Rehabilitation of Adults With Upper-Limb Amputations

Amputation and Limb Prostheses

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Prosthesis

- **A prosthesis is a device that is designed to replace, as much as possible, the function or appearance of a missing limb or body part.**
- **It is a device that is designed to support, supplement, or augment the function of an existing limb or body part.**

Purpose

- A prosthesis is used to provide an individual who has an amputated limb with the opportunity to perform functional tasks, particularly ambulation (walking), which may not be possible without the limb.
- The prosthesis may also be made for use during activities or sports, such as dancing, swimming, cycling, golfing, and climbing.
- The type of prosthesis (artificial limb) used is determined largely by the extent of an amputation or loss and location of the missing extremity.

Amputation levels

- Transphalangeal amputation
- Transmetacarpal amputation
- Transcarpal amputation
- Wrist disarticulation
- Transradial amputation
- Elbow disarticulation
- Transhumeral amputation
- Shoulder disarticulation
- Interscapulothoracic disarticulation

Characteristics of a successful prosthesis:

- comfortable to wear,
- Easy to put on and remove,
- Lightweight,
- Durable, and cosmetically pleasing.
- Mechanical function should be well

Considerations when choosing a prosthesis:

- Amputation level.
- Contour of the residual limb.
- Expected function
- Cognitive function of the patient.
- profession of the patient (eg, desk job vs manual labor).
- Cosmetic importance of the prosthesis .
- Financial resources of the patient.

Most common reasons for an upper extremity amputation

- **Correction or Tumor** aged 0-15 years.
- **Trauma or tumor** is the most common reason for amputation in patients aged 15-45 years,

Problems may occur when using prosthesis are:

- The poor fitting , unequal weight load to lower limbs,.. extra stress or pressure on the other (unaffected) leg, or on the stump.
- The increased pressure…pain and skin problems….another amputation necessary.
- Walking takes extra energy.
- The stump checked every day for redness, blisters, soreness, or swelling.

Prostheses (Artificial limbs) are typically manufactured using the following steps:

Measurement of the stump.

- Measurement of the body to determine the size required for the artificial limb.
- Creation of a model of the stump.
- Formation of thermo-plastic sheet around the model of the stump – This is then used to test the fit of the prosthetic.
- Formation of permanent socket.
- Formation of plastic parts of the artificial limb –
- Different methods are used, including vacuum forming and injection molding.
- Creation of metal parts of the artificial limb
- Assembly of entire limb.

Prostheses are either preparatory (temporary) or definitive (permanent).

- **temporary prosthesis** is fitted while the residual limb is still maturing. A preparatory prosthesis allows the patient to train with the prosthesis several months earlier.

- used to mold the residual limb into the desired shape.

The advantage to using a temporary prosthesis:

- It shrinks the residual limb more effectively than the elastic wrap.
- It allows early bipedal ambulation.
- Certain individuals can return to work.
- It is a positively motivating.
- It reduces the need for complex exercise program.

TYPES OF PROSTHESIS
Functional prostheses generally divided into 2 categories

- ***Body-powered prostheses*** - Cable controlled
- ***Externally powered prostheses*** - Electrically powered .
  - **Myo-electric prostheses**
  - **Switch-controlled prostheses**

Body-powered prostheses

Body powered oprosthesis work by using of cables to link the movement of the body to the prosthesis and to control it.

Body-powered prostheses

- Body-powered prostheses usually are of moderate cost and weight.
- They are the most durable prostheses and have higher sensory feedback.
- cosmetically ……more gross limb movement.

Body Powered functional U.L. Prosthesis:
Terminal device, Wrist unit, operating cord, suspension loop

Externally powered prostheses

- powered by electric motors may provide more proximal function and greater grip strength, along with improved cosmetics, but they can be heavy and expensive.
- Patient-controlled batteries and motors are used to operate these prostheses.
- less sensory feedback and more maintenance than do body-powered prostheses.
- Externally powered prostheses require a control system.

Electric control systems:

A battery operated motor , moves the hand and/or gripper, wrist or elbow by either:

- **Myo-electric control.**
- **Servo control.**
- **Switch control.**

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1- Myo-electric control

- Electrodes pick up microvolts of electricity produced by contractions in the muscles of the residual limb.

- Signals are amplified and then activate the motor.

- In operating hand there may be 2 electrodes; one on extensor muscles and one of flexor muscles groups for opening & closing the hand respectively.

- Alternatively a single site placement for voluntary opening & automatic closing can be used.

- **Wrist** movement can be controlled myo-electrically using 2 site system.

- An electric elbow lock can be activated be a single site placement

. body-powered, upper extremity prostheses have the following components

- **Socket**
- **Suspension**
- **Control-cable system**
- **Terminal device (hooked or hand)**
- **wrist unit**

Socket

- dual-wall design fabricated from lightweight plastic or graphite composite materials.
- Inner socket fabricated.. from flexible plastic materials to provide appropriate contact and fit
- Outer wall designed to be the same length and contour as the opposite sound limb and made from a rigid frame for structural support and for attaching the necessary cables and joints as needed.

Suspension

- The suspension system must hold the prosthesis securely to the residual limb, as well distribute the forces associated with the weight of the prosthesis and any superimposed lifting loads.

Control-cable mechanisms

- **Control-cable mechanisms**
- Body-powered prosthetic limbs use cables to link movements b/w part of the body to the prosthesis in order to control a prosthetic function.

TERMINAL DEVICE

- The major function of the hand is grip
- The 5 different types of grips are as follows
- ***Precision grip***
- ***Tripod grip***
- Lateral grip
- ***Hook power grip***
- ***Spherical grip***

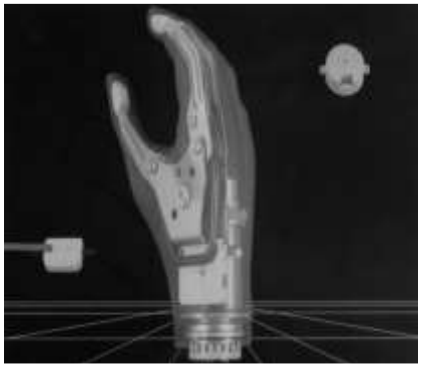
Terminal devices generally are broken down into 2 categories: passive and active.

- **Passive terminal devices**
- Passive terminal devices fall into two classes,
- **designed** for function and those to provide cosmesis.
- E.g..functional passive terminal devices include the **child mitt** frequently used on an infant's first prosthesis to facilitate crawling or
- **Ball handling terminal devices** used by older children and adults for ball sports.
- **Advantage & disadvantage….**

Terminal devices generally are broken down into 2 categories: passive and active.

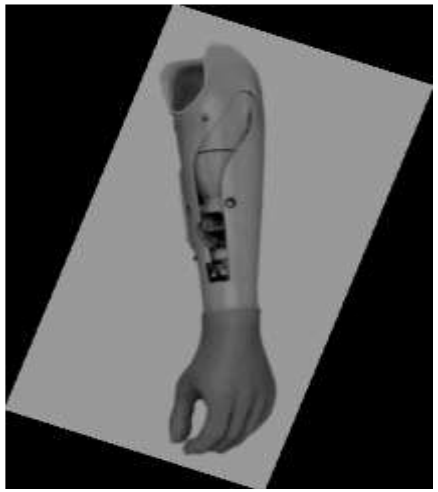
- **Active terminal devices**
- Active terminal devices usually are more functional than cosmetic;

- however, in the near future, active devices that are equally cosmetic and functional may be available.



COSMETIC

FUNCTIONAL CABLE-ACTIVATED TERMINAL DEVICES



MYOELECTRICALLY CONTROLLED

Prosthetic Joints

Wrist unit: •

A cylindrical wrist unit either hand or electrically operated to provide 360° rotation, allow positioning of the terminal device in adequate supination/ pronation range for the required task.

Elbow joint: •

Several forms….

Hand operated joints are commonly used with cosmetic prosthesis.

In addition, body powered elbow joints used

They are operated using operating and elbow lock cords.

Operating cord operates the terminal device when the elbow is locked, while with elbow unlocked it operates the elbow joint.

Rehabilitation of lower limb amputee

What is an Amputation?

Amputation: the surgical removal of a part of the body, a limb or part of a limb

Causative Factors of Amputations

Peripheral arterial disease ❖

Diabetes Mellitus ❖

Gangrene (du to the complication & plaster cast)

Trauma (crushing, frost bite, burns) ❖

Congenital deformities ❖

Chronic Osteomyelitis ❖

Malignant Tumor ❖

Psychological consequences of apmutation

Depression and anxiety

Severe isolation

Violent behaviour

Suicidal ideation

Loss of sense of wholeness

Diabetes

Complications of diabetes that contribute to the increased risk of foot infection include:

1. Neuropathy
   a. Sensory
   b. Autonomic
   c. Motor
2. Peripheral vascular disease
3. Immuno-compromise

High Risk Characteristics for Developing Foot Infections

Duration of diabetes more than 10 years ❖

Age > 40 years ❖

History of smoking ❖

Decreased peripheral pulses ❖

Decreased sensation ❖

History of previous foot ulcers or amputation ❖

Proper Foot Care for Diabetics

Check your sound foot and residual limb for sores, cuts, blisters or other problems every day.
Check your shoes for pebbles and foreign objects.
Wash your foot in warm, not hot, water.
Dry it well, especially between the toes.
Trim toenails straight across.
Protect your foot from extreme hot or cold. If you are cold at night, wear socks.
Never use heating pads or hot water to warm your foot/feet.
Never go barefoot. Wear slippers or socks inside the house.

