Pocketbook of
Physiotherapy Management in Amputation

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To

My beloved husband

Chetan Khanna

and my two

beautiful children

Palak

and

Kashish

Preface

Physiotherapy nowadays has become the integral part of modern medical sciences. This branch of science has already been established itself in the other countries of the world and now becoming popular in India. During my course, I have undergone many problems related to studying any topic in detail. Though there were lots of books on physiotherapy available in the market but for studying any topic in detail was a great problem, especially while making a project or while preparing a speech on specific topic. This was because I had to consult many books in order to collect all the information regarding that topic as there was no such book available which provided me with full information on the topic. This inspired me to write this pocketbook which covers almost all the information regarding the topic. I think this book will be beneficial for all those who want to study the topic in detail.

Though I have made every effort to aviod errors, but in spite of this, error may creep in. If any mistake or discrepancy noted may be brought into my knowledge, I shall be grateful for the same.

Wishing you all the best for your bright future and prosperous life. I also pray for your success in life.

Nidhi Khanna

ACKNOWLEDGMENTS

I take this opportunity to present my sincere gratitude towards all those who have helped me to make all this happen.

This would not have been possible because of the spontaneous and continuous support of many people.

I am grateful to my parents Mr Sukhdev Bakshi and Mrs Mohini Bakshi and my in-laws Mr Vijay Khanna and Mrs Chand Khanna for their continuous support and blessings. Also I would like to show my sincere gratitude to my Nanaji, Mr Gurdayal Mohan who has always been my inspiration.

I would like to thank all the professors for their guidance and encouragement.

With the bottom of my heart I would like to thank my husband Mr Chetan Khanna and my kids Palak and Kashish who have helped me throughout the making of this project. Without them it would not have been possible.

And above all I am also grateful to Shree JP Vij (CEO) and Mr Tarun Duneja (Director-Publishing) of M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi for their moral support and encouragement. It was not possible for me to publish this book without their support.

Last but not the least I would like to thank God Almighty for showering blessing on me.

Contents

Introduction

Amputation is defined as the method of severing a part of the body in order to save the rest of the body. Usually, the decision to amputate is often a last option considered by the surgeon as well as the patient. The patient facing amputation usually undergoes series of other medical and surgical interventions in an attempt to save the affected limb before going for amputation procedure; hence the decision to amputate comes at the end. Amputation is the most devastating and traumatic experience faced by the patient and his family. The thought of missing a part of the body is itself very frightening. Then think when a part of the body is removed, what will be the condition of the person who has undergone such an experience. There is great psychological impact on the patient before and after the surgery. The adaptation by the patient and his family facing such invasive surgery is challenging and takes months or years to recover. Lower limb amputations are much more frequent than the upper limb amputations. Lower limb amputation results in ambulatory problem and needs prosthesis for walking. However upper limb amputations cause greater functional loss because the upper limb is used more functionally and in more diverse ways. Also there is a greater functional sensory loss when upper limb is involved. Amputation surgery may be of two types—open and closed. Open or primary amputation is usually done in the case of infection in which the wound is left open after the amputated part is removed in order

to clear the infection. Here, closing the wound is the second procedure. Whereas closed amputation is done when the tissue viability is as normal as possible. Here, the skin flaps are closed at the time of amputation. Commonly the skin flaps are closed on the posterior and distal aspect of the stump. Closed amputation is more common than open amputation. Amputation is a reconstructive procedure leaving the patient with the best of possible alternatives.

Here, the role of the physiotherapist is very important and challenging. In the case of amputation, the physiotherapy is provided to the patient both preoperatively as well as postoperatively. The main emphasis of the therapist preoperatively is on preparing the patient for surgery by giving psychological support. Also the strengthening of the uninvolved limb is very important because just after surgery (preprosthetic stage), the patient has to depend wholly on the intact limb for his functional activities. Whereas post-operatively, the main emphasis of the physiotherapy management is on making the amputee functional independent by teaching him bed mobility exercises, weight transfer, balance and gait training, etc. With the application of prosthesis, the therapist guides the patient for proper application of the prosthesis and educates him the balancing and gait training with prosthesis.

CHAPTER 1

Amputation

DEFINITION

Amputation is defined as the removal of part of the body or the whole limb in order to save the rest of the body.

AMPUTEE

A person who has got amputated is known as amputee. Through rehabilitation amputees can become useful and productive member of the society.

STUMP

The distal portion of an amputated extremity is known as stump. The healthy stump is very necessary for proper management of prosthesis by an amputee.

INCIDENCE

Amputation surgery is more common in the lower limb as compared to the upper limb. Lower limb

amputation results in ambulatory problem whereas upper limb amputation leads to functional loss. Also the incidence of amputation surgery is common in urban areas than rural areas as the road-traffic accidents and the industrial accidents are more common in urban areas.

GENERAL PRINCIPLES FOR SURGERY

While performing amputation surgery following principles should be kept in mind:

- Amputation procedure is performed when no other alternative is left.
- Surgeon tries to save as much length of the limb as possible.
- During surgery attention is paid to muscles and nerves together with bones.
- Nerve is cut usually proximal to the level of amputation.
- Muscle is cut distal to the level of amputation and should cover the whole bony stump.
- Long posterior flaps are often used in dysvascular amputation because the posterior tissues have a better blood supply than the anterior skin. Also in some cases medial-lateral incisions are given that places the scar away from bony prominence which is one of the major problem with long posterior flap.
- Stabilization of major muscles allows for maximum retention of function which is

achieved by myofacial closure, myoplasty (muscle to muscle closure), myodesis (muscle attached to bone) or tenodesis (tendon attached to bone).

- The major blood vessels are doubly ligated with nonabsorbable sutures.
- The skin should be mobile and sensible.
- The use of tourniquet is advisable in order to obtain bloodless field. But is avoided in the case of ischemic limb.

Chapter 2
Indications for Amputation

Diseases

Diseases that can cause amputation are varied, but the most common ones are peripheral vascular disease (PVD) and diabetes mellitus (DM). Vascular disease limits the circulation to the extremities. Diabetes, which affects blood sugar, can decrease the body's ability to heal itself. About 75% of amputations in this category occur in older patients.

Trauma

Trauma resulting in amputation is most frequently related to motor vehicle accidents and industrial accidents. It may also occur due to compound fractures, blood vessel rupture, stab or gunshot.

Congenital Abnormalities

Congenital malformation or birth defects can result in either the person having no limb or a very short limb that is treated as an amputation, for which a prosthetic device is made.

Tumors

Tumors including both benign and malignant, usually malignant tumors commonly need amputation of the limb. And this surgical procedure is performed through the normal tissues proximal to the diseased part.

Infection

Many types of infection may lead to amputation, the most common being gangrene. The other includes ulceration, osteomyelitis, etc. Usually medical procedures are implemented first but when these infections do not respond to medical treatment then amputation is performed.

Neurological Disorder

Such as an anesthetic limb, for example a complete plexus avulsion. These anesthetic limbs often develop ulcerations, infection and severe tissue damages. The tissue damage due to repeated infections and ulceration may lead even to auto-amputation in neglected patients.

CHAPTER 3

Types of Amputation

There are two main types of amputation open amputation and closed amputation.

Open Amputation

Also known as Guillotine amputation is the one in which the skin is not closed over the amputation stump at the time amputation surgery or when the wound is not healthy (Fig. 3.1). After few days the skin is covered by:

- Secondary closure, in this the skin flap is closed after few days.
- Plastic repair, in this the skin flaps are repaired and then closed whereas the bone is left intact.
- Reconstruction of the stump, here the terminal scar tissue as well as part of the bone is removed and then the stump is reconstructed.
- Reamputation, in this the amputation is done again at the higher level.

Closed Amputation

In this method the skin flap is closed at the time of surgery. It is usually done when there is no

Fig. 3.1: Unilateral transtibial open amputation

Fig. 3.2: Unilateral transtibial closed amputation

infection, contamination or devitalization at the site of amputation. In this case primary closure is achieved. Long posterior flaps are often used because the posterior tissues have a better blood supply than the anterior skin. This places the scar anteriorly over the distal end of tibia. The other flap used is an angular medial-lateral incision that places the scar away from bony prominence which is one of the major problems in long posterior flap (Fig. 3.2).

Chapter 4
Complications of Amputation

Common complications following amputation surgery are:

- Hematoma due to inadequate homeostasis.
- Failure to heal due to inadequate blood supply.
- Vascularity of sutures.
- Skin flap necrosis.
- Neuroma of crushed nerve.
- Painful stump.
- Phantom pain or sensation.
- Formation of joint contractures.

CHAPTER 5

Ideal Stump

The common features of ideal stump are:

- It should be of adequate length.
- Skin overlying should be well healed with good vascularity and sensation. Also it should be devoid of any pressure sores.
- Joint just proximal to the amputation area should have full range of motion.
- Shape of the stump should be conical.
- Neuroma should not be present.
- Muscle power of the muscles nearer to the amputated area should be normal.
- Bone head should be transverse and blunt and also well covered with skin.
- The selection of the level of amputation depends upon—pathology present, viability of tissue and need of the patient.

CHAPTER 6

Levels of Amputation

The level of amputation is decided after full assessment of the patient and the part to be amputated. A limb is amputated to a level which ensures that all necrotic tissues have been excised and the residual portion of limb will heal and be viable. The higher the level of the amputation, the greater the handicap. The levels of amputation seen in clinical practice are:

LEVELS OF AMPUTATION IN LOWER LIMB (Figs 6.1 and 6.2)

- ***Hemipelvectomy or Hindquarter:*** At this level of amputation, half of the pelvis together with hip joint and the distal part of it (almost full limb) is removed. This type of amputation is usually rare and occurs in malignant cases.
- ***Hip disarticulation:*** At this level of amputation, the hip joint is disarticulated whereas the pelvis remains intact. Hip joint together with its distal part is removed. Intact pelvis provides good weight bearing as compared to the earlier case. It is usually done in the case of vascular insufficiency.

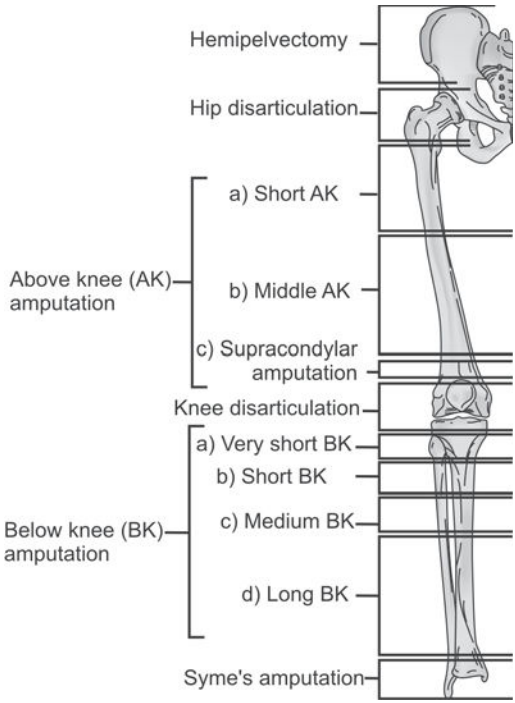


Fig. 6.1: Levels of amputation in lower limb above ankle

- ***Above knee amputation (AKA) or Trans-femoral amputation:*** Above knee amputation (AKA) usually occurs 12 cm above knee joint but can be extended depending upon the situation. When the amputation occurs at this level then the healing is very good but the

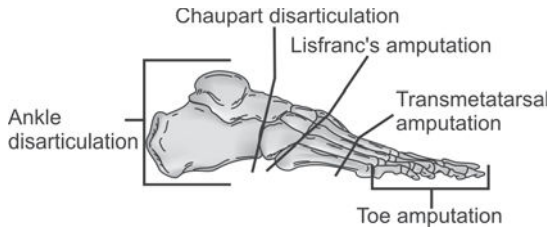


Fig. 6.2: Levels of amputation below ankle

prosthetic management is very difficult because of loss of knee joint. Proprioception from the knee joint will be lost and the patient must bear the weight on the prosthesis at the ischial tuberosity. Here complication of flexion contracture deformity at the hip joint is quite common but with proper physiotherapy it could be avoided.

- ***Knee disarticulation:*** At this level, the tibia together with fibula are removed but the patella is retained and the patellar tendon is sutured to the anterior cruciate ligament, the hamstrings are sutured to the posterior cruciate ligament. In this, most of the proprioception of the knee joint is retained as well as the muscles around the stump are well balanced. The prosthetic management is very good in this condition. The weight bearing is through femoral condyle.
- ***Below knee amputation (BKA) or Transtibial amputation:*** At this level, the site of ampu-

tation is below knee (usual level is 12-14 cm below knee joint). Here both tibia and fibula are cut and removed together with its distal part. The great advantage is that the normal knee joint and its proprioception is retained and therefore the balance as well as the gait pattern will be more easily attained. The fibula is sectioned slightly more proximally than the tibia and the end of the tibia is leveled to avoid a prominent bone end, the prosthetic management is excellent and the weight bearing is through patellar tendon.

- ***Syme's amputation:*** The amputation at this level is performed at the distal level of tibia and fibula, proximal to the ankle joint. The intact skin over the heel is attached back to the end of the stump with or without a part of the calcaneum. Because of the intact heel, it becomes an end bearing stump and the patients generally manages very well walking even bare foot after this type of amputation.
- ***Chaupart's amputation:*** Here the amputation occurs at the talonavicular joint.
- ***Lisfranc's amputation:*** Here the amputation occurs at the intertarsal joint.
- ***Transmetatarsal amputation:*** Here the amputation occurs through the midsection of all metatarsals.
- ***Disarticulations of toes:*** In this entire ray (toes plus metatarsal) are removed. Toe amputations

are usually indicated for localized gangrene of distal end of the toe or severe infection of a metatarsal.

LEVELS OF AMPUTATION IN UPPER LIMB (Fig. 6.3)

- ***Forequarter amputation:*** Here the amputation is carried out proximal to the shoulder joint.

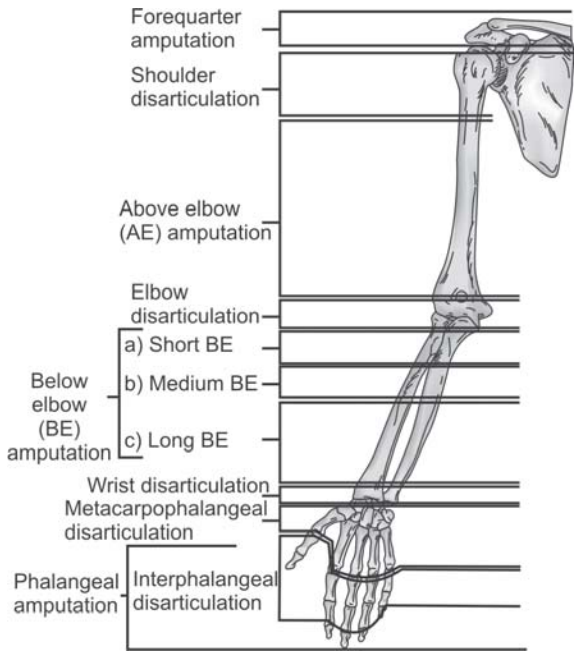


Fig. 6.3: Levels of amputation in upper limb

In this, part of the scapula and clavicle are removed along with shoulder girdle muscles. This type of amputation is indicated for malignant bone tumors of the upper end of the humerus.

