controlled range of motion. Many studies support the short term benefits of CPM use after surgery in that patients gain ROM more quickly and therefore, may experience earlier discharge from the hospital. CPM decreases postoperative pain and postoperative complications.

CPM has been reported to be effective in lessening the negative effects of joint immobilization in conditions such as arthritis, contractures, and intra articular fractures; and in improving the recovery rate and ROM after a variety of surgical
procedures. Basic research and clinical studies reported by Salter have demonstrated the effectiveness of CPM in

- Preventing development of adhesions and contractures and thus joint stiffness.
- Providing a stimulating effect on the healing of tendons and ligaments.
- Enhancing healing of incisions over the moving joint.
- Increasing synovial fluid lubrication of the joint, and thus increasing the rate of intra articular cartilage healing and regeneration.
- Preventing the degradating effects of immobilization
- Providing a quicker return of ROM
- Decreasing postoperative pain.

General Guidelines

1. The device may be applied to the involved extremity immediately after surgery while the patient is still under anesthesia or as soon as possible if bulky dressings prevent early motion.

2. The arc of motion for the joint is determined. Often a low arc of 20 to 30 degrees is used initially and progressed to 10 to 15 degrees per day as tolerated. The portion of the range used initially is based on range available and patient tolerance.

3. The rate of motion is determined ; usually 1 cycle per 45 seconds or per 2 minutes is well tolerated.

4. The amount of time on the CPM machine varies for different protocols; anywhere from continuous for 24 hours to continuous for 1 hour, three times a day. The longer periods of time per day reportedly result in a shorter hospital stay, fewer postoperative complications and greater range of motion at discharge, although no significant difference was found in a study comparing 5 hours per day with 20 hours per day of CPM. A recent study compared short duration with long duration. CPM application and found that patient compliance and the most gained range occurred with a CPM duration between 4 to 8 hours.

5. Physical therapy treatments are usually initiated during periods when the patient is not on CPM, including active assistive and muscle setting exercise. It is important that patients learn to use and develop motor control of the ROM as motion improves.
6. Duration minimum for CPM is usually less than 1 week or when a satisfactory range of motion is reached. Because CPM devices are portable, home use is possible in cases where the therapist or physician deems additional time would be beneficial. In these cases, the patient, a family member, or caregiver is instructed in proper application.

7. CPM machines are designed to be adjustable, easily controlled, versatile and portable. Some are battery operated (with rechargeable batteries) to allow the individual to wear the device for up to 8 hours while functioning with daily activities.

**Short Answer Type Questions**

1. Define suspension.

2. Name the different types of suspension.

**Long Answer Type Questions**

1. Explain in detail the different types of suspension.

2. What is continuous passive motion? Explain in detail the benefit of it?