Pre-operative Assessment

Neurovascular and functional status of extremity .

Function and Condition of residual limb (in case of traumatic amputation)

Circulatory status and function of unaffected limb

Signs & Symptoms of infection (culture required)

Nutritional Status

Concurrent medical problems

Current medications

Psychological Support Preparation

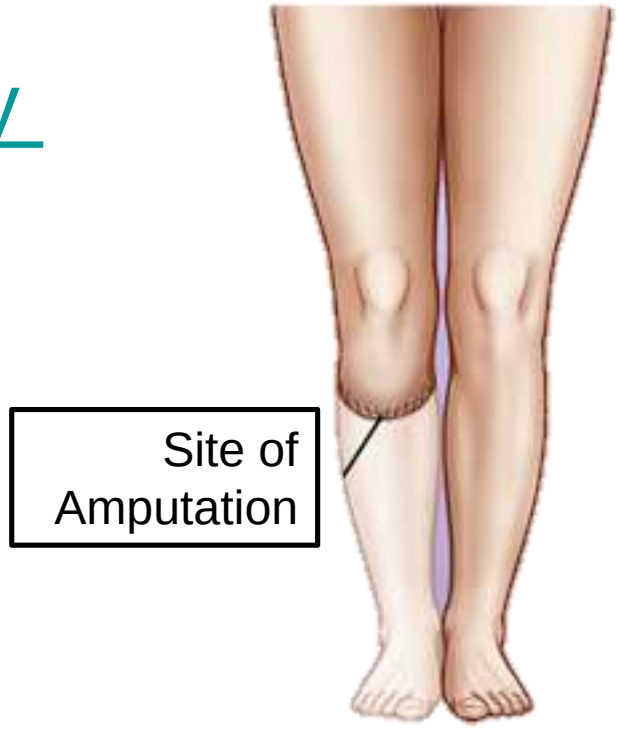
Emotional reaction to amputation

Circumstances surrounding amputation

Occupational and social Rehabilitation

Primary Amputation

Above the Knee Primary Amputation



Above the Knee

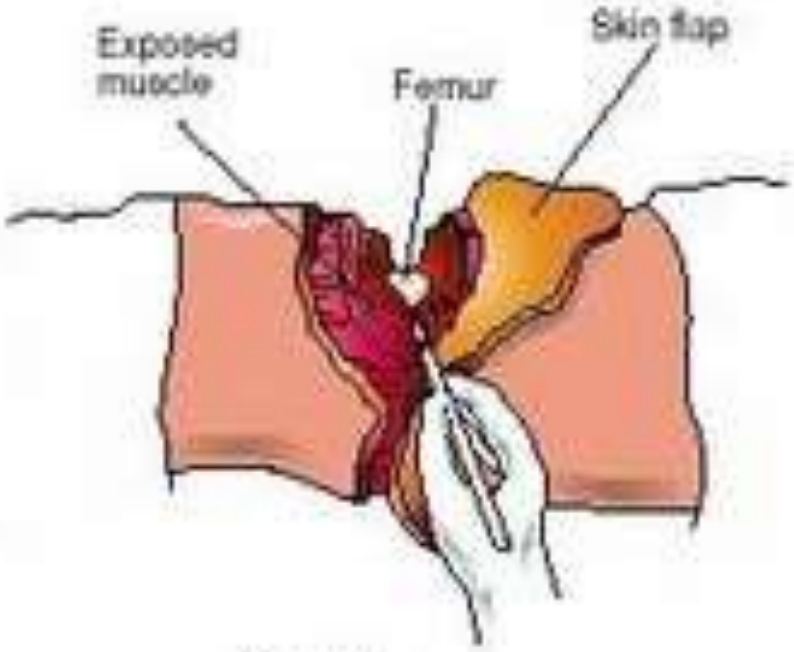


Figure A

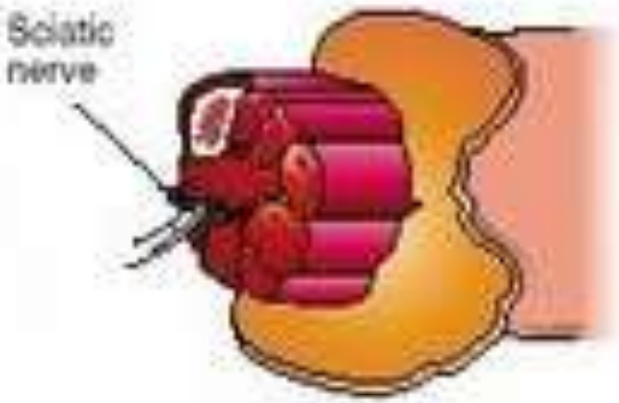


Figure B

Figure C

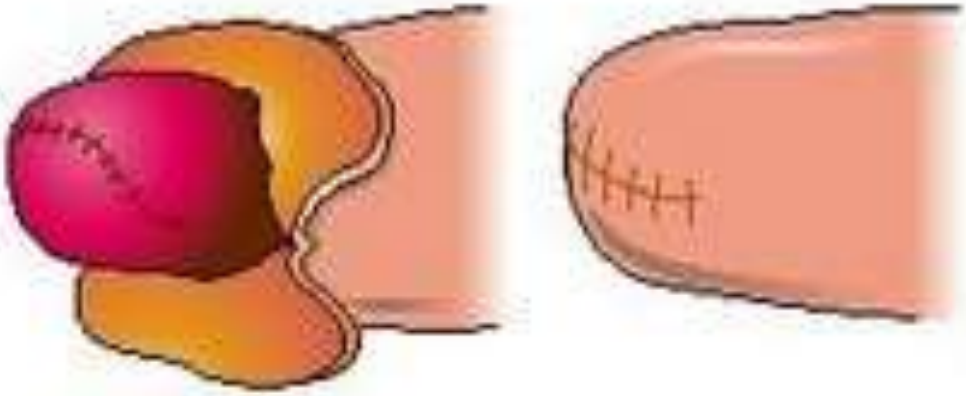


Figure D

Post- Operative Interventions

Monitor for complications

Pain management

Education & support

Promote mobility/ independent self-care

Enhancing Body Image

Promote wound healing

Skin Care & Stump Hygiene

Wash at night,,..fragrance free soap or antiseptic cleaner

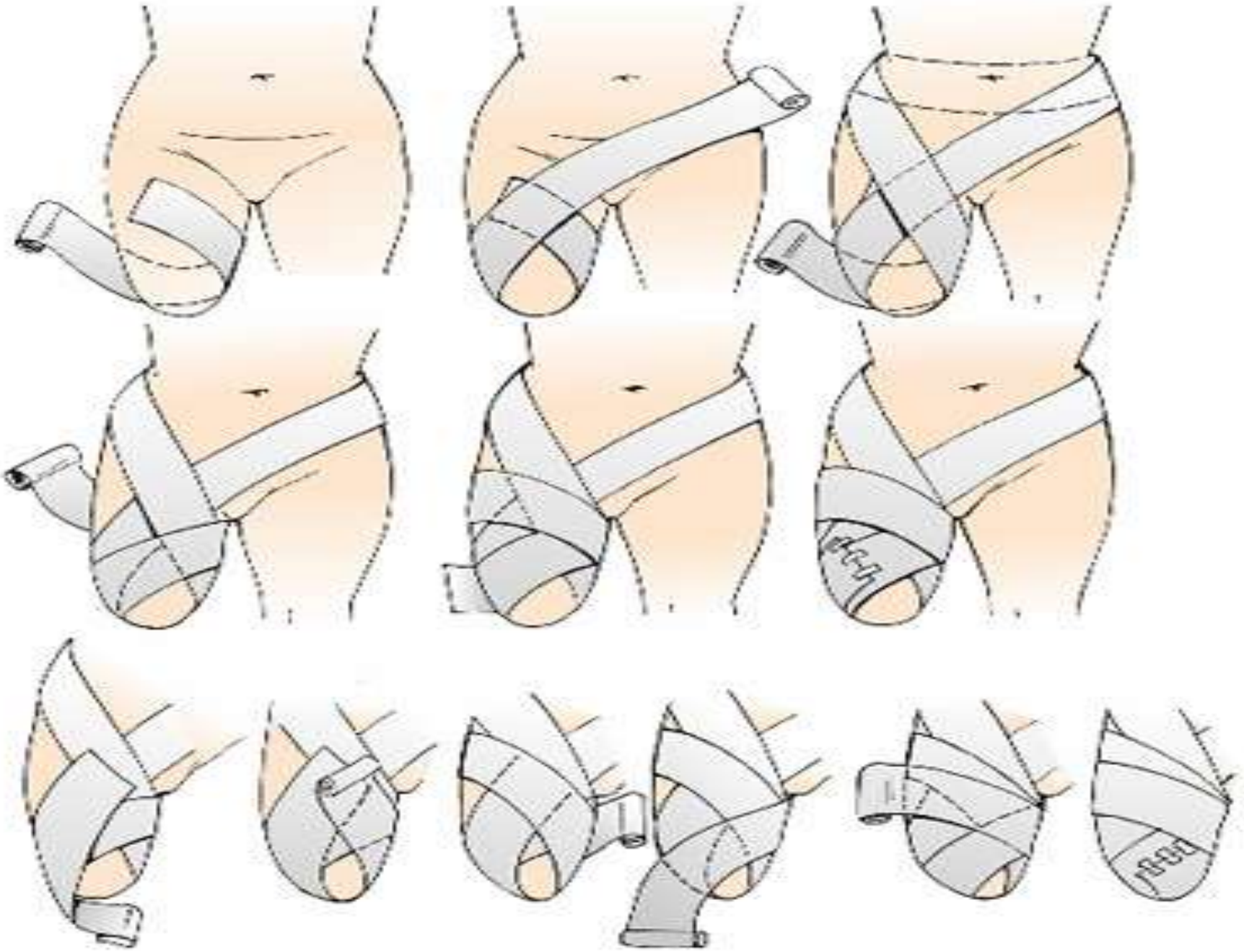
Rinse well

Dry thoroughly

General wound care

"Figure of 8" Method to Wrap your Residual Limb

Figure of 8 Method to Wrap your Residual Limb



Surgical Complications

- Hemorrhage
- Infection