- ***Shoulder disarticulation:*** In this, the site of amputation is at the shoulder joint, but here the head of the humerus is preserved.
- ***Above elbow amputation (AEA):*** Here the amputation level is above elbow, dissecting the humerus with part of humerus and distal to it being removed.
- ***Elbow disarticulation:*** In this the site of amputation is elbow joint and is quite uncommon.
- ***Below elbow amputation (BEA):*** Here the amputation site is below the elbow dissecting both the radius and ulna. In this type of amputation part of both bones and its distal end is being removed.
- ***Wrist disarticulation:*** In this, the site of amputation is at the wrist joint, i.e. through radiocarpal joint.
- ***Ray amputation:*** In this type, the finger or phalanx is removed together with respective metacarpal from the carpo-metacarpal joint.
- ***Krukenberg amputation:*** It is performed in a patient with bilateral below elbow amputation. In this operation, the forearm is split between the radius and the ulna to provide the grip so that the patient can hold the spoon or lighter objects.

CHAPTER 7

Physiotherapy Management in Amputation

Management of these patients is a team work which include:

- Physician
- Physiotherapist
- Prosthetist
- Occupational therapist
- Social worker
- Dietician
- Vocational counselor.

Physiotherapy plays a significant role in the management of an amputee before as well as after the amputation procedure. The basic aim of physiotherapy management is to rehabilitate the amputee with the help of various interventions, training and psychological procedures so that he can be back to his normal life. The program is planned according to the patient. The older patients are difficult to manage as compared to young people but the rehabilitation of younger people are more prolong as the basic requirement

of these are to go back to their daily routine. The rehabilitation program is divided into:

1. Preoperative period
2. Postoperative period, which further include:
    a. Preprosthetic stage
    b. Postprosthetic stage.

CHAPTER 8

Preoperative Stage

The preoperative stage includes the period before the patient undergoes surgery. This stage is usually absent in the case of trauma or any other emergency case. In this stage the patient is fully assessed and prepared for the surgery. This stage is present when the cause of amputation is infection, disease or any congenital deformity.

Before starting the rehabilitation of a person full assessment of the patient is very necessary.

ASSESSMENT

The assessment of the patient preoperatively is done under following headings:

a. Subjective examination
b. Objective examination.

Subjective Examination

The subjective examination include the history taken by the patient or from his relatives in case where the patient is either unconscious or a child. Each heading under this is of great importance in the diagnosis and planning the effective treatment.

Name of the patient: It is essential for the identification of the patient.

Age of the patient: As some diseases or mode of injury is common in particular age group hence it is necessary to know the age of the patient.

Sex: Whether male or female as some diseases are common in males and some are common in females.

Occupation of the patient: It is essential for planning the treatment accordingly.

Marital status: Whether the patient is married or not.

Address of the patient: In order to have an idea of the general status of the patient, his surroundings.

Ward number/ward name: It is necessary for the identification of the patient.

Date of admission: Necessary for keeping the record.

History of any past surgical intervention: Patient is asked whether he had undergone any surgical procedure earlier or not.

History of past illness: Patient is asked whether he has got the history of chronic illness like diabetes, hypertension or tuberculosis as the presence of any of these diseases can alter the treatment process and in that situation treatment plan is made accordingly.

History of present illness:

- *Cause of surgery:* Whether it is a consequence of some disease, any tumor or due to trauma
- *Location* of the surgical site
- *Nature* of the area to be excised
- *Full assessment* of the area to be excised
- *Behavior* of pain on the site

Personal history:

- *Type of work:* The patient is doing, is it hard work or sedentary work
- *Habit,* alcohol intake or cigarette smoking
- *Social status* of the patient
- *Dietary habit,* is he an overeater or under nutrient?
- *Family history,* members of the family

History of treatment: Any treatment which the patient has taken before taking the decision of this surgical procedure.

Social and family history: The social and family history is very important for planning the management program as it gives some indications that how much the family would support during the rehabilitation process.

Psychological status: Assessment of the psychological status is very important as the idea of loosing a limb itself produces great psychological trauma leading to depression. Some people could not bear loosing their body part and even want to

die rather than living without it. Such people need moral support not only from the therapist but from his entire family.

Objective Examination

It is again divided into two headings:
1. Observation
2. Examination

Observation

The observation include the general appearance, posture, gait and handedness of the patient.

General appearance: It include:
- Texture of the skin (for any scar or lesion)
- Moisture of the skin (is it scaly or dry)
- Sensation of the skin (absent or present)
- Dermatology of the skin.

Posture and gait: Observation of posture and gait is not possible in the case of traumatic condition but could be observed in the case of diseased condition.

Handedness: It is very necessary to know either the patient is right handed or left handed so that the treatment plan is made accordingly.

Examination

It include physical examination as well as the mental examination:

Physical examination: It includes muscle power testing of the upper limb, trunk as well as the lower limb apart from the affected limb. Checking of the power of the crutch muscles is very important and this is done with the help of Manual Muscle Testing (MMT).

- *Manual muscle testing (MMT):* The muscles testing is graded into following grades:
  - 5 Normal: Complete range of motion (ROM) against gravity with full resistance.
  - 4 Good: Complete ROM against gravity with some resistance.
  - 3 Fair: Complete ROM against gravity.
  - 2 Poor: Complete ROM with gravity eliminated.
  - 1 Trace: Slight contraction, no joint motion.
  - 0 Zero: No contraction.

  Testing of an individual muscles of the limbs and trunk requires special training.
- *Range of motion (ROM):* Range of motion is checked in both the uninvolved as well as the involved side (side to be amputated). ROM can be tested with the help of goniometer. Goniometry refers to the measurement of angles created at human joints by the bones of the body and the instrument used for this purpose is known as goniometer. Measurement of angles at the joint helps in determining the range of motion at that joint and thus helps evaluating the amount of deformity present.

Before testing with goniometer following principle should be followed:

- *Positioning*: Positioning is an important part of goniometry because it is used to place the joints in a zero starting position and help to stabilize the proximal joint segment. It also affects the amount of tension in soft tissue structure surrounding the joint.
- *Stabilization*: Stabilization of the proximal joint of the patient helps in isolating the motion of the joint to be examined. Isolating the motion to one joint helps to ensure that the true measurement of the motion is obtained rather than a measurement of combined motions that occur at a series of joints.
- *Measuring instrument*: Though a variety of methods are used to measure the joint motion ranging from simple paper tracing and tape to electrogoniometer and motion analysis system, but universal goniometer is most preferred. Universal goniometer may be contructed of plastic or metal and are in many size and shape. Its typical design consist of a body and two thin extension called a stationary arm and a moving arm. The body of universal goniometer resembles a protractor and may be in the form of half circle or full circle. One arm of the gonimeter is stationary and

the other is movable, which is attached to the center of the body of the goniometer in order to permit free movement of the arm on the body.

- *Alignment*: Goniometer alignment refers to the alignment of the arm of the goniometer with the proximal and distal segments of the joint being evaluated. Bony prominence are used as a hallmark to visualize the joint segment. The stationary arm is often aligned parallel to the logitudinal axis of the proximal segment of the joint and the moving arm is aligned parallel to the longitudinal axis of the distal segment of the joint.

- *Cardiovascular examination:* This is done in order to avoid postoperative complications. After surgical procedure the patient would become bed-ridden for few days which may lead to accumulation of secretions in the respiratory tract and thus interferes with the rehabilitation of a person. Proper cardiovascular examination helps the therapist to give appropriate information of the cardiac as well as respiratory condition of the patient and accordingly the treatment plan is made. For cardiovascular examination inspection, palpation, percussion and auscultation is done.
  - *Inspection:* Shape of the chest is inspected to see the symmetry of the chest.

- See for the level of shoulders, any protraction, retraction or drooping. Also look for any muscle wasting.
- Common chest deformities are noted like—barrel chest, *pectus carinatum*, *pectus excavatum*, bulging, depression or flattened.
- Breathing pattern is checked, normally the breathing pattern in males is "Abdomino-thoracic" and in females it is usually "Thoraco-abdominal".
- The rate, regularity and location of respiration are noted at rest and in activity. The normal ratio of inspiration to expiration is 1:2 and in activity is 1:1.
- Look for the chest movement, normally both the sides of chest wall have uniform movements.
- See for any shift of mediastinum, normally it is situated centrally. Any shift of it from its position indicates abnormal condition.

– *Palpation:* Following things are noted with palpation:
  - Any swelling present
  - Any pain or tenderness
  - Position of trachea is seen
  - Tactile vocal fremitus is seen which is increased in case of lung consolidation and decreased in the case of effusion.

- Other vibrations are also palpated, which is normally absent in the healthy individuals such as pleural friction rub, rales, bronchial fremitus, etc.
- Lymph nodes in cervical, axillary and supraclavicular region must be palpated as nodes are often enlarged during chest infection or any disease of the chest.

– *Percussion:* By percussion lung density is noted specially air to solid ratio in the lung, normally percussion over normal lung produces resonant note whereas dull note is seen in the case of consolidated lung and hyper-resonant in the case of pneumothorax.

– *Auscultation:* Here the lung sounds are heard with the help of stethoscope, normally there is active inspiration with bronchial and alveolar phase then passive expiration. The abnormal sound may be wheezing, rhonchi, stridor, crepitation or pleural rub.

The cardiovascular examination is done to look for the normal functioning of the lungs.

- ***Balance:*** Evaluation of the balance is very necessary before planning the rehabilitation program, especially in the case of lower limb amputation. Lower limb amputation may lead

to ambulatory problem hence the proper sense of balance is very important in this case, as a person with abnormal balance sense need a long-term rehabilitation regime whereas a person with proper sense of balance need a short-term rehabilitation regime. Balance is examined both in sitting and standing position. The assessment of balance gives the appropriate information of existing sense of balancing in a patient and thus accordingly rehabilitation program is set for that individual.

- ***Functional abilities:*** It include all the activities that the person does in his daily routine and which make him independence to live. The therapist need to know how independent is a patient in his daily living, what activities he can perform and which he could not perform actively. This is very necessary for planning the treatment program.

PREOPERATIVE TREATMENT

AIMS OF TREATMENT

1. **To provide chest mobility and ventilatory training** in order to avoid complications postoperatively.
2. **Strengthening of all the muscles** of the limb except the one undergoing amputation surgery. And especially the crutch muscles are

emphasised as these muscles are of great use in gait training in the case of lower limb amputation.

3. **To provide mobility** of all the joints.
4. **Improve the mobility** of other areas of the body.
5. **Teaching methodology** of positioning in bed, technique of trasfer, balancing, wheelchair monitoring.
6. **Psychological reassurance**.
7. **Provide relaxation** to the patient.

MEANS OF TREATMENT

To Provide Chest Mobility and Ventilatory Training

For this breathing exercises, postural drainage, coughing and huffing techniques and chest mobility exercises are given to the patient.

Breathing Exercises

Different types of breathing exercises and ventilatory training are given to the patient in order to clear the secretions in the lungs. Breathing exercises also helps in increasing the strength and endurance of repiratory muscles and also improves the ventilation. Since the patient would be bed ridden for few days after the surgery hence the lungs should be clear in order to avoid respiratory complications. There are various forms

of breathing exercises like diaphragmatic breathing, segmental breathing, glossopharyngeal breathing and pursed-lip breathing. Among these diaphragmatic breathing and segmental breathing is most frequently used.

1. ***Diaphragmatic breathing:*** Diaphragm is the main muscle of inspiration and thus helps in controlled breathing, but when it gets compromised due to some reason then it is facilitated through breathing pattern which emphasize on use of diaphragm in breathing and also improves the efficiency of ventilation. Diaphragmatic breathing exercises are also used to mobilize lung secretions during postural drainage.

   Procedure: The procedure for giving diaphragmatic breathing are:

   a. The position of the patient while giving exercise should be such that it gives comfort to the patient and the gravity assists the diaphragm, such as a semi-Fowler's position.
   b. Give relaxation to the shoulder girdle muscles by providing shoulder rolls or shoulder shrugs prior to exercise.
   c. Now place one hand on the rectus abdominis (just below the anterior costal margin) and ask the patient to breath in slowly and deeply through nose.

d. During this period the shoulder of the patient sould be kept relaxed and upper chest quite, allowing the abdomen to rise.
e. Then tell the patient to slowly let all the air out using controlled expiration.
f. Then ask the patient to repeat this 3 to 4 times and then relax, do not allow the patient to hyperventilate.
g. If the patient is having difficulty in using diaphragm during inspiration, then ask the patient to inhale several times in succession through nose by using sniffing action.
h. When the patient is mastered of this, ask the patient to practice this exercise exercise daily three times a day by keeping his own hand on the abdomen (Fig. 8.1).

Fig. 8.1: Diaphragmatic breathing

The other type of breathing exercise which is given to the patient include **segmental breathing** in which patient is taught to expand the localized area of the lung while keeping the other area quite.

2. ***Localized basal expansion:*** This is a useful technique for the patients with a stiff lower rib cage.

   Procedure

   a. The position of the patient is either sitting or hook lying.
   b. Place the hand on the lower rib and ask the patient to breath out, as the he breath out place a pressure into the ribs with the palm of the hand.
   c. Just prior to inspiration put a quick downward and inward stretch to the chest, thus placing a stretch on the external intercostal to facilitate their contraction.
   d. 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.
   e. Then again as the patient breath out, assist by gently squeezing the rib in a downward and inward direction.
   f. The patient may then be taught to perform the maneuver independently.

3. ***Posterior basal expansion:*** This type of segmental breathing is useful where the

secretions are accumulated on the posterior segment of the lower lobes.

Procedure

a. The patient sits or lean forward on a pillow, slightly bending the hips.
b. The hand of the therapist should be over the posterior aspect of the lower ribs.
c. The same procedure is done as in lateral costal breathing.

4. ***Right middle lobe or lingula expansion***
   a. The patient is in sitting position.
   b. The therapist places his hand at either right or left side of the patient's chest, just below axilla.
   c. Follow the same procedure as described for lateral costal expansion (Fig. 8.2).

Postural drainage: Postural drainage is the intervention for airway clearance. In this the mobilization of the secretions of the lungs is done

Fig. 8.2: Segmental breathing (bilateral-lateral costal expansion)

by placing the patient in various positions so that the gravity assist in the drainage process. The manual technique used during postural drainage therapy include:

- *Percussion*: It is performed with cupped hands over the lung segment which has to be drained. The cupped hand is alternatively striked over the patient's chest wall in rhythmic pattern. Percussion is continued for several minutes or until the patient needs to alter position to cough. Percussion over the bony prominence should be avoided.
- *Vibration:* This technique is used in conjunction with percussion and applied only during expiration as the patient is deep breathing to move the secretions to the larger airways. Vibration is applied by placing both the hands on the chest wall and gently compressing and rapidly vibrating the chest wall as the patient breathes out. Pressure is applied in the direction of chest movement.
- *Shaking*: It is the vigorous form of vibration applied during exhalation, in this technique the therapist's thumb are locked together and the fingers are wrapped around the chest wall. Here too shaking is accompanied with compression.