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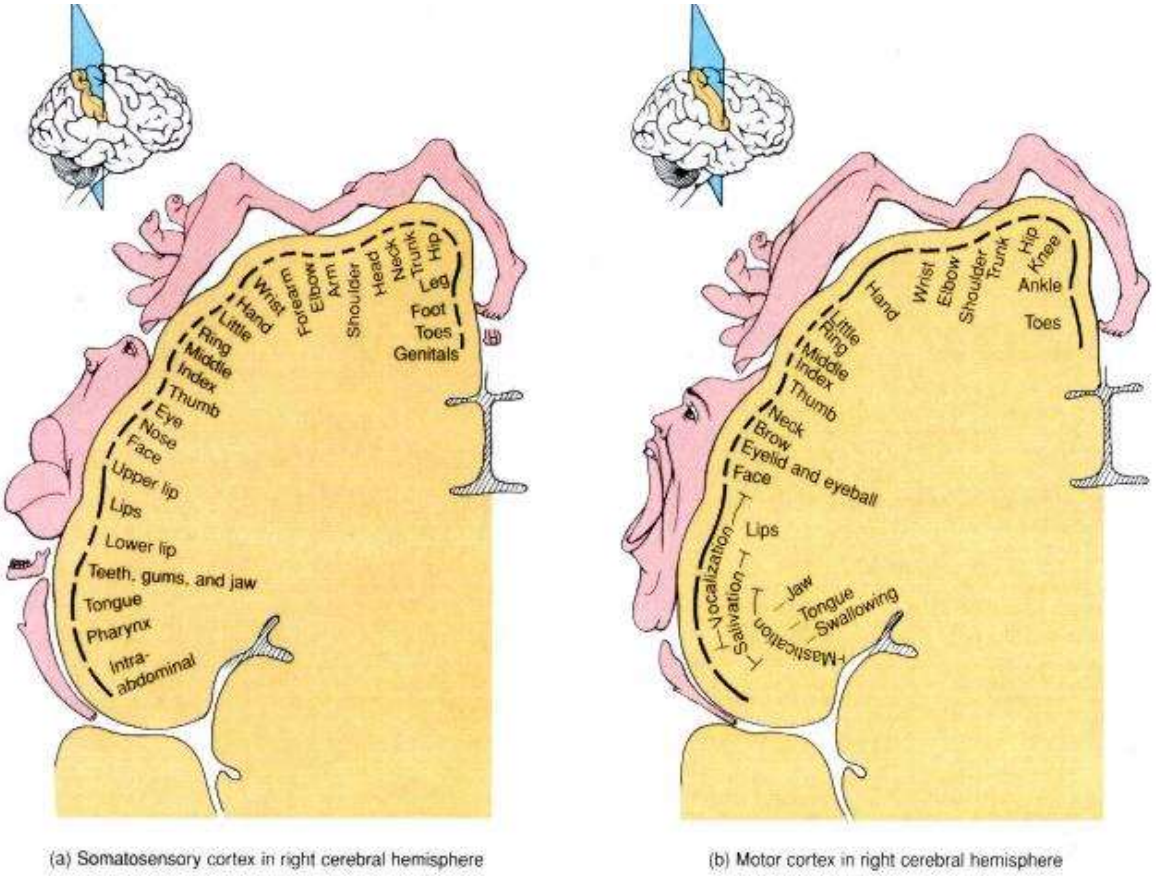
Complication of Amputations

- Joint contractures
- Energy issues
- Phantom limb pain
- Bony growth
- Skin Breakdown

Blistering

Necrosis

Phantom Limb Pain



(a) Somatosensory cortex in right cerebral hemisphere

(b) Motor cortex in right cerebral hemisphere

What is PLP?❖

The somatosensory homonculus❖

Phantom Limb Pain: Coping Techniques

- Acupuncture❖
- Anaesthetics❖
- Chiropractic
- Cold❖
- Desensitization❖
- Dietary and Herbal ❖ Supplements
- Electrical Stimulation❖
- Exercise❖
- Heat❖
- Magnetic Therapy❖
- Massage❖
- Medications❖
- Psychotherapy❖
- Wearing Your Artificial ❖ Limb

PROSTHETICS
LOWER EXTREMITY

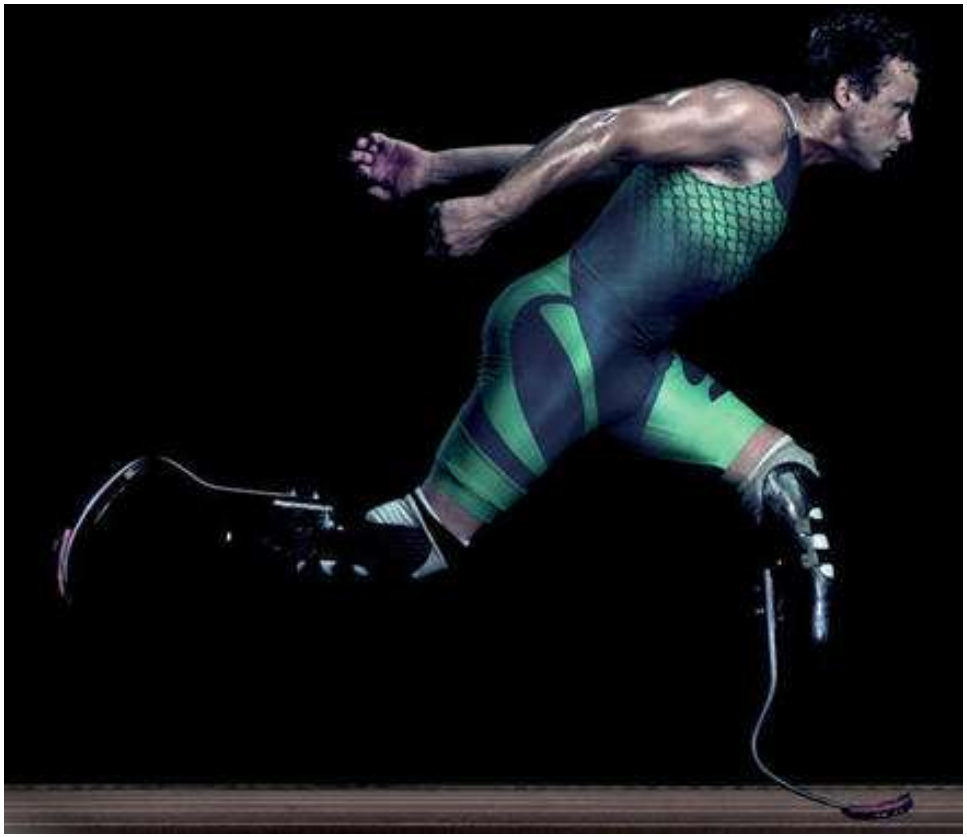
BELOW KNEE

KNEE
DISARTICULATION

ABOVE KNEE

HIP
DISARTICULATION

Prosthetics



Rehabilitation

There are 5 Stages of Rehabilitation:

Healing and Starting Physiotherapy .1

Visiting the Prosthetist .2

Choosing an Artificial Limb .3

Learning to Use your Artificial Limb .4

Life as a New Amputee .5

Rehabilitation of lower limb amputee :

Therapy plays an integral role in preparing a patient for a lower-extremity orthotic or prosthetic device and training them with that device once it has been fabricated.

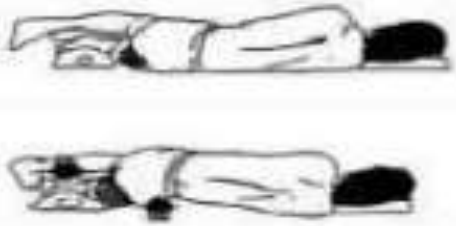
Once a patient receives a prosthetic or orthotic device, the therapist is then responsible for evaluating that patient with their device

Exercise After Amputation

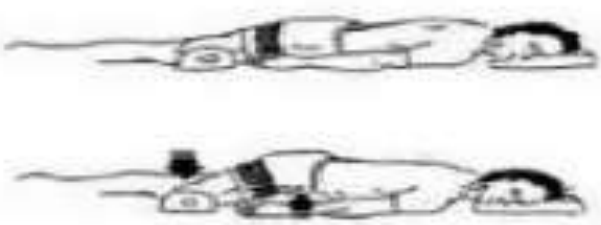
- ROM to prevent flexion contractures, particularly of the hip and knee
- Trapeze and overhead frame
- Firm mattress
- Prone position every 3 to 4 hours
- Elevation of lower-leg residual limb

Prosthetic rehabilitation program exercise

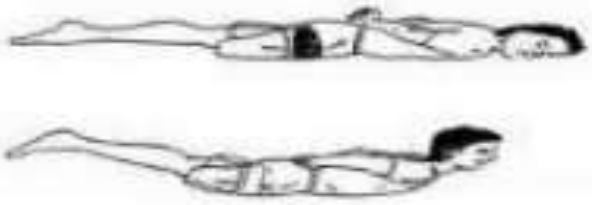
1. HIP EXTENSION



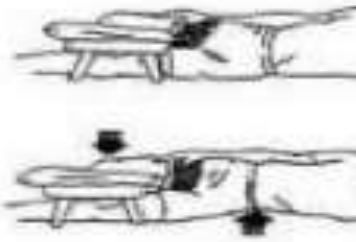
2. HIP ABDUCTION



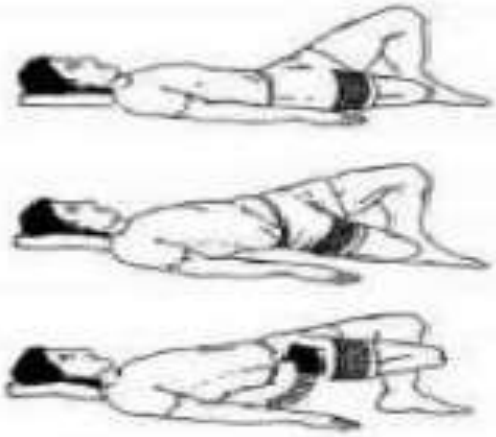
3. HIP FLEXION



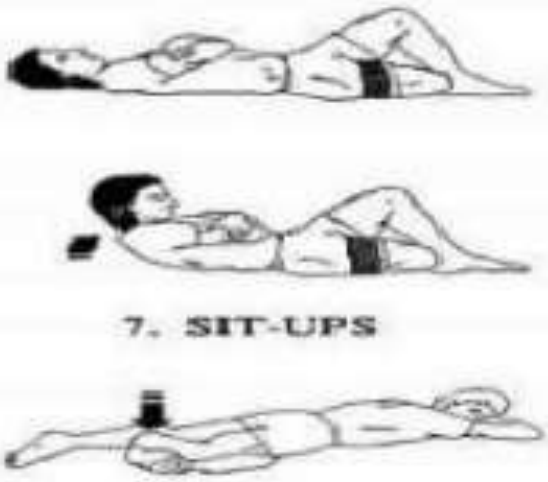
4. BACK EXTENSION



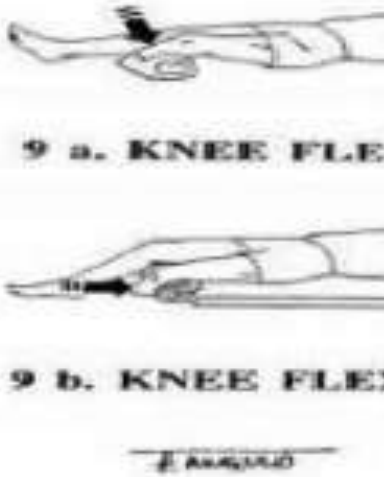
5. HIP ADDUCT



6. BRIDGING



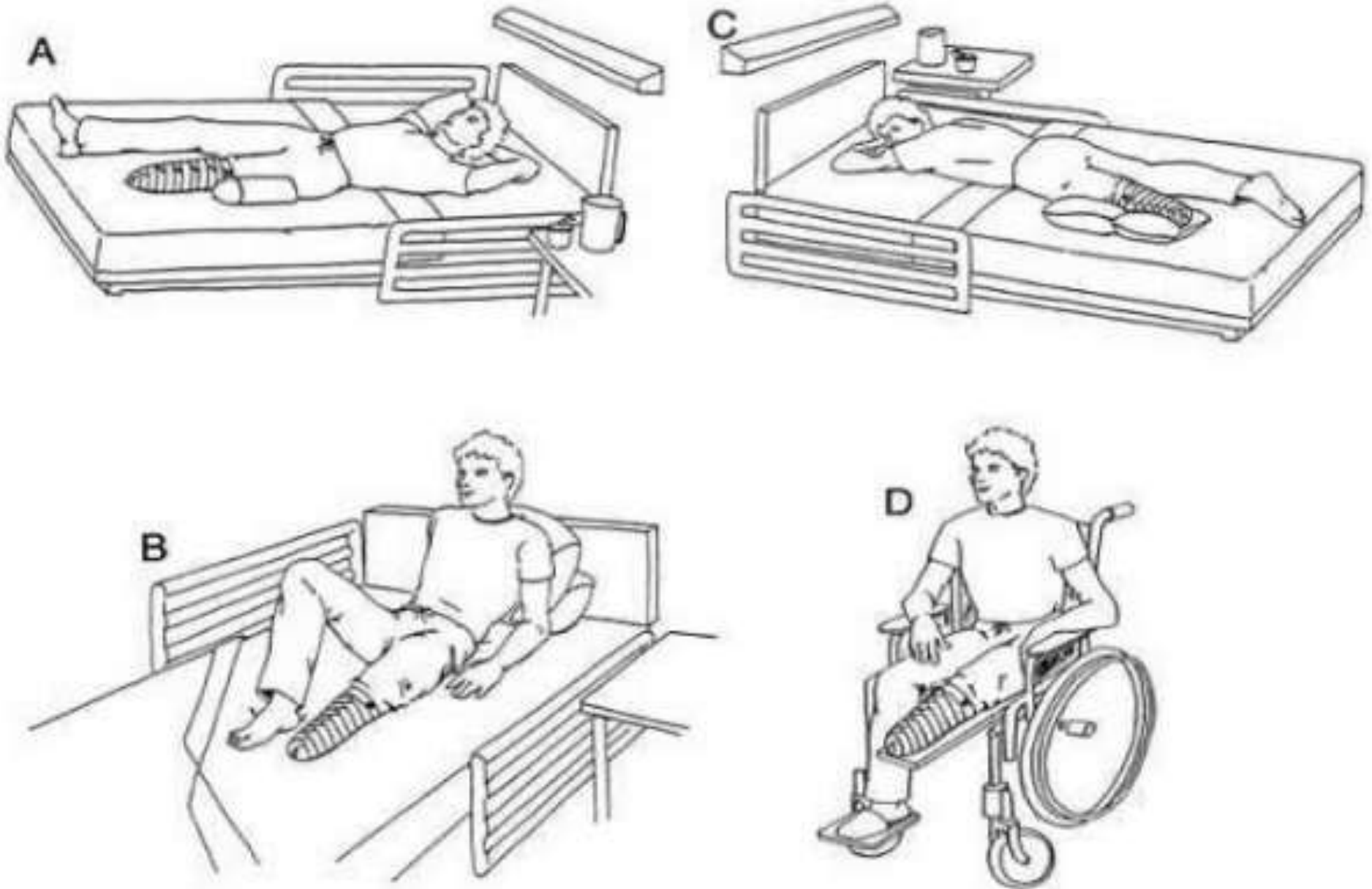