These intervention thus helps in removing all secretions from the lungs and facilitate airway clearance (Figs 8.3 to 8.14).

Fig. 8.3: Postural drainage on anterior apical segment
(Percussion applied under the clavicle)

Fig. 8.4: Postural drainage on posterior apical segment
(Percussion applied above the scapulae)

Fig. 8.5: Postural drainage on anterior segment
(Percussion applied bilaterally directly over the nipple)

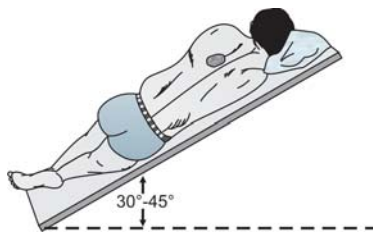


Fig. 8.6: Postural drainage on posterior segment (left)
(Percussion applied directly over the left scapula)

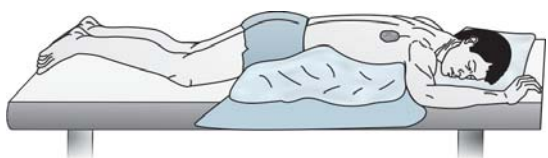


Fig. 8.7: Postural drainage on posterior segment (right)
(Percussion applied directly over the right scapula)

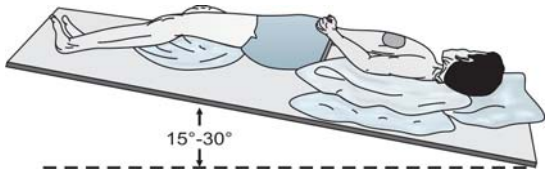


Fig. 8.8: Postural drainage on lingula
(Percussion applied under the left breast)

Fig. 8.9: Postural drainage on middle lobe
(Percussion applied under the right breast)

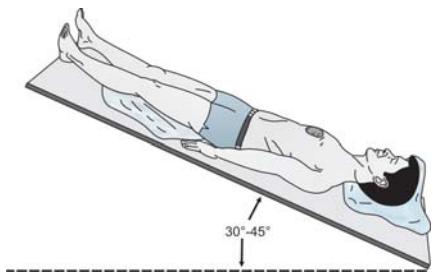


Fig. 8.10: Postural drainage on anterior segment of lower lobe
(Percussion applied bilaterally over the lower portion of the ribs)

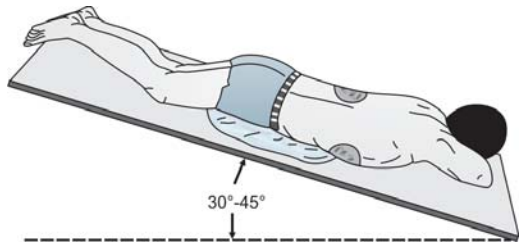


Fig. 8.11: Postural drainage on posterior segment of lower lobe (Percussion applied bilaterally over the lower portion of the ribs)

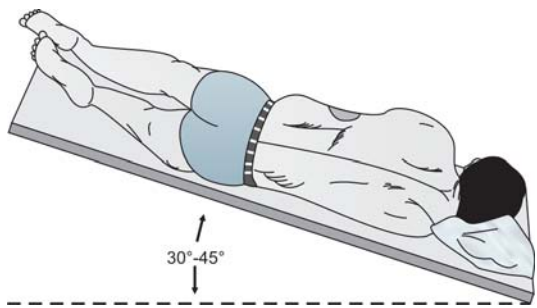


Fig. 8.12: Postural drainage on lateral segment of lower lobe (left) (Percussion applied over the lower lateral aspect of left rib cage)

Coughing and huffing: This is yet another technique of clearing the lungs from unwanted secretions accumulated in the respiratory airway.

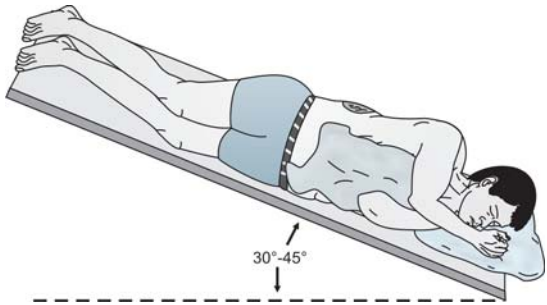


Fig. 8.13: Postural drainage on lateral segment of lower lobe (right) (Percussion applied over the lower lateral aspect of right rib cage)

Fig. 8.14: Postural drainage on superior segment of lower lobe (Percussion applied bilaterally directly below the scapula

Before teaching the patient the procedure for effective cough, it is the duty of the therapist to explain the importance of effective cough in airway clearance. For this:

1. Place the patient in relaxed position (semi-Fowler position is prefered).
2. Teach the patient deep diaphragmatic breathing.
3. Demonstrate a sharp, deep, coughing.
4. By placing the hand of the patient to his abdomen, ask him to huff three times with expiration and feel the contraction of the abdomen muscle.
5. Now ask the patient to take a deep but relaxed inspiration , followed by a sharp double cough.
6. The second cough during a single expiration is usually more productive.

Additional means to facilitate cough include therapist-assisted technique, self-assisted technique, splinting, humidification, tracheal stimulation or suction (Fig. 8.15).

Chest mobility exercises: These exercises are the one that combines the active movements of the trunk or extremities with deep breathing. They are specially designed to improve the mobility of the chest wall, trunk and shoulder girdles. Chest

Fig. 8.15: Assisted manual cough technique

mobility exercises also emphasis on the depth of inspiration or controlled expiration. Together with exercises therapist instruct the patient for postural correction and manual stretching of the chest wall, trunk and extremities. Like in order to mobilize one side of the chest, the procedure would be as follows:

1. While sitting, ask the patient to bend away from the tight side in order to lengthen the hypomobile structures and expand it during inspiration.
2. Now tell the patient to bend toward the tight side and breath out (Fig. 8.16).
3. Progress it, now by raising the arm on the tight side of the chest over the head and side-bend away from the tight side. This will put extra-stretch on hypomobile tissues.

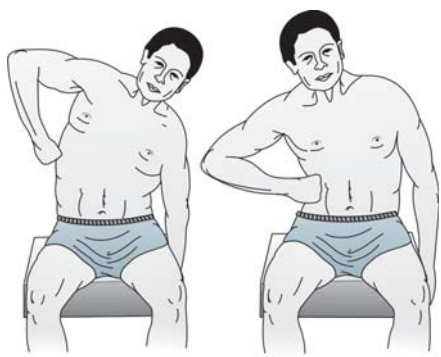


Fig. 8.16: Chest mobilization during inspiration and expiration

Strengthening Exercises

Strengthening exercises are given to the crutch muscles of the upper limb and to the unaffected lower limb in the case of lower limb amputation. The reason behind this is that after amputation the patient would try to put his whole body weight on the unaffected lower limb and for gait training or before application of prosthetics the patient would use crutches and hence the upper limb muscles should be strong enough to hold the crutches. Thus for performing all these activities efficiently, strengthening exercises should be given to the muscles involved in these activities. And in the case of upper limb amputation, strengthening exercises are provided to the lower limb and the uninvolved upper limb. Main muscles where strengthening is needed include the extensors and adductors of the shoulder, extensors of the elbow bilaterally as these are the major crutch muscles. Whereas strengthening exercises are given to the extensors and abductor of the hip and quadricep of the unaffected leg. Following exercises shows the way of strengthening these muscles.

For shoulder extensors and adductors (Figs 8.17 to 8.20): The extensors of the shoulder are deltoid (posterior fibers), Teres Major, Latissimus Dorsi and Pectoris Major. For strengthening of these muscles the physiotherapist resist the extension

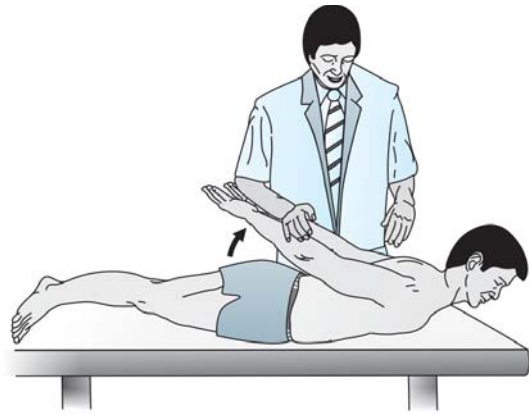


Fig. 8.17: Strengthening exercises for shoulder extensors

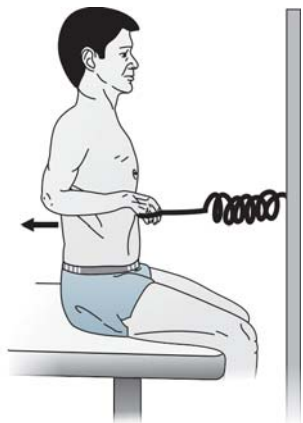


Fig. 8.18: Strengthening exercises for shoulder extensors with the help of spring

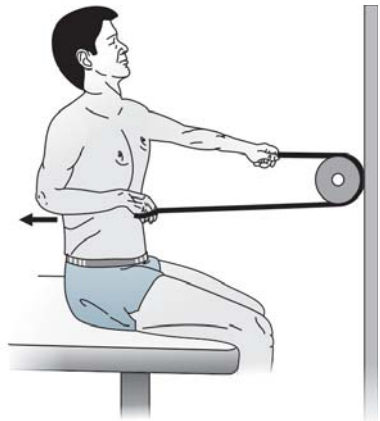


Fig. 8.19: Strengthening exercises for shoulder extensors with the help of pulley

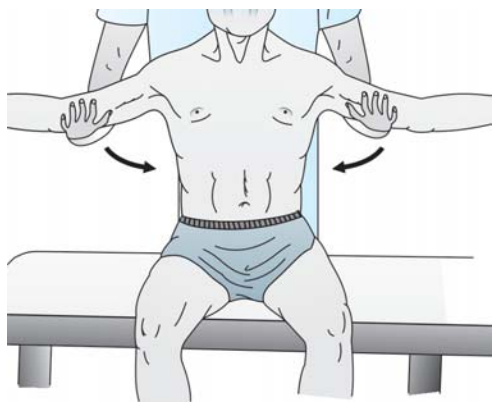


Fig. 8.20: Strengthening exercises for shoulder adductors

of the arm with one hand placed behind the elbow as the patient draws the arm backwards. Weights, springs and self-resistance can also be arranged.

And for the adduction of the shoulder the main muscles are Pectoralis Major, Latissimus Dorsi, Teres Major and Coracobrachialis, strengthening to these muscles are provided by resisting its action.

For the extensors of the elbow (Figs 8.21 and 8.22): The main muscle for elbow extension is Tricep assisted by Anconeus. For strengthening of these muscles manual resistance is given to elbow extension with pronation; the elbow is supported by the pressure on the triceps. Another way for

Fig. 8.21: Strengthening exercises for the extensors of the elbow by applying manual resistance

the strengthening of the muscles include lifting the weights vertically in the hands when the body is in crook lying or standing.

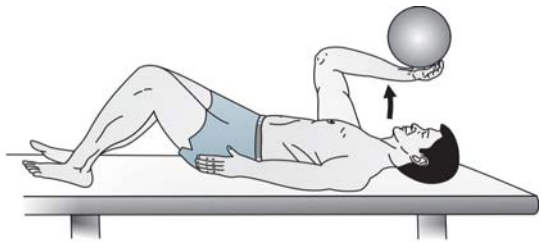


Fig. 8.22: Strengthening exercises for extensors of the elbow with the help of weighted ball

For the hip extensors and abductors (Figs 8.23 and 8.24): The main muscles for hip extension are Gluteus Maximus and Hamstrings. The strengthening to these muscles are provided by giving resistance to these muscles, manual resistance is given when the leg is in prone lying or side lying. Resistance is given on the sole of the foot which is plantiflexed and over the hamstrings. The second way is resisting the trunk from stoop high ride or stoop stride sitting. A simple and effective method of giving weight resistance is from stoop standing with a weight attached to the foot, and the medicine ball held between the feet. Even springs and pulleys can also be arranged in many ways—A spring is arranged against the extended leg from

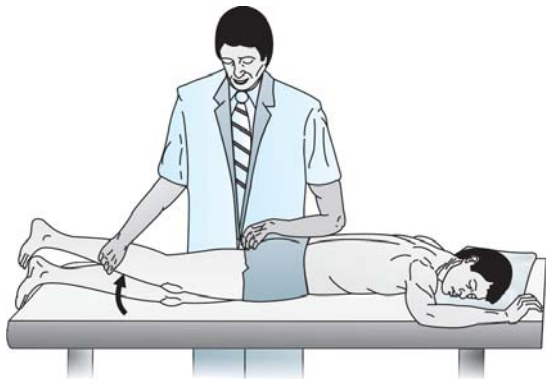


Fig. 8.23: Strengthening exercises for hip extensors, with resistance applied by the therapist

Fig. 8.24: Strengthening exercises for hip abductor

lying position, also weight or pulley can be arranged against the extended leg as a whole. And from sitting position, during thrusting movement or only the hip is resisted.

And for the hip abductor which include Gluteus Medius, Gluteus Minimus and Tensor Fascia Lata, Strengthening can be provided in various ways. Usually a small degree of abduction produces a lateral tilt of the pelvis on the standing leg during the weight tranference, then the resistance is provided to the leg shortening and it is easily arranged by fixing one foot and resisting the movement of the other. Even the resistance to the abductors can be given in prone lying or supine lying. In this leg is in suspension and the resistance is being arranged horizontally. Weight is given in half standing or in side lying.

Knee extensors (Figs 8.25 to 8.27): The main knee extensor is Quadriceps muscles (Rectus Femoris, Vastus Lateralis, Vastus Medialis, Vastus Intermedius). Manual resistance can be given to this muscle in variety of positions, i.e. in half lying, high sitting and prone lying. Springs and weights can also be arranged to provide resistance to Quadriceps.

To Provide Mobility of All the Joints

This can be achieved by giving mobilization techniques to all the joints with the emphasis on

Fig. 8.25: Strengthening exercises for knee extensors with the help of pulley

Fig. 8.26: Strengthening exercises for knee extensors with the help of weights

Fig. 8.27: Strengthening exercises for knee extensors given by the therapist manually

the suspectible joints. Mobilization are the passive, skilled manual therapy techniques applied to joints and the related soft tissues at varing speed using both the physiological and accessory motions for therapeutic purposes. The physiological movements include movements like flexion, extension, abduction, adduction and rotation whereas the accessory movements include gliding, sliding, rolling, etc. Mobilization technique has been asigned some grades and the dose according to the need of the patient. The grades for mobilization are:

Grade I: Small amplitude rhythmic oscillations given at the beginning of the range.

Grade II: Large amplitude rhythmic oscillations performed within range, not reaching the limit.

Grade III: Large amplitude rhythmic oscillations performed upto the limit of available range and stressed into tissue resistance.

Grade IV: Small amplitude rhythmic oscillations performed at the limit of the available range and stressed into tissue resistance.

Grade V: Small amplitude, high velocity thrust performed at the limit of the available range.

Grades I and II are used to reduce pain whereas Grades III and IV are used for increasing the range at the particular joint. Since in this case there is no pain involved, we will give mobilization in Grade III and in Grade IV. The main joints which need mobilization technique are:

Shoulder Joint

Mobilization of the shoulder in the case of Above Elbow Amputation (AEA) is of great importance. It is given to the involved limb or the limb to be amputated. Proper application of mobilization technique helps in avoiding contracture formation at this joint which is one of the major complication of the amputation surgery and also keeps the joint mobile which is very necessary as after surgery, this joint has to become more functional. In

shoulder joint traction, distraction, anterior, posterior and caudal glides are given to the patient in order to make it mobile.

Traction/distraction: For providing traction/ distraction the position of the patient is supine lying. The therapist hold the patient from axilla with thumb just distal to the joint margin anteriorly and fingers posteriorly with one hand whereas the other hand supports the humerus from the lateral surface.With the hand in the axilla, the humerus is moved laterally (Fig. 8.28).

- *Anterior glide:* The position of the patient is prone lying over the edge of the table supported by the therapist's thigh. The therapist place the ulnar border of his hand just distal to the

Fig. 8.28: Traction given at the shoulder joint

Fig. 8.29: Anterior glide given to the patient at the shoulder joint

posterior angle of the acromion process, with fingers pointing superiorly and the mobilizing force is given by this hand. The gliding to the humerus is given in an anterior and slightly medial direction (Fig. 8.29).

- *Posterior glide:* The position of the patient is supine lying, and the therapist hold the patient from distal humerus with one hand whereas the other hand supports the arm against the trunk (Fig. 8.30). Now the hand which give support has the lateral border of it just distal to the anterior margin of the joint with the

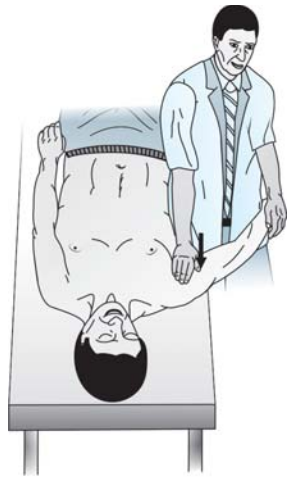


Fig. 8.32: Posterior glide given to the patient at the shoulder joint

finger pointing superiorly (this hand gives mobilizing force). The gliding of the humeral head is in the posterior direction, i.e towards the plinth.

- *Caudal glide:* The position of the patient is high sitting with 70 to 80 degrees abduction (Fig. 8.31). The therapist place one hand on the lower surface of humerus for support whereas the other hand is placed on the shoulder joint superiorly. Now this hand gives mobilizing force in the downward direction.

Fig. 8.31: Caudal glide given to the patient at the shoulder joint

Hip joint: The mobilisation of the hip joint is of great importance in the case of above knee amputation (AKA). In hip anterior, posterior and caudal glide is provided in order to increase the mobility at that joint.

- *Anterior glide:* The patient is in prone position, with hip over the edge of the table (Fig. 8.32). Now the therapist hold the patient's leg with one hand whereas the other hand is placed on the proximal thigh, just below the buttock and the force is applied in the downward direction (Fig. 8.32).

Fig. 8.32: Anterior glide given to the patient at the knee joint

- *Posterior glide:* The patient is in supine position with hip at the end of the table. The patient is asked to flex the other hip and hold the thigh against the chest with the hands. The therapist hold the patient the leg by one hand whereas place the other hand on the anterior surface of the proximal thigh. Now the force is applied throug proximal hand in a posterior direction (Fig. 8.33).
- *Caudal glide:* The patient is in supine position with knee extended, the therapist hold the patient on the lower leg just proximal to the malleoli. The force is applied along the long axis by pulling the leg towards yourself.

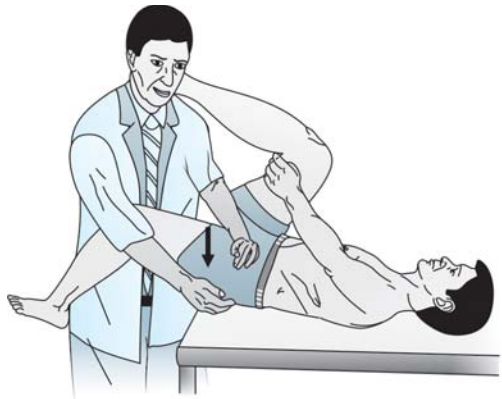


Fig. 8.33: Posterior glide given to the patient at the hip joint

Knee joint: The mobilization of the knee joint plays a major role in the Below Knee Amputation (BKA). In knee joint anterior and posterior glides are given to mobilize the joint. Mobilizing knee joint in the case of transtibial amputation is very necessary.

- *Anterior glide:*The patient is in prone position with knee in the resting position and tibia is rotated in latral rotation. The therapist grasp the distal tibia with one hand and the palm of the other hand on the posterior aspect of the proximal tibia. The force is applied by the hand on the proximal tibia in the anterior direction (Fig. 8.34).

Fig. 8.34: Anterior glide given to the patient at the knee joint

- *Posterior glide:* The patient is in supine position with foot resting on the table. The therapist sits on the table with thigh fixating the patient's foot. With both hands grasp around the tibia, fingers pointing posteriorly and thumbs anteriorly. The tibia is pushed posteriorly by the therapist with the help of fingers (Fig. 8.35).

Improve the Mobility of Other Areas of the Body

Mobility to other areas of the body like trunk, pelvis, etc. is also very important in order to compensate for the deficiencies and restrictions due to posthesis. Mobility of the trunk is provided

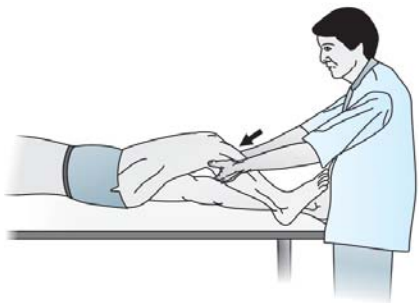


Fig. 8.35: Posterior glide given to the patient at the knee joint

by giving flexion, extension and rotational exercises to the trunk. Also rolling and bridging exercises provide mobility to the trunk and pelvis (Figs 8.36 to 8.42).

Fig. 8.36: Trunk extension in sitting position

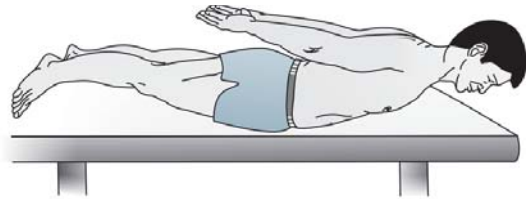
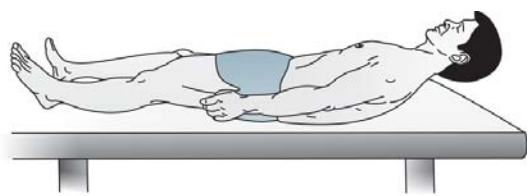


Fig. 8.37: Trunk extension from lying position

Fig. 8.38



Figs 8.38 and 8.39: Trunk flexion from lying position

Fig. 8.40: Side flexion in standing position

Fig. 8.41: Trunk rotation in standing position

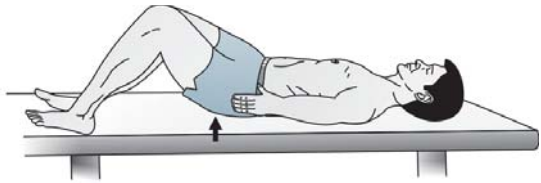


Fig. 8.42: Pelvic raising or bridging exercise

Teaching Methodology

Teaching methodology of positioning in bed, technique of trasfer, balancing, and wheelchair monitoring.

Positioning in Bed

The positioning of the patient should be such that it provides full comfort to the patient and avoid the formation of contractures. The contracture prone area should be kept in full extension like knee, it should never be kept in flexion position as this would increase the chances of flexion contracture at knee. Similarly hip is very prone to go in flexion and ankle into plantar flexion. Usually, the patient keep the pillow under the knee in transtibial and transfemoral which can lead to formation hip as well as knee flexion contracture. Similarly, in the case of upper limb amputation there are chances of contracture formation at the shoulder and elbow joint. Hence, in these cases also the joints should be kept in full extension.

Hence, educating the patient of these basic techique could avoid the complication of contracture formation.

Techniques of Transfer

Patient should be taught the correct technique of tranfer of weight from one position to other position on the bed or transfer from bed to wheelchair and wheelchair to bed if the wheelchair is prescribed to him. But in some cases the use of wheelchair is not prescribed to the patient by the surgeon this is because in such cases the stump is good enough to carry the load of prosthesis. In these cases directly temporary prosthesis is given to the amputee. For this the patient is educated how to transfer the initial weight of the body on to the prosthesis. All these information to the patient helps him to cope up with the functional activities to be dealt by him after surgery. Also the patient should be taught some basic bed mobility exercises so that he remain independent in performing basic activities of daily living.

Balance Technique

Balance is the ability to keep the body in equilibrium both in dynamic and static position. Center of gravity plays a vital role in maintaining balance. Static balancing is based on isometric

contraction and co-contraction of the muscles and it has rigid stability of one part over the other. Generally balancing is developed from moving the stable position this can be done by holding in antigravity position like—prone-on-elbow, quadruped, sitting, kneeling, half-kneeling, plantigrade or standing. Dynamic balancing is based on keeping the balance while walking or doing activities. This can be done by shifting the weight or reaching in any of the above mentioned postures. In this case the muscles work isotonically. The therapist train the patient in keeping balance of the body without the limb that is to be amputated. Balance on uninvolved limb is taught as well practiced so that the patient remain functional after surgery also and hence could perform his ADL (Activities of Daily Living).

Monitoring Wheelchair

Patient is educated about the working of wheelchair so that when the patient returns from the operation theatre and use the wheelchair then he is familiar with it. The patient's wheelchair is designed for comfort and ease of manipulation. There are various types of wheelchair available and is recommended to the patient according to the needs of an individual and his disabilities. Usually wheelchair comes in three sizes—adult, child and tiny tot. The common components of wheelchair include (Fig. 8.43):

- Frame
- Tyres
- Wheels
- Wheel Lock
- Casters
- Push rim
- Footrests
- Tilt bar

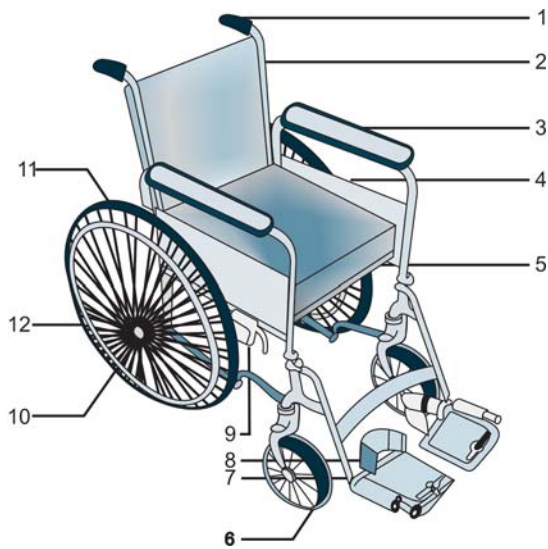


Fig. 8.43: Parts of wheelchair: **(1)** Handgrip **(2)** Backrest **(3)** Armrest **(4)** Cloth guard **(5)** Seat **(6)** Footrest **(7)** Casters **(8)** Heel loop **(9)** Brakes **(10)** Axel/antitip bar **(11)** Handrim **(12)** Wheel and tyres

- Backrest
- Armrest
- Cushions
- Seats
- Handrest
- Cloth guard
- Antitip bar.

The various types of modifications are done in the wheelchair in order to provide ease to the patient and to fulfill the need of the patient.

Psychological Reassurance

Since the patient has to undergo such a devasting surgery, it is very necessary to educate the patient and build up his confidence. This can be done by talking to the patient and telling him the need and importance of surgery. Patient should be made aware that the removal of the part of the body is necessary and if not done may result in the spread of poison to the whole body which may be very fatal and may lead to death. Build-up the confidence of the patient and teach him to cope up with the situation and try to live up with the fact that now onwards he has to live without the body part which will be removed after the amputation surgery.

Relaxation

It is the duty of the therapist to make the patient relax both physically and mentally before going

for the surgery. And for this give some relaxation techniques in the form of support, comfort, restful atmosphere, some relaxing exercises.

Support

Adequate support is very important in providing relaxation to the patient. Various forms and modifications of the lying position are used to provide full support to the body and hence provide relaxation to the patient. The position of the patient varies according to the condition of the patient and his preference.

Supine position: When the patient is in supine position, one pillow is kept under the head of the patient which prevent the rolling of the head on either side and provide support to the neck posteriorly. A small pillow is kept under the knees, relieving the tension on hamstrings and ilio-femoral ligament and to give support to lumbar spine. The feet are held in the mid-position by a sandbag whereas one pillow is kept under the elbow with arm slightly abducted at the shoulder and elbow slightly flexed (Fig. 8.44).

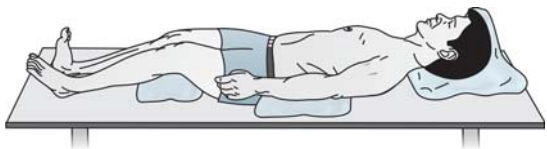


Fig. 8.44: Shows position of patient in supine lying

Half-lying: In this position the child is in half lying position with thighs fully supported and feet rest on the floor or footstool. Here one pillow is kept under the head of the patient (Fig. 8.45).

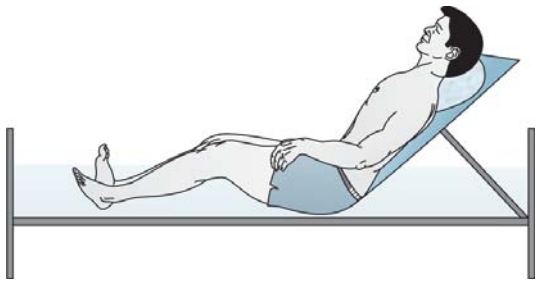


Fig. 8.45: Shows position of patient in half-lying

Prone lying: In this position head is turned to one side and rest on the pillow. One pillow is kept under the hips and lower abdomen as it prevents the hollowing of the back and one pillow under the lower leg, this is done to elevate the lower leg little so that the knees are slightly bent and the toes are free (Fig. 8.46).

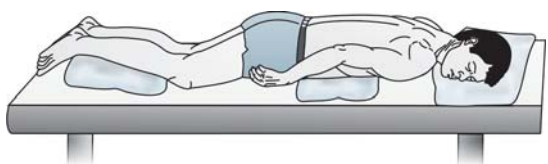


Fig. 8.46: Shows position of patient in prone position

Side-lying: The body in this position is turned to one side. One pillow is kept under the head supporting the neck and head, another pillow is kept under the upper arm and the third pillow is kept between the two legs. This position makes the body relaxed (Fig. 8.47).

Fig. 8.47: Shows position of patient in side-lying

Comfort

This is another way of providing relaxation to the patient and includes freedom to breath, warmth, abdominal quiescence and mild degree of physical fatigue.