7. SIT-UPS



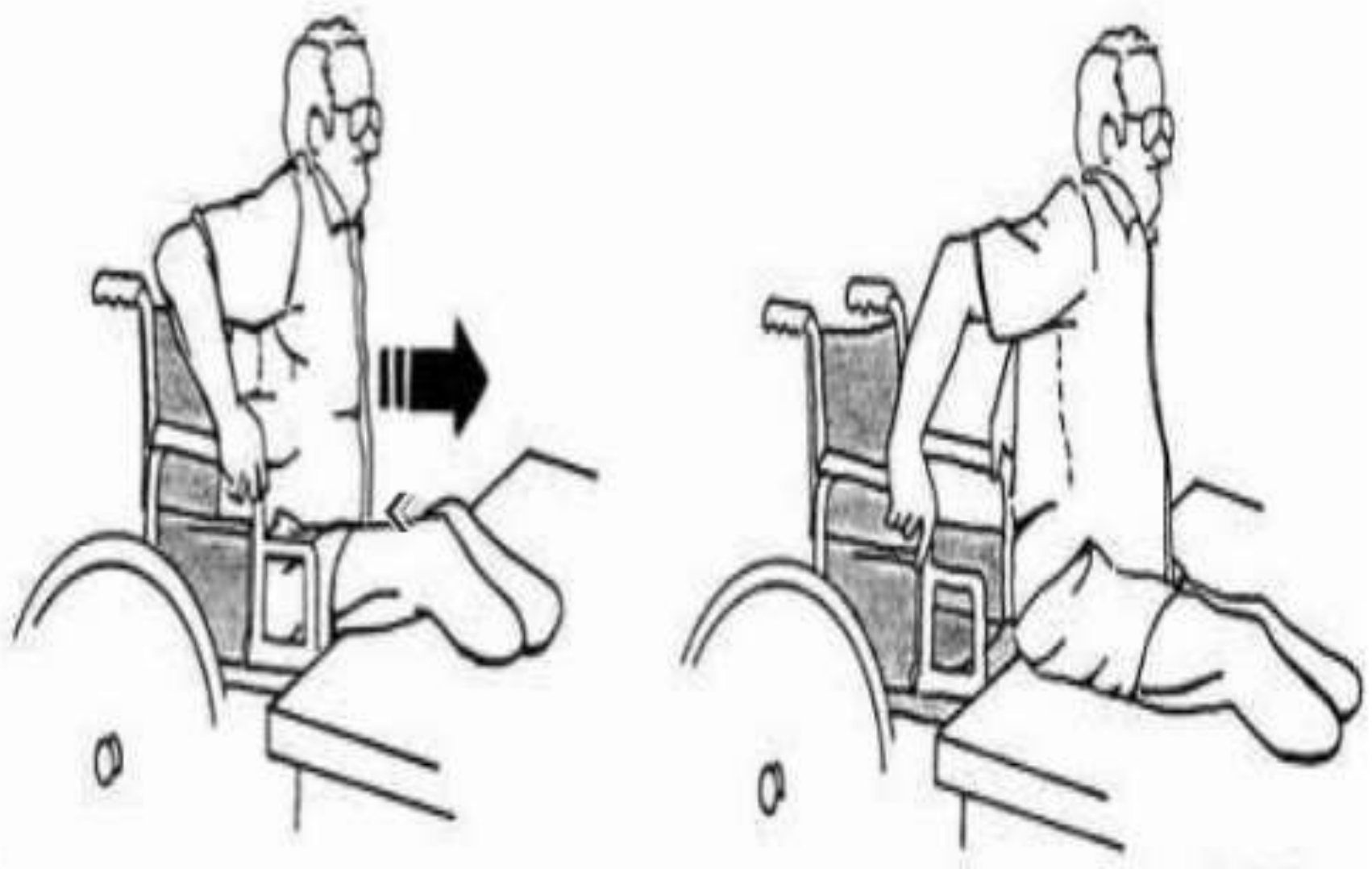
9 a. KNEE FLE

9 b. KNEE FLE

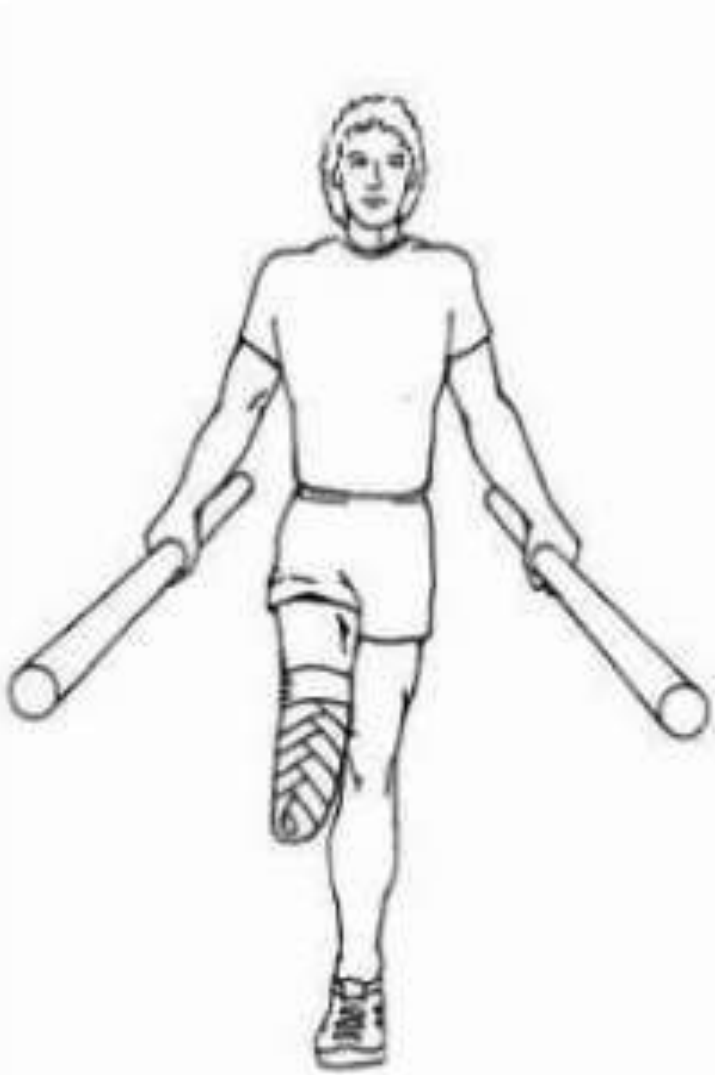
Proper residual-limb positioning



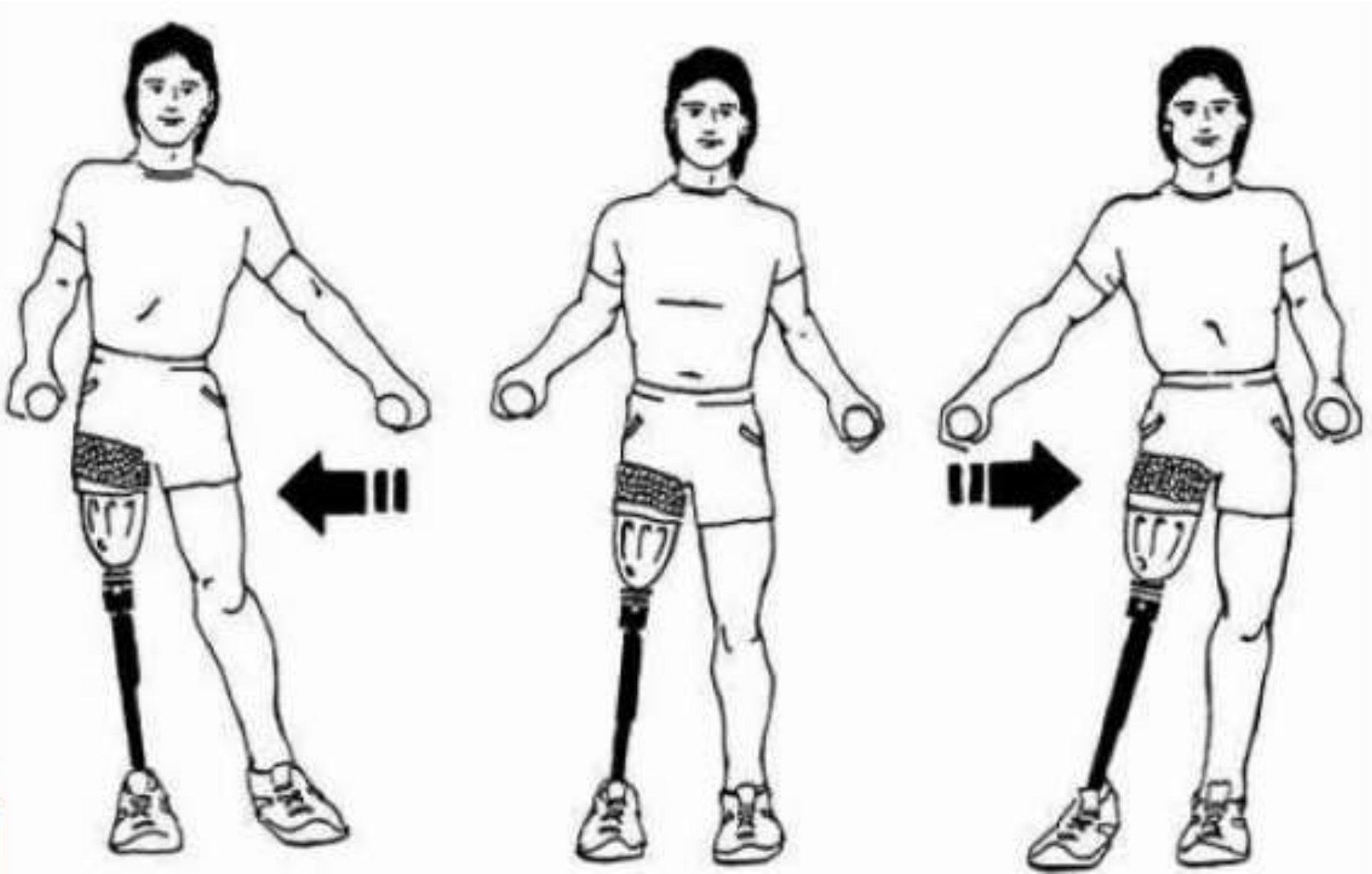
Head-on wheelchair-to-mat transfer



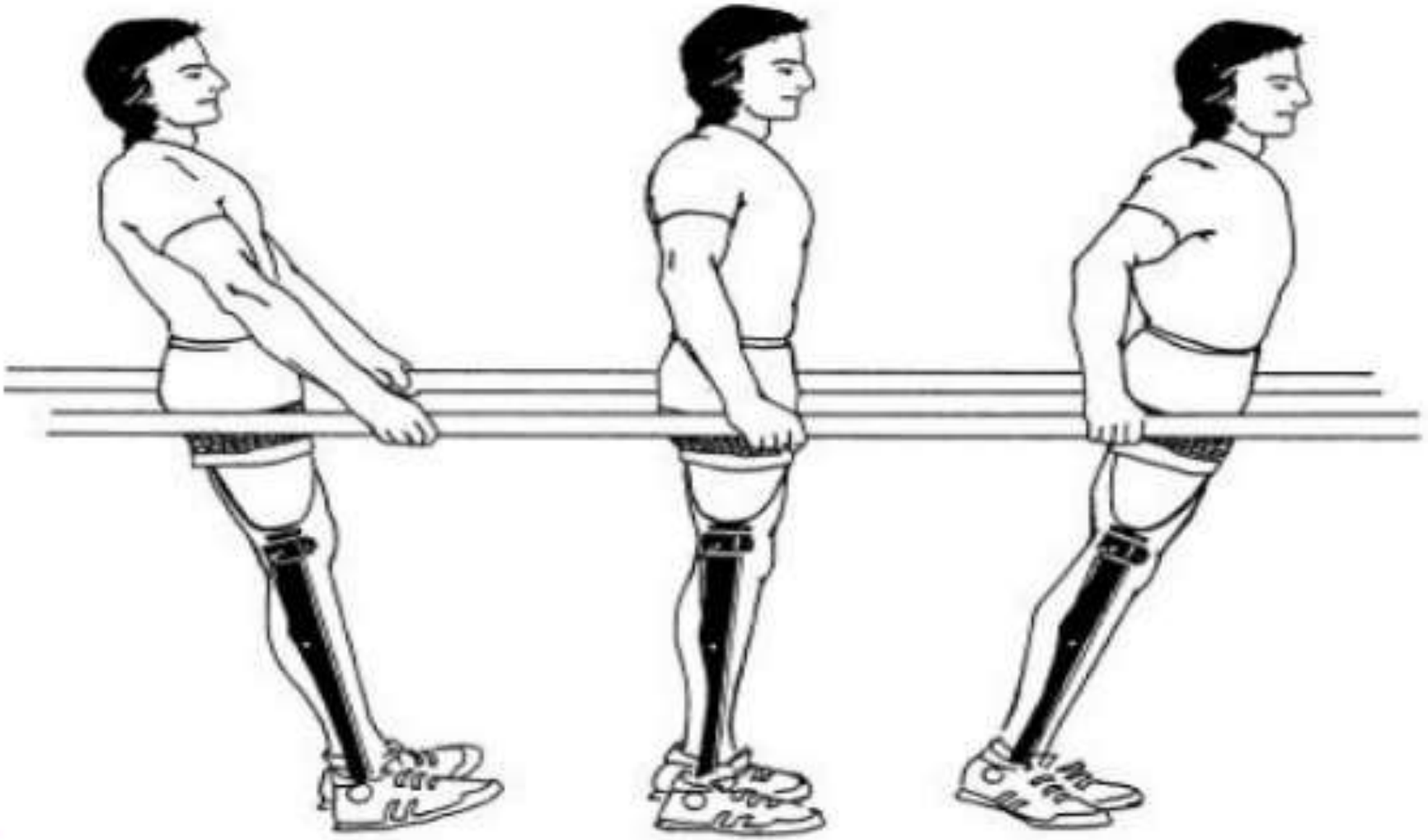
Balancing activities



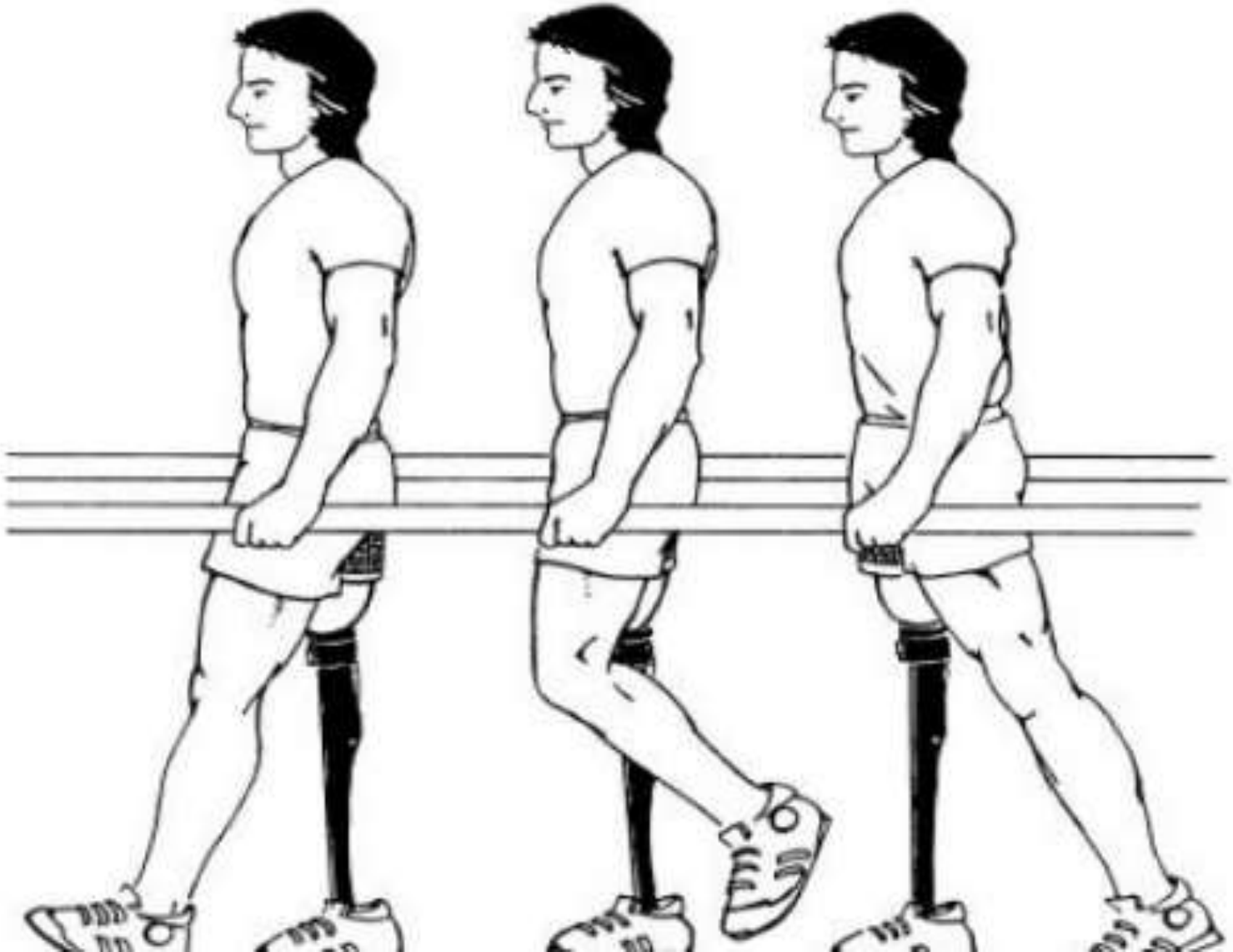
Lateral weight-shifting and balance orientation