Freedom to breath: Remove all the constrictive clothing so that the patient can breath freely which can be in the form of corset, belts or buttons.

Warmth: The warmth can be provided to the patient in the form of blanket, hot water bottle, electric blanket or by nonluminous infrared irradiation.

Abdominal quiescence: This can be done by giving the meal light but well balanced to the patient. Also at regular interval emptying of bladder is necessary.

Physical fatigue: If the condition of the patient is such that he can do little physical work then small walk in the open air may provide relaxation to him. But if the condition of the patient does not allow the physical activity then it is avoided.

Restful Atmosphere

Restful atmosphere provide more of mental relaxation as compared to physical relaxation. It can be done by:

- Keeping the treatment room as quite as possible
- The furnishing of the room should be soft and warm, bright lights and strong colors on the wall of the room should be avoided.
- The appearance of the therapist should be expressive, well dressed and smile on the face. All these things do affect the psychology of the patient and give relaxation to the patient.
- The conversation of the therapist to the patient should be brief and understanding. The therapist should keep her voice low pitched and clear, she should talk to the patient in his language and interest.

Additional Relaxation Methods

It includes:

Consciousness of breathing: In the quite and comfortable position the mind remain active and

turn towards problems and anxiety, so in this condition the concentration on one's breathing helps in providing relaxation to the mind. The patient is asked to take deep breath, concentrate on its rhythm and then expire the air with a slight pause at the end of expiration.

Progressive relaxation: In this method the relaxation is provided progressively and look almost similar to "Savasana" or "Still pose".

Passive movement: Rhythmical passive movements of the limbs may provide some degree of relaxation in certain cases. Usually passive movements are given to the group of muscles together such as flexion and extension of hip, knee and and ankle.

CHAPTER 9

Postoperative Stage

After the amputation surgery when the patient returns to the ward the physiotherapy management starts from that point onwards. The treatment should not be started before full assessment of the patient and particularly the stump.

ASSESSMENT OF THE PATIENT POSTOPERATIVELY

It include both subjective as well as objective examination of the patient.

Subjective Examination

It include various questions which should be asked to the patient postoperatively. Like:

- How does he feel after the surgery?
- Is there any pain or abnormal sensation?
- If it is there where is it located?
- Is the pain intermittent or constant?
- What is the intensity of pain?

- Is the pain or abnormal sensation due to missing limb (phantom sensation)?
- Anything which is causing uncomfort to the patient?

Phantom sensation is an abnormal feeling the patient has for the amputated limb. The patient feels the sensation in the amputated part of the limb even though that part of the limb is not there. This sensation is experienced by each and every one who has undergone limb amputation. The sensation which the patient feels is a mixture of many feelings, the patient after amputation feels as if someone is touching the amputated limb or pressure is being applied to the missing body part, cold, wetness, itching, tickle, pain or even fatigue. The intensity of this sensation may vary from person to person.

Phantom pain is the painful sensation perceived in the missing body part. It is usually experience by the amputee during the injury healing process. Phantom pain is common but is unpredictable in terms of severity, frequency, duration or character. Phantom pain begins as soon the surgery is completed and remains for weeks but usually stabilizes after few months, but may occur again after several months or years of amputation. Mostly phantom pain persisting for more than a year is usually difficult to treat and does not

change character after that time. Phantom pain may be in the form of:

- Knifelike
- Sticking
- Shooting
- Pricking
- Burning
- Squeezing
- Throbbing
- Pressing
- Cramplike
- Sawing
- Dull.

Stump pain is the pain arising from the residual part of the body, which is felt in the missing part of the body. Stump pain is localized to the end of the stump. It is usually in the form of sharp sticking pain. This pain usually occurs due to formation of neuroma where the the nerve was cut during surgery. Stump pain also occurs from adjacent joint or surrounding tissues which results due to changing stress to the tissues. This type of pain is severe immediately after amputation and subsides quickly with healing.

Objective Examination

It is further divided into:

1. Observation
2. Examination

Observation

The observation starts by first observing the remaining good limb by noting.

- Sensation
- Pulses
- Temperature
- Skin condition

Then move to the amputated part and assessed the stump which can be done by thorough check of the stump's:

- Shape (Is it cylindrical, conical, bony, bulbous or edematous).
- Swelling is checked
- Any bleeding from the sutured part
- Color and temperature of the stump is checked.

Examination

Before examination the examiner should read full report of the patient. This will give an idea to the therapist which muscle have been cut and which muscle is available to move the limb and provide stability during functional movements.

Firstly length and circumference of the stump is measured. Then the level at which the amputation surgery had occurred. Also measured the ulcer length if it is present.

Active movement: It is necessary to know how much strength or ability is available in the muscles to move the remaining joints in the remaining

stump and the range of active motion available in those joints. Usually the range of motion of the remaining joint is almost normal but may be affected by contracture formation or scarring, especially for the hip and the knee joint in the case of lower limb amputation. This is necessary because accordingly prosthetics are recommended to the patient. Also range of motion of the good limb must be assessed as now onwards the stress on this limb would be more especially in the lower limb amputation. And in the case of upper limb amputation if the dominant limb has undergone amputation then the opposite limb would become dominant and new skills will have to be learned by that limb. In whatever case the thorough assessment of the remaining whole limb is necessary. The active movement include:

a. *For hip*: Flexion, extension, abduction, adduction and rotation.
b. *For knee*: Flexion, extension.
c. *For ankle:* Dorsiflexion, plantar flexion, inversion, eversion.
d. *For shoulder:* Flexion, extension, abduction, adduction, rotation.
e. *For elbow*: Flexion, extension.
f. *For wrist*: Flexion, extension, radial deviation, ulnar deviation.

Passive movement: Passive movement is done in both the amputated as well as the normal limb in order to know the the available range of motion

and to prevent contracture formation, and if the contracture has already formed then it helps in restoring range of motion. Passive movements are all same as performed actively by the patient but in this the therapist does these movement till the end range which helps in understanding the end feel present so that if by chance the contracture occurs then the proper stretching procedure can be initiated. And if laxity is there then the amputee is instructed in proper stabilization exercises.

Resisted isometric movement: These movements are performed on the muscles of both the amputated limb as well as the normal limb in order to check the available strength and endurance present that will enable the patient to use prosthetics. In the lower limb muscles of the hip and knee are especially important to check. Whereas in the upper limb muscles of the shoulder are most important to be checked.

Functional assessment: The functional assessment involves examination of following points:

a. Patient's gait and endurance is carefully noted and need of external support is determined.
b. Next is the examination of the bed mobility of the patient, that is whether the patient can move on the bed easily or not or does he need assistance? Is the patient able to move from lying to sitting or lie prone?

c. Transferring activity of the patient is noted, that is whether the patient is able to transfer from sitting to standing and from bed to wheelchair.
d. Balance of the patient is determined by identifying whether the patient can balance in sitting and standing.
e. The patient's ability to get from and down to different types of chairs.
f. The patient's ability to use the mobility aids is seen, whether he can use the wheelchair or not?
g. The patient ability to go up and down the stairs and ramps and his ability to move in confined places.
h. The patient's ability to stand up from the floor, his ability to kneel, picking objects from the floor, etc.
i. For the upper limb amputee, the patient's ability to perform ADL (activities of daily living) is identified.

Sensational testing: The sensation of the stump is noticed and tested. Usually hypersensitive areas if present are desensitized whereas the area where there is no sensation there protection is needed. The sensation of the stump is tested with the help of hot/cold water in the test tube and by light touch.

Palpation: The palpation of the remaining stump is done during examination in order to look for any swelling or edema.

TREATMENT INTERVENTIONS

The postoperative treatment is divided into two phases:

1. Preprosthetic stage
2. Prosthetic stage.

Preprosthetic stage is the stage when the prosthesis had not been given to the patient, i.e. the phase just after the surgery. This stage is very important for the physiotherapist as in this stage there are chances of developing various complications which may further lead to deformities. Whereas the prosthetic stage is the phase when prosthesis is being given to the patient for the functional use. Here the main role of the physiotherapist is to teach the correct use of prosthesis and make the patient functionally independent.

CHAPTER 10

Preprosthetic Stage

This is the stage when the patient returns to the ward after surgery or amputation and the prosthetics are not yet given to the patient. This is the stage when physiotherapy plays a vital role.

AIMS OF THE PHYSIOTHERAPY TREATMENT

a. To take care of the stump hygiene
b. To prevent stump edema
c. To strengthen the muscles of the stump
d. To prevent contracture formation
e. To prevent complications arising post-operatively
f. To strengthen the muscles of the intact leg and also crutch muscles (in case of lower limb)
g. To teach balance ad transfers (in lower limb)
h. To restore functional independence
i. To re-educate walking (in lower limb)
j. To treat phantom pain

MEANS OF THE TREATMENT

To Take Care of the Stump Hygiene

When amputation surgery is over then firstly the physiotherapist's attention is to take care of the residual limb. Usually elastic wrap or shrinkers are used as the postoperative dressing; this is a form of soft dressing. Rigid dressing and semirigid dressing can also be used but soft dressing is much more popular than these. This is because the soft dressing is relatively less expensive, light-weighted and readily available. Elastic wrap and shrinkers are the types of soft-dressing which reduces the size of the residual limb and hence avoid edema (Figs 10.1 and 10.2). The bandage applied should be worn 24 hours a day, except when bathing. While using elastic wrap it should be taken care that it provides proper compression to the stump. A dressing is applied to the incision followed by some form of gauze pad and then the compression is given. But the only drawbacks of the elastic wrap is that it requires frequent rewrapping. Whereas shrinkers are socks like garments knitted of heavy cotton which is conical in shape and comes in variety of sizes. Both transtibial and transfemoral shrinkers are available in the market.

The care of the residual limb is done as follows:

- Proper hygiene and skin care are important. When the incisions healed up and the sutures

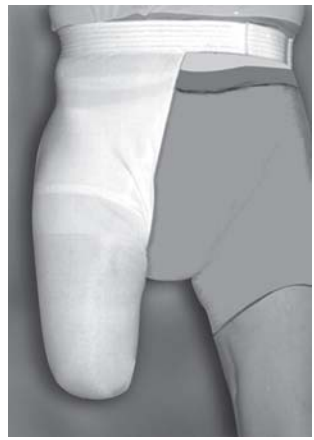


Fig. 10.1: Shrinker, transfemoral

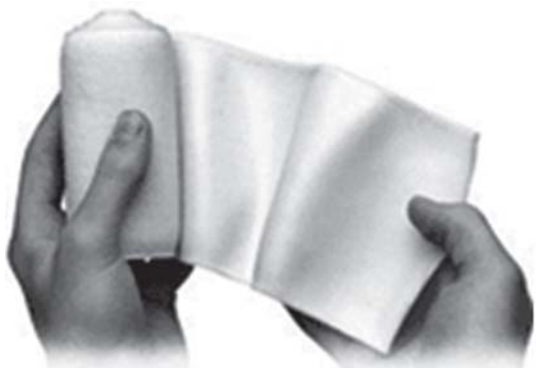


Fig. 10.2: Elastic wrap

are removed, the amputee can bathe normally. The residual limb should be cleaned daily with wet cloth and then dried up. Patient with dry skin can apply skin lotion to make the skin smooth and soft. Care must be taken to avoid abrasions, cuts and other skin problems.

- If the skin of the residual limb is affected by any of the dermatological problems such as eczema, psoriasis or radiation burns then it should be treated with ultraviolet irradiation, whirlpool, reflex heating or medication. Whirlpool is generally avoided as it increases circulation and can lead to edema formation, and if used, then used with caution.
- After the healing of the incisions there is chances of scar formation which can be reduce with friction massage. The massage is done gently and slowly in order to prevent or mobilize adherent scar tissue.
- The therapist should take care of the sensations in the residual limb which could be done by testing the sensation of the skin regularly.

To Prevent Stump Edema

As edema formation at the distal end of the residual is common hence the main emphasis of the therapist is controlling the edema formation and it can be controlled by following ways:

Elevation

The elevation is given either by raising the foot end of the bed or by placing the stump board under the stump. Use of pillow under the stump for elevation is contraindicated as this may lead to flexion deformity.

Bandaging

Application of compressive bandage or shrinkers is of great help in reducing edema formation. This method is very useful in reducing edema as application of bandage not only prevent edema but also improves the venous drainage. Also, the stump is made conical which is very important for the fitting of the prosthetics. The effective way of wrapping is very important, usually the patient tend to wrap in circular manner thus causing a tourniquet which compromises healing and causing the development of bulbous end (Figs 10.3 and 10.4).

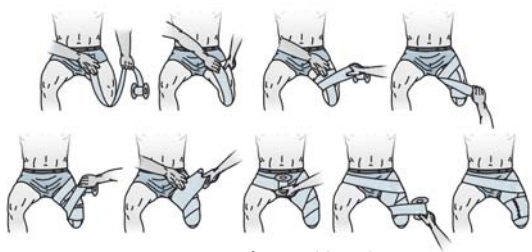


Fig. 10.3: Transfemoral bandaging

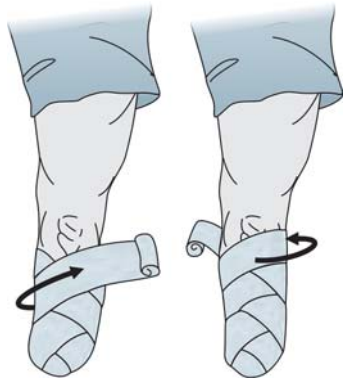


Fig. 10.4: Transtibial bandaging

Residual limb wrapping: There are several methods of wrapping the residual limb. Even the patients can wrap their residual limb on their own. An effective bandage is smooth and wrinkle free, with angular turns provided pressure distally and promotes proximal joint extension. The ends of the bandage are fastened with tape, safety pin or Velcro. While bandaging it should be kept in mind that it should not be very tight or very loose. The tight bandaging may lead to obstruction of the arteries resulting in pain and necrosis. And the loose bandage is of no use as it will not compress the stump properly resulting in edema formation. Usually the elastic bandage used for transtibial bandaging are three; each one is 4 inches in size

whereas in the case of transfemoral two bandages are used one of 6 inches and the other of 4 inches.

Principles of bandaging the stump

a. The pressure of the bandage should be moderately firm and evenly distributed, decreasing proximally.
b. Extra-pressure is required over the corners in order to give the conical shape to the stump.
c. Diagonal, oblique or spiral turns should be used while doing bandaging. Circular turns are avoided as it may produce a tourniquet effect leading to "chocking" of the stump.
d. The above knee bandaging is done with hip in extension and adduction.
e. The below knee stump should be bandaged with knee in slight flexion.

To Strengthen the Muscle of the Stump

It is very necessary to strengthen the muscles of the stump as the patient has to carry the prosthetics by it and also the patient has the body weight transferred to the stump after amputation. The exercise program is individually designed and includes strengthening balance and coordination activities.

For Below Knee Amputation (BKA)

In this type of amputation the main emphasis is to strengthen the quadriceps and hamstrings (Figs 10.5 to 10.7). For quadriceps strengthening, the

Fig. 10.5: Strengthening of quadriceps muscles

Fig. 10.6: Isometric contraction of quadriceps muscles

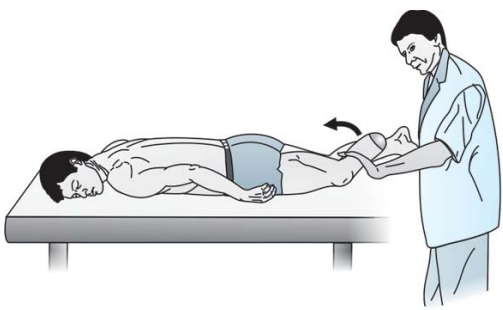


Fig. 10.7: Strengthening of hamstring muscles

patient is allowed to sit and extend his stump and the therapist provides resistane to this action which increases with progression. Also isometric contraction is given to the quadriceps muscles by allowing the patient to press a roll of cloth placed under his knees when he is in supine position. And for the strengthening of hamstrings, the patient is allowed to lie down prone and asked to flex his knees of the stump whereas the therapist provides resistance to this action.

For Above Knee Amputation (AKA)

In this type of amputation the main emphasis is to strengthen the hip flexors, extensors, abductors and adductors (Figs 10.8 to 10.11). For hip flexors strengthening, the patient is allowed to lie supine and asked to flex the stump while therapist

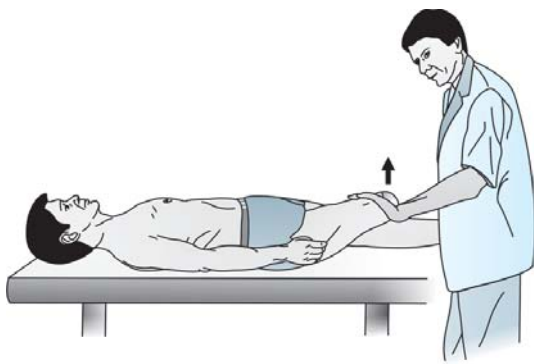


Fig. 10.8: Strengthening of flexor muscles of hip

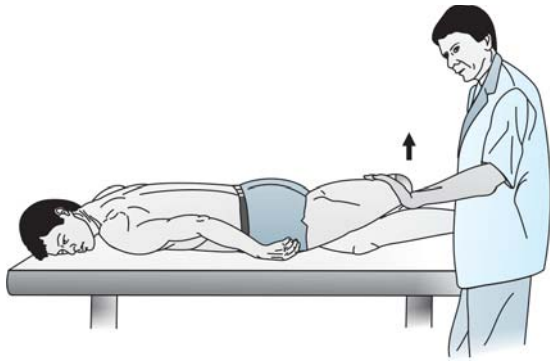


Fig. 10.9: Strengthening of extensor muscles of hip

Fig. 10.10: Strengthening of abductor muscles of hip

provides resistance to this action. For the strengthening of hip extensors, the patient is allowed to lie prone and asked to extend the stump and the therapist provides resistance to this action.

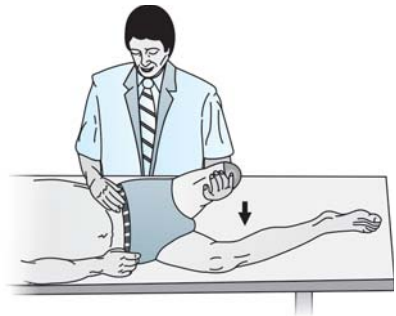


Fig. 10.11: Strengthening of adductor muscles of hip

For the strengthening of hip abductors, the patient is allowed to lie down in a sidelying position and asked to raise his stump up in the air while therapist provides resistance to this action. For the strengthening of hip adductors, the patient lies supine with a roll of cloth placed between the stump and the uninvolved limb and the patient is asked to press this cloth with the stump. All these exercises are given to make the stump strong.

For Below Elbow Amputation (BEA)

In the case of below elbow amputation, the main emphasis is to strengthen the tricep and bicep muscles of the stump. For the stengthening of tricep, the amputee is asked to extend his elbow from the flexed position of the stump while he is in the sitting position and with progression the

Fig. 10.12: Strengthening of tricep muscle

Fig. 10.13: Strengthening of bicep muscle

therapist provides resistance to his action. And for the strengthening of bicep, the amputee is asked to flex his elbow from the extended position of the stump while he is in sitting position. Similarly, with progression the resistance is given to his action by the therapist (Figs 10.12 and 10.13).

For Above Elbow Amputation (AEA)

In the case of above elbow amputation, strengthening is mainly given to the shoulder flexors, extensors, abductors and adductors of the stump. For the strengthening of shoulder flexors, ask the amputee to flex the shoulder while he is in supine position and the resistance is given to his action

by the therapist. And for the strengthening of extensors, ask the amputee to extend the shoulder when he is in prone position and resistance is offered to his action by the therapist. For the strengthening of abductors of the shoulder, the positoin of the amputee should be in side lying and the amputee is asked to raise his stump in the air while therapist provide resistance to this action (Figs 10.14 and 10.15). For the strengthening of adductors of the shoulder, the amputee is asked to bring back the stump to the normal position when it is in abducted position and while performing this action the therapist provide resistance to it (Figs 10.16 and 10.17).

Fig. 10.14: Strengthening of flexor muscles of shoulder

Fig. 10.15: Strengthening of extensor muscles of shoulder

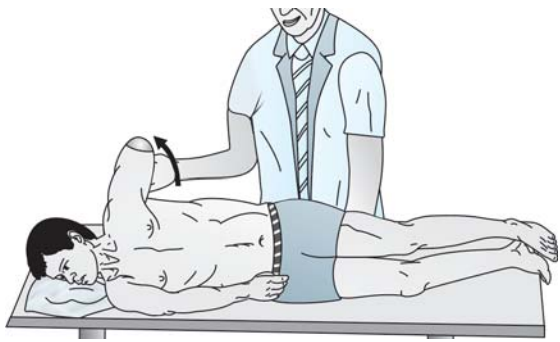


Fig. 10.16: Strengthening of abductor muscles of shoulder

Fig. 10.17: Strengthening of adductor muscles of shoulder

To Prevent Contracture Formation

Contractures usually develops as a result of muscle imbalance or fascial tightness or as a result of faulty positioning such as prolonged sitting or placing the residual limb on a pillow. In order to prevent contracture formation and hence prevent deformity proper positioning, regular exercises, manual mobilization as well as stretching exercises are given to the patient.

Proper Positioning

There is a great importance of proper positioning as it helps in preventing contracture formation and hence deformity. Usually, the stump is made to lie in close contact with the normal limb. In case

of below knee amputation the knees of the amputee must be as straight as possible and the position of the patient should be supine lying. This is because there are chances of knee flexion in BKA. Whereas in the case of above knee amputation prone lying is the best position as this position avoids flexion deformity at the hip joint which is usually seen in the case of AKA. Similar in the case with below elbow amputation (BEA) and above elbow amputation (AEA) (Figs 10.18 and 10.19).

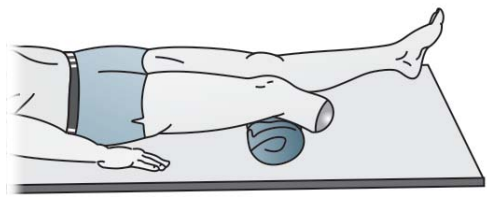
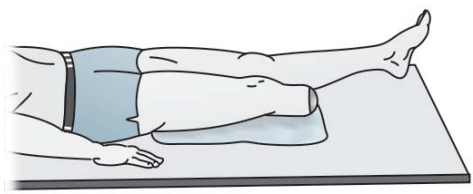


Fig. 10.18



Figs 10.18 and 10.19: Improper positioning of the amputated limb

Active Exercises

Active exercises of the residual limb should be performed regularly initially thrice a day and afterwards twice a day. This will avoid the formation of contractures and hence deformities. In above knee amputation (AKA), there is chances of hip flexion contracture so in this case active exercises at the hip joint is quite effective in avoiding the chance of flexion contracture at the hip. Hip flexion, extension, abduction, adduction and rotation (medial and lateral) are performed in full range. In the case of below knee amputation (BKA), there is the chance of knee flexion deformity. In this active exercises at the knee (flexion, extension) is practiced at the regular basis. In the case of above elbow amputation, active exercises are given to the shoulder which include flexion, extension, abduction and adduction. In the case of below elbow amputation, active exercises to the elbow joint is necessary which include flexion and extension exercises.

Stretching Maneuver

This is yet another method of preventing contracture formation. Usually the chances of contracture formation is in the hip (flexion deformity) in the case of AKA and at knee (flexion deformity) in the case of BKA in the lower limb amputation. Whereas in upper limb amputation, there are chances of flexion deformity at shoulder

in the AEA and flexion deformity at elbow in BEA. Here manual stretching is given and then maintaining it in that position with weights for a considerable length of time helps in reducing the stiffness or tightness in these muscles and thus reduces the chances of contracture formation. Also after stretching the stretched muscle is maintained in splints in order to maintain the muscle in lengthened position for a considerable length of time.

Manual Mobilization

Manual mobilization at the joint just proximal to the amputation site reduces the chances of contracture formation. In AKA, the mobilization is given to the hip joint (anterior, posterior and caudal glide) whereas in BKA, mobilization is given to the knee joint of the amputated side. It include anterior and posterior glide together with patellar mobilization. In AEA, mobilization is given to shoulder joint whereas in BEA, mobilization is given to the elbow joint of te amputated side.

Proprioceptive Neuromuscular Facilitation (PNF)

PNF techniques are more effective than the passive stretching. Hold-relax and hold-relax active contraction that utilizes resisted contraction of antagonist muscles may increase range of motion, particularly of the knee.

- Also the more effective way, mainly for reducing knee flexion contracture is giving PTB (patellar tendon bearing) prosthesis to the amputee which is aligned in such a way that it gives stretching to the hamstring muscle and thus avoid the formation of contracture. For hip flexion contracture prosthesis can be given but it is very difficult to walk with such prosthesis that prevent hip flexion.

To Prevent Complications Arising Postoperatively

As the patient is bed ridden postoperatively hence there are chances of various complications which should be kept in mind. Most common complication arising postoperatively include:

Chest Complication

This is the most common complication postoperatively and could be avoided by giving different types of breathing exercises preoperatively as well as postoperatively and if needed postural drainage is also implemented to clear the secretions accumulated in the respiratory tract.

Deep Vein Thrombosis (DVT)

There are chances of deep vein thrombosis in the normal limb as the patient is at bed rest. Hence vigorous exercises are given at the foot (ankle toe pump exercises) to avoid DVT.

Muscle Contractures

Due to immobilization there are chances of joint contractures. To avoid this mobilizing exercises are given to both involved and spared limb joints.

To Strengthen the Muscles of the Intact Leg and also Crutch Muscles (in the Case of Lower Limb Amputation)

Strengthening exercises (PRE) as well as PNF techniques are given to both the upper limb (crutch muscles) and the lower limb.

For Upper Limb

Strengthening exercises are given to the shoulder flexors, extensors, abductor, adductor medial rotators as well as lateral rotators. For elbow strengthening is given to the flexors as well as extensors. And the exercises are given by using pulleys, weight and springs.

For Trunk

For trunk, mobility exercises like trunk flexion, extension and rotation together with bridging and rolling is given to the amputee.

For Unaffected Limb

The exercises to the unaffected limb is started at the very first day. The exercises are started with

the static exercises followed by free exercises and then resisted exercises.

For Affected Limb

The muscle groups to be concentrated are:

- In above elbow amputation—Strengthening exercises are given to flexors, abductors and extensors of the shoulder. And scapular elevators and retractors of the normal side.
- In below elbow amputation—Strengthening is provided to elbow flexors, extensors, pronators and supinators of the forearm.
- In above knee amputation—Strengthening is given to hip extensors, abductors, flexors and shoulder girdle muscles.
- In below knee amputation—Strengthening is given to knee extensors and flexors, hip abductors and extensors.

To Teach Balance and Transfers

Balance and transfer is taught to the patient (specially in the lower limb amputation) in various positions that help the patient to be off the bed as soon as possible and become functional independent. The positions include:

Prone-on-elbow

The patient is first allowed to lie prone then slowly come on the elbow so that the full weight bearing is through shoulders and the elbow is flexed. This

improves the trunk, upper extremity and neck/head control.

Bridging or Pelvic Elevation

For this the patient is in hook-lying position (supine with hips and knees flexed and feet flat on the mat) and elevates the pelvis off the mat. This exercise is very useful in fascilitating pelvic motions and strengthening low back hip extensors in order to prepare for the stance phase of the gait.

Rolling

The position of the patient is supine. The therapist asks the patient to clasp his hand over the head and try to roll his body first to one side and then to the other side. This improves the lower trunk, pelvis and lower extremity.

Sitting

Sitting is mainly useful to promote static and dynamic control. There are two types of sitting positions—Short sitting (in this position, the patients hips and knees are flexed with feet flat on the floor) and Long sitting (in this position, the hips are flexed and the knees are extended on the supporting surface. This position improves the upper trunk, lower trunk and head/neck control. The use of wobble board can also improve sitting balance.

Sit-to-Stand

This position needs coordination of movements and proper motor response. Initially the patient shifts the weight forward with flexing the trunk forward, then lifts the pelvis off the ground or the sitting surface and then finally stands with his full weight on his uninvolved extremity with the support.

Modified Plantigrade

This is the early weight bearing posture. In this the patient is in standing position with a support in the form of table or chair. The patient is asked to scoot forward in the chair. The patient shifts his weight forward to the plentigrade position. It improves head/neck, upper trunk, upper extremity, lower trunk and the uninvolved lower extremity.

Standing

The patient is then encouraged to stand erect with the help of some mobility aid like tripod or quadripod.

To Restore Functional Independence

From the very first day the patient is encouraged to do his own work. This will not only increase the confidence in the patient but will also make

him independent so that he will not depend on anyone for his work. The amputee is taught about the self-care, changing clothes, dressing and other ADL (activities of daily living). Here the role of the occupational therapist is more as compared to the physiotherapist. The occupational therapist modify the skill for improving ADL and other activities regarding the patient's occupation. This will help the patient to return to his daily living and make him functional independence.

To Re-educate Walking

In the case of lower limb amputation, after the few days of surgery about 4 to 5 days, the patient is allowed for partial weight bearing between the parallel bars. And the unaffected limb is protected with shoes. While the amputee starts his gait training in parallel bars, balance in the standing position is also taught to the patient. With time the amputee is further trained for crutch walking which also provide partial weight-bearing on the lower limb. The amputee with unilateral lower limb amputation is quite independent using a three-point gait pattern on crutches. Crutch walking is good preparation for prosthetic ambulation and person using crutches have no difficulty learning to use a prosthesis. While crutch walking maximum load is on the upper extremity (mainly shoulder muscles). When the amputee is good enough to carry the prosthetic, it is given to the

patient. PPAM is given to the amputee in bed, parallel bar and in crutches. PPAM (pneumatic post-amputation mobility aids) is the mobility aid with rigid metal frame having outer and inner cuff and it also have air pump unit with gauge. These are inflatable and produce pumping effect over the stump.