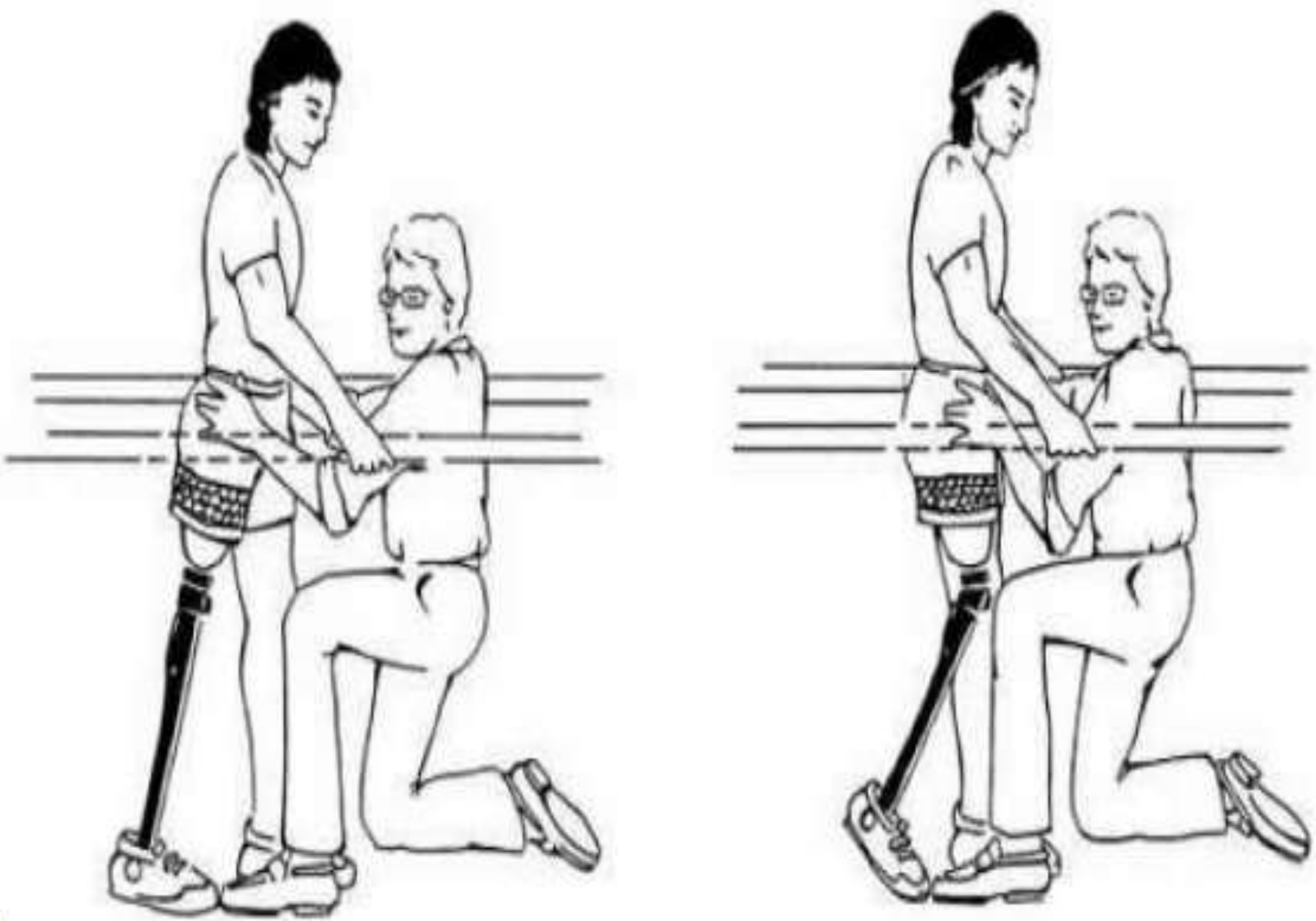
orientation



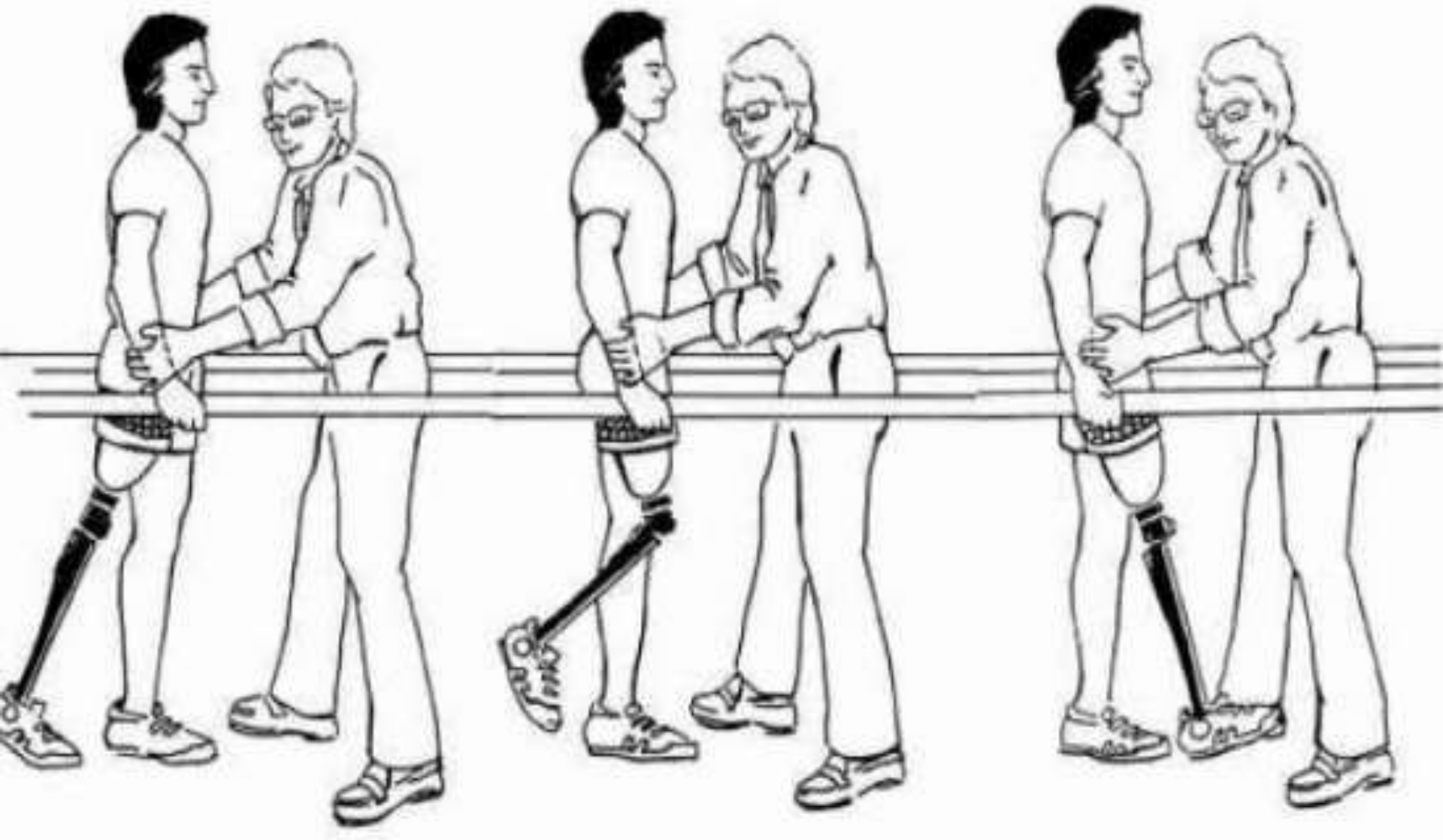
Sound-leg stepping is designed to orient the amputee to gait biomechanics



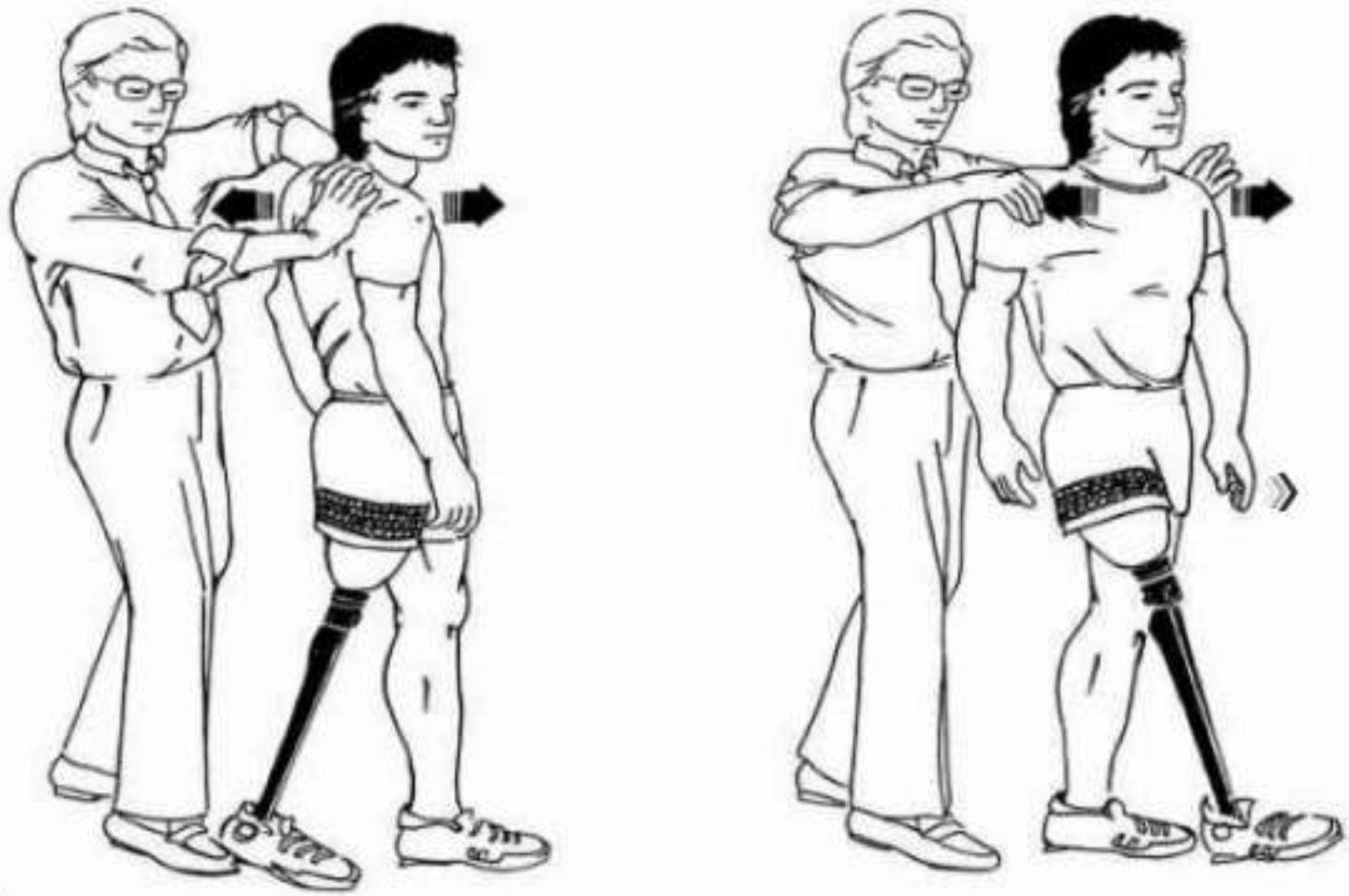
Rhythmic initiation designed to prohibit transverse rotation of the pelvis