To Treat Phantom Pain

Phantom pain often follows amputation. Phantom pain is characterized as cramping sensation or shooting or burning pain. This pain may either be localized or diffuse, continuous or intermittent, temporary or permanent. For the treatment of phantom pain, adequate amount of analgesics are given to the patient. Physiotherapy treatment include—TENS, IFT or ultrasound. All these modalities are quite effective in reducing phantom pain.

CHAPTER 11

Prosthetic Stage

This is the stage when the stump is strong enough to carry the prosthesis. Different types of prosthesis are available for different levels of amputation.

PROSTHESIS

Prosthesis is defined as the artificial limb used to replace a missing limb in order to restore or provide function. They are manufactured by the prosthetists.

BASIC COMPONENTS OF PROSTHESIS

The basic component include (Figs 11.1 and 11.2):

a. Suspension or harness system
b. Socket
c. Shin/shank piece
d. Terminal device
e. Control unit.

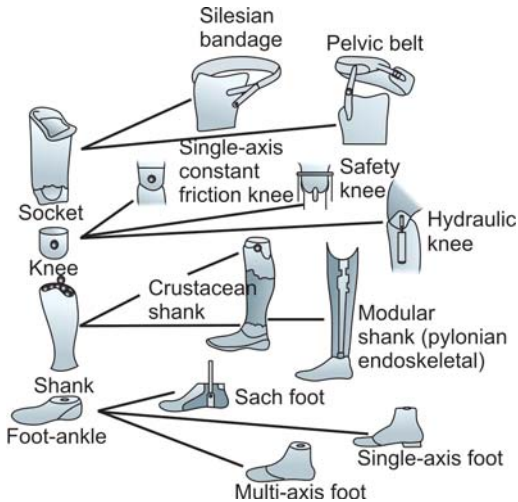


Fig. 11.1: Parts of lower limb prosthesis

Suspension or Harness System

Suspension is given in the case of lower limb amputation and is needed for proper attachment to the proximal part of the stump to the prosthesis. Depending upon the level of amputation, three types of suspension are available:

1. Flexible attachment
2. Brim contour
3. Thigh corset.

Harness system is given in the case of upper limb amputation and is in the form of figure-of-

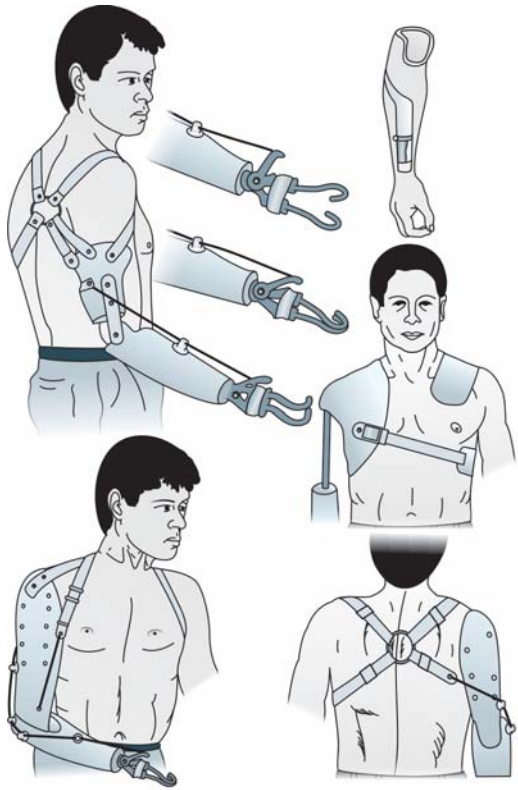


Fig. 11.2: Parts of upper limb prosthesis

eight. It is used to suspend the upper limb prosthesis and control the terminal device.

Socket

Socket helps to support the body weight and hold the residual limb firmly during all activities.Two types of socket are available depending on the status of the stump:

1. ***Hard socket:*** It is used for ideal below knee stump
2. ***Hard socket with inner lining:*** It is used when the stump is having bony prominence with minimum muscular covering and in anaesthetic stumps (sensory impairement). It should be preferred in the case of diabetes as well as in old age.

Joints

The joints which are amputated placed by the artificial mechanical joints. Like –

- Elbow unit (in upper limb amputation)
- Knee joint assembly (in lower limb amputation).

Body of Prostheses (Shin/Shank Piece)

There are two types of shin/shank piece:

Exoskeleton

Also known as conventional prostheses are made of wood or rigid plastic. The rigid exterior of the prosthesis is in the form of anatomical structure. The shank is usually made up of plastic which

Fig. 11.3: Exoskeleton shank

match the color of skin of the user. The exoskeleton prosthesis are very durable but are now rarely used as they are less lifelike and do not permit changes in angulations of the prosthesis (Fig. 11.3).

Endoskeleton

Also known as Modular, is made up tube frame (pylon made of metal or carbon fiber) covered with foam rubber and a sturdy stocking or similar finish. Endoskeleton prosthesis is much more popular than exoskeleton because this is more natural than exoskeleton and pylon in it permits angulations of the prosthesis which may contribute to comfort and ease of walking (Fig. 11.4).

Fig. 11.4: Endoskeleton shank

Terminal Device

It may include mechanical or myoelectric hand in the case of upper limb amputation whereas Non-articulated foot (SACH foot, JAIPUR foot or SAFE foot) and Articulated foot (Single-axis feet or multiple-axis feet) in case the of lower limb amputation. Mechanical hand is attached to the wrist unit and is operated by cable control. It consists of a plastic, spring-controlled device with fingers that are controlled by the control cables of prosthesis. Myoelectric hand is computer operated modernized form of terminal device.

Figures 11.5 to 11.8 explain types of terminal devices.

Fig. 11.5: Mechanical hand

Fig. 11.6: Myoelectric hand

Fig. 11.7: Jaipur foot

Fig. 11.8: SACH foot

Control System (in the Upper Limb Amputation)

The control mechanism may be body itself or externally powered to activate the terminal device. But this system is absent in cosmetic terminal devices.

MATERIAL USED FOR PROSTHESIS

- Metal
- Leather
- Plastics
- Wood.

PROSTHESIS FOR LOWER LIMB AMPUTATION

Depending upon the level of amputation the prosthesis for lower limb include:

Hemipelvectomy Prosthesis

The prosthesis design include (Figs 11.9 and 11.10):

Suspension: Through total tissue contact with locking over the iliac crest. Sometimes shoulder suspension is given to some patients for additional support.

Fig. 11.9: Exoskeleton hemipelvectomy prosthesis

Fig. 11.10: Endoskeleton hemipelvectomy prosthesis

Socket: Socket is totally embracing the pelvis enclosing both the iliac crest. The weight bearing area is ischial tuberosity and the buttock of the non-amputated side.

Shin/shank piece: It can be exoskeletal or endo-skeletal.

Knee joint assembly: Knee joint assembly consist of knee lock which could be hand operated or automatically operated.

Ankle/foot assembly: The terminal device is usually SACH (Solid Ankle Cushion Heel) foot.

Hip Disarticulation Prosthesis

The prosthesis design include (Fig. 11.11):

Suspension: It is in the form of total tissue contact with locking over the iliac crests.

Socket: Socket is totally embracing enclosing both the iliac crest. The weight bearing area is ischium and the buttock of the amputated side.

Shin/shank piece: It can either be exoskeleton or Endoskeleton.

Knee joint assembly: The knee joint constructed is in slight hyperextension in order to provide stability in the stance phase. Knee lock is either hand operated or semi-automatic.

Ankle/foot assembly: Usually SACH foot is preferred as it provide maximum stability to the foot.

Fig. 11.11: Hip disarticulation prosthesis

Above Knee Prosthesis

The prosthesis design include:

Suspension: It is in the form of pelvic band with a multiaxial joint. Also suction socket with valve or with modular assembly can be used in place of pelvic band.

Socket: It is in the form of quadrilateral H-type socket so that the body weight is transmitted through the ischial seat and the posterior brim of the socket.

Knee joint assembly: It include hand operated or semi-automatic locking system with constant friction device.

Fig. 11.12: Shows above knee prosthesis

Ankle/foot assembly: SACH foot or uniaxial/multiaxial foot.

Knee Disarticulation Prosthesis

The prosthesis design include (Fig. 11.12):

Suspension: It can be in the form of rigid pelvic band or a waist band.

Socket: It is in the form of thigh corset with ischial seat.

Knee joint assembly: Uniaxial knee joint with automatic or manual locking ring.

Ankle/foot assembly: SACH foot or uniaxial foot.

Fig. 11.13: Knee disarticulation prosthesis

Below Knee Prosthesis

There are two types of prosthesis for BK amputation (Figs 11.13 and 11.14)

1. Conventional Prosthesis with thigh corset.
2. Patellar tendon bearing prosthesis (PTB).

Conventional Prosthesis

These are usually given to the patient with unstable knee joint, flexion deformity, very short stump or anesthetic stup. It include:

Thigh corset: It is made up of blocked leather with steel uprights and front fastening.

Fig. 11.14: Below knee prosthesis

Suspension: It is in the form of rigid pelvic band or waist belt.

Socket: It is made up of metal, wood or moulded polyester resin which extends proximal to the lower pole of patella.

Knee joint assembly: It is in the form of uniaxial knee joint providing free movements.

Ankle/foot assembly: Usually uniaxial foot is preferred.

Patellar Tendon Prosthesis (PTB)

Usually PTB prosthesis is preferred as compared to conventional prosthesis. It is because this is easy and handy for long stump, its design include:

Suspension: It is in the form of elastic stocking or supracondylar cuff.

Socket: It consist of inner soft socket with hard covering, major weight bearing is on he patellar tendon, medial flare of tibia and tibial condyle.

Ankle/foot assembly: Uniaxial or multiaxial or SACH foot.

Syme's Prosthesis

It can be in many forms (Fig. 11.15):

Plastic Syme Prosthesis

In this type, the outer socket which is quite hard is lined bypelite liner with medial and posterior access panel. The terminal device is in the form of uniaxial or SACH foot.

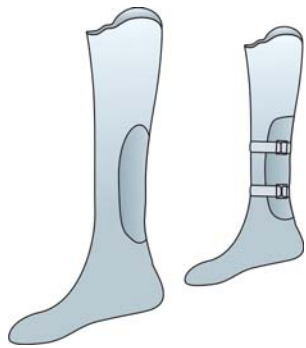


Fig. 11.15: Syme's amputation prosthesis

Metal Syme Prosthesis

In this type, there is leather liner with opening on the posterior side fitted inside the metal socket. The terminal device is uniaxial foot.

Tongue and Bolt Syme

In this type, the socket is of leather with front open two side steels connecting the socket to the foot piece.

Partial Foot Prosthesis

It is in the form of:

1. Simple shoe fillermade up of leather covered with ortholene, is fitted in the shoes.
2. Short leather ankle corset attached to the wooden foot worn inside the shoe.

The design of the prosthesis depend on the stump and thus patient achieves total freedom to ambulate and do all his activities.

Figures 11.16 and 11.17 explain types of partial foot prosthesis.

Prosthesis for Bilateral Amputation

Amputees with bilateral amputation have problem with balance and equilibrium because in such people there is lack of proprioceptive feedback from the walking surface. Amputee with bilateral below knee amputation have potential for ambulation and therefore in such people short

Fig. 11.16

Figs 11.16 and 11.17: Types of partial foot prosthesis

prosthesis which can bring about the center of gravity and control of balance is recommended. But in amputees with bilateral above knee amputation prosthesis is usually not affected and in such people wheelchair is the best mode of ambulation. Amputees with bilateral amputation need special training in adjustment of prosthesis in balancing, standing, walking, transfer and stair climbing. Also the physiotherapy management emphasis on the mobility of the trunk and pelvis beside giving strengthening and balance training.

PROSTHESIS FOR UPPER LIMB AMPUTATION

Forequarter Prosthesis

The prosthesis design include:

- Plastazote cap, padded with foam and retaining straps are given. Even a sleeve-fitter cosmetic prosthesis can be supplied.

Shoulder Disarticulation Prosthesis

It include extended shoulder cap in order to hold the prosthesis. The flexion at the shoulder joint is brought about by the strong protraction of the shoulder girdle which provide tension to the flexion cord. Hand piece is in the form of cosmetic hand or split hook type (Fig. 11.18).

Fig. 11.18: Shoulder disarticulation prosthesis

Above Elbow Prosthesis

It also include extended shoulder cap for holding prosthesis and the flexion in this case is brought about by the combined action of scapular protraction and arm flexion. Automatic functional locking is achieved by reverse movement of combined depression and extension of the arm (Fig. 11.19).

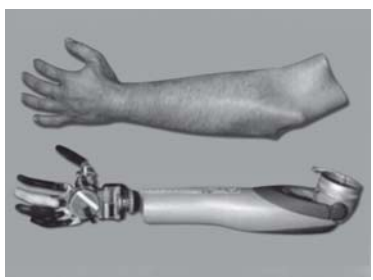


Fig. 11.19: Above elbow prosthesis

Below Elbow Prosthesis

It include cup socket, harnessing belt with operational cord in order to activate the terminal device (Fig. 11.20).

Fig. 11.20: Below elbow prosthesis

Wrist Disarticulation Prosthesis

For this, split socket forearm with wrist rotation unit is given. A locking device is given for supination and pronation of the forearm (Fig. 11.21).

Fig. 11.21: Wrist disarticulation prosthesis

UPPER AND LOWER LIMB COMBINATION

One Upper Limb and One Lower Limb

The lower limb prosthesis is fitted first in order to provide ambulation to the amputee so that he can do his basic functional activities. Prosthesis for upper limb is given at the later stage when the amputee had attained proficiency in ambulation.

One Upper and Bilateral Lower Limbs

In this case upper limb prosthesis is fitted first and then the lower limb prosthesis are given.

PHYSIOTHERAPY TREATMENT

Aims of Physiotherapy Treatment

a. **Correct method of application and removal** of prosthesis
b. **Early detection of complication** arising due to prosthesis
c. **Balance and co-ordination** with prosthesis
d. **Gait training** in lower limb amputee
e. Transferring activities.
f. Stair climbing.
g. **Functional training** in the case of upper limb amputee
h. **Guidance** on proper maintenance of prosthesis.

MEANS OF PHYSIOTHERAPY TREATMENT

Correct Method of Application and Removal of Prosthesis

The correct way application and removal of prosthesis is very important as it may lead to injury to the stump. Putting the prosthesis on the stump is called as donning. Initially the stump is covered with socks and sheath. After that the stump is inserted into the socket. Socket is worn during sitting but tightening of shoe laces and corset is done while standing to ensure the proper lodgment of stump into the socket. The upper limb prosthesis is checked with the patient in sitting position. Any discomfort on the pressure areas is noted and managed. And the prosthesis is removed carefully so that it does not cause any injury to the stump.

Early Detection of Complication Arising due to Prosthesis

Certain complications arises due to prosthesis which if detected at early stage can help in managing it at correct time. In some cases the pressure areas if causes discomfort is being neglected can cause severe damage to the limb. If it is detected at the correct time can be managed and thus the complication going to arise due to it could be managed. If the prosthesis is not made correctly may injure the stump and cause infection to it.