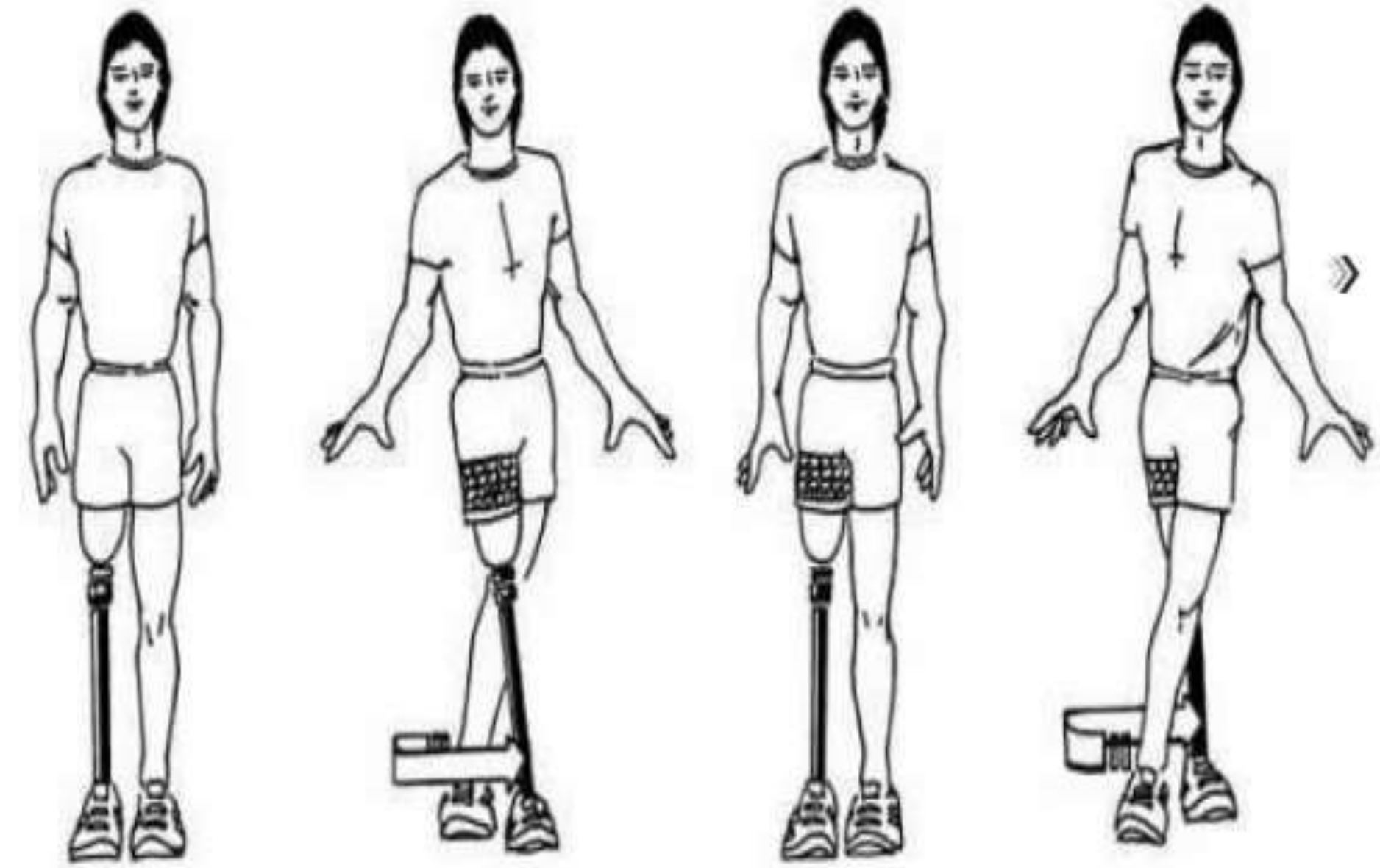
Resistive gait techniques



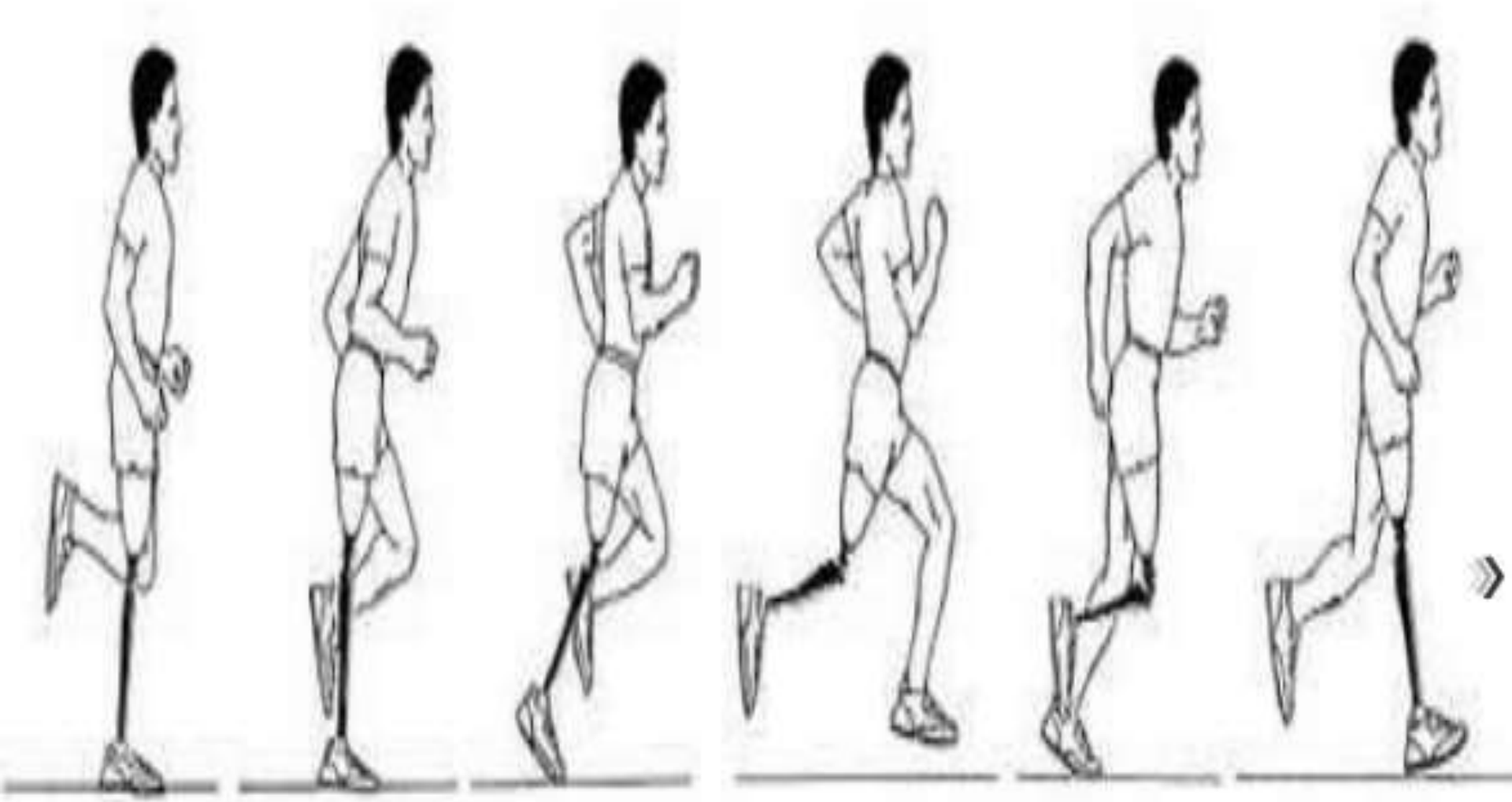
Passive trunk rotation will assist in restoring arm swing for improved balance



Braiding is an exercise designed to improve prosthetic control, balance, and coordination



Transfemoral amputee running gait cycle



Weight bearing activity

Mat exercises

Lower Limb Prosthesis

I- Immediate post- operative prosthesis

- Used for young patients, usually after a traumatic injury.

- Consists of rigid dressing (formed of plaster or fiber glass padded with felt, cotton, or poly urethane), pylon, and foot.

- Pylon is usually made of aluminum, steel or plastic.

- It helps patient to gain psychological support, early walking (with assistive device 5-12 days post operative) leads to less hospital stay, and reduce phantom pain.

- Disadvantages are the possibility of impaired healing & falls due to early ambulation.

Contraindication:

- History of slow wounds healing.
- Extreme obesity.
- Excessive preoperative edema.
- Lack of 45 days preoperative ambulation.

II – Temporary prostheses

- usually used for 3 to 6 month after amputation.
- It helps early weight bearing, and reduces edema.
- It consists of a socket, pylon, foot.
- It can be modified so that the foot in moved in medial, lateral, anterior, posterior inversion, eversion direction. These adjustments help to correct gait deviations, increase energy efficiency, and make walking more efficient.
- used in early stages of gait training.
- can be converted to definitive prosthesis with cosmetic modifications.

III- Definitive prosthesis

- It is used when limb volume becomes stable.
- It can be applied 3-9 months postoperative.
- Life span 3-5 years.
- Changes are needed when there is residual limb atrophy, weight gain or loss., and excessive wear after prosthesis.

Prosthetic foot

It should be: •

1- Providing stable base of support.

2- Shock absorption.

3- Joint & muscles stimulation.

4- Cosmetic appearance.