Balance and Co-ordination

Since the patient is wearing the prosthesis first time, he needs full balance while wearing the prosthesis. For this he needs good guidance and proper balancing and this is taught to him by the physiotherapist. A graduated program for increasing prosthetic tolerance minimizes the danger of skin abrasion. Some patient take use of parallel bar at the initial stage for support. When the patient uses bar, the therapist should advice the patient to rest the open hand on the bar frather than using a viselike grip. Static balance is taught in leveled pelvis and shoulder, vertical trunk without excessive lordosis and equal weight bearing.Then therapist encourages to shift the body weight onto the prosthesis. Patient is asked to maintain the balance without looking at the floor. Mirror can also be used to provide visual feedback. Then progression is made to dynamic balancing which improve the medial-lateral, sagittal and rotary control. Then weight bearing is taught, first the patient is asked to equal weight on both the legs. The therapist is encouraged for proper weight shifting, stride position and stepping position. Stepping on a low level stool helps the patient to shift his weight on prosthesis.

Gait Training

After the patient having full control on balancing and co-ordination, he is taught about the proper gait movements. Gait training is started with:

Parallel Bar

Initially the ambulation or gait training is started with parallel bar which is also used for balancing purpose. Parallel bar are rigid and support the patient right through the length of the bars (Fig. 11.22). It provides full support and encourages the patient to walk and the mirror at the front of it gives feedback to his walking. While training in parallel bar, therapist should notice the stance and swing phase and correct where it is altering from the normal pattern. Also all the determinants should be noticed and taken care off.

Fig. 11.22: Parallel bar

Frames

The commonest type is the lightweight frame with four feet which is adjustable in height. Frames provide partial weight bearing and full support to the patient. In frames the base of support is quite large hence it encourages the patient to walk as the risk to fall is minimal. The patient lifts the frame and put forward then leans on it and then takes two steps. Every time the patient take a step, he should keep the frame well forward and then proceed. In some cases with the patient having full balance and control, the use of frame is not there and the patient moves directly to crutch walking.

Figures 11.23 and 11.24 Show types of frames.

Fig. 11.23: Standard frame

Fig. 11.24: Rotator frame

Crutches

Crutches are one of the popular mobility aid which reduces the weight-bearing on either one or both legs depending on the situation and need. There are basically three types of crutches.

1. ***Axillary crutches:*** Axillary crutches are made up of wood with an axillary pad, a hand piece and a rubber ferrule. The length of the crutch is adjustable according to the need of the patient (Fig. 11.25).
2. ***Elbow crutches:*** These are made up of metal

Fig. 11.25: Axillary crutch

with metal or plastic forearm band and a rubber ferrule. These are also adjustable in length. These crutches are usually recommended to patients with strong arms (Fig. 11.26).

3. ***Gutter crutch:*** These are made up of metal with padded forearm support and a strap, an adjustable hand piece and a rubber ferrule. These crutches are usually recommended to the could take weight through hands, wrist and elbow like—Rheumatoid arthritis (Fig. 11.27).
4. ***Canes:*** Canes or sticks are either made of wood or metal with curved or straight hand piece. The wooden canes are cut according to the required length whereas the metal canes are adjustable. There are various types of canes—(Fig. 11.28)
   a. Wooden cane
   b. Aluminum cane

Fig. 11.26: Elbow crutch

Fig. 11.27: Gutter crutch

Fig. 11.28: Types of canes

c. Tripod
d. Quadripod

Transferring Activities

The patient on a wheelchair need training on transferring the body weight from bed to wheelchair and wheelchair to bed.

Initially the patient should park the wheelchair near to plinth. Then after locking it and raising the footrest, the patient should sit forward and transfer the weight to the intact leg, then push down on the chair armrest. Putting the sound foot close to thechair enables rising by extending the

knee and hip on the sound side. Sitting is done by placing the sound foot close to the chair and lowering oneself by controlled hip and knee flexion on the sound side.

Transferring into an automobile also involves great skill. In order to enter the right side of an automobile, the prosthesis wearer faces towards the front of the car and enter the car first putting the sound leg, then trunk and finally the prosthetic leg. The person with left prosthesis finds that sitting sideways with both feet out the car door is easiest.

Stair Climbing

The next step in gait training is the stair climbing which is taught to the patient when the patient has full confidence in walking with prosthesis. The patient with Syme's and transtibial amputations generally ascend and descend stairs and inclines with steps of equal length in step-over-step progression. Whereas in the case of transfemoral amputation, the patient ascend by leading with the sound foot and learn to descend by first placing the prosthesis on the lower step. A few individuals with transfemoral learn to control prosthetic knee flexion in order to descend step-over-step. If the stairs are very steep, the individual may climb diagonally or sidestep with the prosthesis kept on the downhill side.

Functional Activities with Prosthesis

Functional training has an important role in the rehabilitation process. Patient should realize that he can lead a normal life without the amputated part and is one of the important member of the society. For this the patient is trained to do his functional activities without the help of anyone. The training program for performing functional activities include—

- Stair climbing
- Negotiating ramps
- Retrieving objects from floor
- Kneeling
- Sitting on floor
- Driving vehicle
- Engaging in sports

Guidance on Proper Maintenance of Prosthesis

After the application of prosthesis, it is the duty of the amputee to take care of the prosthesis. For the proper maintenance of the prosthesis certain points should be kept in mind which is taught by the physiotherapist.

- Firstly after the removal of prosthesis it should be taken care that it is placed in proper place as frequent fall of prosthesis can harm the components of the prosthesis.
- Secondly the the prosthesis should never be kept near the water as this may cause rusting

of iron components of the prosthesis and destruction to other components also.

- Thirdly the prosthesis should be cleaned every day with the dry cloth.
- Oiling of the prosthesis parts is done where ever there is need.

CHAPTER 12

Case Study

CASE 1

Since the case is of road-traffic accident, hence in this case there is no preoperative stage. The patient was taken for the surgery (above knee amputation). When the patient return to the ward after surgery, physical assessment of the patient was done which include subjective and objective examination (Fig. 12.1).

Fig. 12.1: Unilaterally limb amputated patient in post-operative ward

Subjective Examination

Name of the patient—Vijay Shankar

Age—48 years

Sex—Male

Address—Kanauj, Kanpur.

Hospital—Hallet

Ward no.—4

Bed no.—28

Occupation—Shopkeeper

Marital status—Married

History of any past surgical intervention—No history of any past surgical operation

History of past illness—No history of diabetes, hypertension or tuberculosis

History of present illness

- *Cause of surgery*—Trauma (road-traffic accident)
- *Location*—Above knee
- *Nature*—The skin at the site of injury was lacerating at the time injury
- *Behavior of pain*—Very painful

Personal history

- *Habit*—No such habit (alcohol intake or cigarette smoking)
- *Social status of the patient*—Middle class person
- *Dietary habit*—Normal diet

- *Family history*—No member of the family had undergone any surgical procedure.

History of treatment—Not taken treatment anywhere.

Social and family history—Family is supporting. There is one wife and two children in the family.

Psychological status—Patient is in anxiety and mentally upset.

Objective Examination

It is again divided into two headings:
1. Observation
2. Examination

Observation

General appearance of the unaffected side:
1. **Temperature**—Normal
2. **Skin condition**—Normal
3. **Sensation**—Normal

Assessment of the stump:
- **Shape of the stump**—Conical
- **Swelling**—No swelling
- **Any bleeding** of the sutured part—No
- **Texture of the skin** (for any scar or lesion)—Normal
- **Moisture of the skin** (is it scaly or dry)—Normal

- **Sensation of the skin** (absent or present)—Normal
- **Dermatology** of the skin—Normal
- **Temperature** of the stump—Normal
- **Bandaging**—Proper bandaging

Examination

Active movement, passive movement, resistive movements are performed to evaluate the strength of the muscles left. Also functional assessment is done (Fig. 12.2).

Fig. 12.2: Examination of unilaterally limb amputated patient in ward

Manual Muscle Testing

Lower limb

	Right side	*Left side*
Hip flexion	Grade 4+	Grade 2
Hip extension	Grade 4+	Grade 2
Hip abduction	Grade 4+	Grade 2
Hip adduction	Grade 4+	Grade 2
Hip rotation	Grade 4+	Grade 2
Knee flexion	Grade 4	amputated
Knee extension	Grade 4	amputated
Ankle dorsiflexion	Grade 4+	amputated
Ankle plantar flexion	Grade 4+	amputated

Upper Limb

	Right side	*Left side*
Shoulder flexion	Grade 4+	Grade 3+
Shoulder extension	Grade 4+	Grade 3+
Shoulder abduction	Grade 4+	Grade 3+
Shoulder adduction	Grade 4+	Grade 3+
Shoulder rotation	Grade 4+	Grade 3+
Elbow flexion	Grade 4+	Grade 4
Elbow extension	Grade 4+	Grade 4
Wrist dosiflexion	Grade 4+	Grade 4+
Wrist plantar flexion	Grade 4+	Grade 4+
Ulnar deviation	Grade 4+	Grade 4+
Radial deviation	Grade 4+	Grade 4+

Range of Motion

Lower Limb

	Right side	*Left side*
Hip flexion	0-120°	0-100°
Hip extension	0-20°	0-15°
Hip abduction	0-40°	0-30°
Hip adduction	0-15°	0-10°
Hip rotation	0-45°	0-20°
Knee flexion	0-135°	amputated
Knee extension	135-0°	amputated
Ankle dorsiflexion	0-35°	amputated
Ankle plantarflexion	0-40°	amputated

Upper Limb

	Right side	*Left side*
Shoulder flexion	0-170°	0-170°
Shoulder extension	0-45°	0-45°
Shoulder abduction	0-170°	0-170°
Shoulder adduction	170-0°	170-0°
Shoulder rotation	0-90°	0-90°
Elbow flexion	0-140°	0-140°
Elbow extension	140-0°	140-0°
Wrist dorsiflexion	0-65°	0-65°
Wrist plantarflexion	0-70°	0-70°
Ulnar deviation	0-25°	0-25°
Radial deviation	0-30°	0-30°

Deep Tendon Reflexes

Bicep reflex—Normal
Triceps reflex—Normal
Quadriceps reflex (of unaffected side)—Normal
Knee jerk (of unaffected side)—Normal
Tendo-achilles reflex (of unaffected side)—Normal

Pathological Reflexes

Babinki's sign—Absent
Clonus—Absent
Pendular movement—Absent

After full assessment of the patient the physiotherapy treatment was given as mentioned above. Patient was also advised for the application of above knee prosthesis (Fig. 12.3).

Fig. 12.3: Patient receives physiotherapy in ward

CASE 2

Another was a case of bilateral amputation. It was also the case of road-traffic accident, hence in this case also the preoperative phase was absent and the patient was shifted to emergency theatre for amputation surgery.

Fig. 12.4: Bilaterally limb amputated patient in postoperative ward

Subjective Examination

Name of the patient—Hari Kishan
Age—21 years
Sex—Male
Address—Kalanpur, Kanpur.
Hospital—Hallet
Ward no.—4

Bed no.—18

Occupation—Student

Marital status—Unmarried

History of any past surgical intervention—No history of any past surgical operation.

History of past illness—No history of diabetes, hypertension or tuberculosis.

History of present illness

- *Cause of surgery*—Trauma (road-traffic accident)
- *Location*—Above knee bilaterally
- *Nature*—The skin at the site of injury was lacerating at the time injury
- *Behavior of pain*—Very painful

Personal history

- *Habit*—No such habit (alcohol intake or cigarette smoking)
- *Social status of the patient*—middle class person
- *Dietary habit*—normal diet
- *Family history*—No member of the family had undergone any surgical procedure

History of treatment—Not taken treatment anywhere.

Social and family history—Family is supporting. There is father, mother and two brothers.

Psychological status—Patient is in anxiety and mentally upset.

Objective Examination

It is again divided into two headings:
1. Observation
2. Examination.

Observation

General appearance of both the stumps:
- **Shape of the stump**—Conical
- **Swelling**—No swelling
- **Any bleeding** of the sutured part—Yes
- **Texture of the skin** (for any scar or lesion)—Normal
- **Moisture** of the skin (is it scaly or dry)—Normal
- **Sensation** of the skin (absent or present)—Normal
- **Dermatology** of the skin—Normal
- **Temperature** of the stump—Normal
- **Bandaging**—Proper bandaging

Examination

Active movement,passive movement, resistive movement are performed to evaluate the strength of the muscles left. Also functional assessment is done.

Manual Muscle Testing

Lower Limb

	Right side	*Left side*
Hip flexion	Grade 3	Grade 3

Hip extension	Grade 3	Grade 3
Hip abduction	Grade 3	Grade 3
Hip adduction	Grade 3	Grade 3
Hip rotation	Grade 3	Grade 3

Upper Limb

	Right side	*Left side*
Shoulder flexion	Grade 4+	Grade 3+
Shoulder extension	Grade 4+	Grade 3+
Shoulder abduction	Grade 4+	Grade 3+
Shoulder adduction	Grade 4+	Grade 3+
Shoulder rotation	Grade 4+	Grade 3+
Elbow flexion	Grade 4+	Grade 4
Elbow extension	Grade 4+	Grade 4
Wrist dosiflexion	Grade 4+	Grade 4+
Wrist plantarflexion	Grade 4+	Grade 4+
Ulnar deviation	Grade 4+	Grade 4+
Radial deviation	Grade 4+	Grade 4+

Range of Motion

Lower Limb

	Right side	*Left side*
Hip flexion	0-100°	0-100°
Hip extension	0- 20°	0-20°
Hip abduction	0- 40°	0-40°
Hip adduction	0- 15°	0-15°
Hip rotation	0- 40°	0-40°

Upper Limb

	Right side	*Left side*
Shoulder flexion	0-120°	0-120°
Shoulder extension	0-45°	0-45°
Shoulder abduction	0-170°	0-170°
Shoulder adduction	170-0°	170-0°
Shoulder rotation	0-70°	0-70°
Elbow flexion	0-150°	0-150°
Elbow extension	150-0°	150-0°
Wrist dosiflexion	0-80°	0-80°
Wrist plantarflexion	0-70°	0-70°
Ulnar deviation	0-25°	0-25°
Radial deviation	0-30°	0-30°

Deep Tendon Reflexes

Bicep reflex—normal
Tricep reflex—normal

After full assessment of the patient the physiotherapy treatment was given as mentioned above (Fig. 12.5). Patient was also advised for the wheelchair application as in his case ambulation is the main problem. The therapist should emphasis in strengthening of upper limb muscles as this would now be more functional.

Fig. 12.5: Patient needs physiotherapy

CONCLUSION

Hereby we conclude that the application of proper physiotherapy management both preoperatively and postoperatively helps in managing this devastating event. Preoperative management emphasis on the proper chest physiotherapy, strengthening programs and psychological reassurance of the patient. Whereas postoperative management emphasis on the preventing complications like muscle contractures, DVT, etc. proper management with prosthesis and making the patient functional and ambulatory.

The main area of management which is very difficult to be dealt with is the psychological aspect. Usually the patients go into depression and it becomes very difficult for the therapist to deal

with such patients. Sometimes the patient becomes so depressed that they don't want to even live without the amputated part. Dealing with such patient is a difficult task for the therapist. But it becomes the duty of the therapist to treat such patient with patience and make them an independent member of the society.

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