Rehabilitation in Neuropathies

Salekzamani Y. MD
Associate Professor
Department of Physical Medicine and Rehabilitation
Tabriz Medical Sciences University

Rehabilitation Strategies (modalities)

- Exercises
- Orthosis
- Ambulatory Assistive Devices
- Adaptive Equipment
- Environmental Modifications

Exercise

- Flexibility
- Resistance/ Strengthening
- Aerobic
- Balance

Flexibility Stretching

- Range-of-motion (ROM)
- Part of the standard of care for the prevention and management of contractures
- Might help to manage pain

Aerobic Exercises

- In healthy individuals, moderate intensity physical activity significantly improves overall health.
- Improving the outcomes of several chronic diseases, such as heart disease, stroke, and type 2 diabetes.
- American College of Sports Medicine (ACSM) declared that "Exercise is medicine" inviting physicians to write exercise prescriptions to promote physical activity and exercise as standard parts of disease prevention and medical treatment
- Aerobic exercise training, or cardiorespiratory fitness training:
- an activity that uses large muscle groups, that can be maintained continuously, and that is rhythmical and aerobic in nature such as walking, hiking, running, cycling, and swimming.
- Potential role in:
- – improving aerobic capacity
- – improving mood, quality of life, sleep, functional independence
- – preventing chronic diseases and maintaining bone density

Resistance /Strengthening Exercises

- Repeated muscle actions against resistance:
- Isometric:
- performed at a constant muscle length with no joint movement, as in wall squat hold and plank exercises
- Concentric:
- the muscle generates force while shortening, as when lifting a dumbbell towards the body
- Eccentric:
- the muscle generates force while lengthening, as when lowering a weight away from the body or landing back on the ground after jumping
- avoid eccentric
- For healthy adults, the ACSM recommends:
- at least one set of 8 to 12 repetitions per exercise
- about 10 exercises to condition all major muscle groups
- 2 to 3 days per week
- at loads of at least 45% to 50% of the one-repetition maximum (1RM) (which is the maximal load that can be lifted throughout the full ROM once).

Balance Training

- **Impaired balance due to:**
- - Sensory neuropathy
- - Muscle weakness

- Patients with balance problem are at risk for falls

General Exercise Recommendation

- the level of training and expected outcomes depend on:
- - the diagnosis, disease severity, and rate of progression
- With regards to safety, the consensus is to allow sub-maximum aerobic training (either structured exercise or as part of recreational activities) for most patients in order to avoid deconditioning which would compound the existing weakness.
- Resistance exercise programs might be added as long as one is careful to avoid overwork weakness
- Muscles that do not have antigravity strength should not be exercised
- Repeated eccentric muscle actions should be avoided
- **Clinical signs of overwork:**
- - excessive post exercise fatigue
- - pain
- - weakness
- - delayed onset muscle soreness

ORTHOSES

- Objectives in neuromuscular patients:
- improve function
- provide comfort
- conserve energy
- prevent deformity
- Fabrication types:
- prefabricated
- custom made
- Team work:
- Therapists and orthotists with experience with neuromuscular diseases can provide invaluable input as to the best orthosis to suit the individual patient's needs
- They can help adjust the orthosis as the status of a patient's functional needs change with time.
- Patient feedback on the comfort and fit of the device is paramount.

Lower Limb Orthoses

- AFO
- The most common type of orthotic device prescribed for neuromuscular patients
- - Used by patients with ankle dorsiflexion weakness to promote clearing of the toes and foot during the swing phase of gait, thus leading to a safer and more efficient ambulation
- - Used to prevent the development of ankle plantar flexion contractures
- Brace customization and modification is essential to ensure the best possible fit, patient comfort and compliance, as well as maximize functional outcomes.
- A few sessions of gait training with a skilled therapist are also needed to optimize braced gait

Guide in using AFO

- If skin redness, pain, or callouses develop, the brace should be promptly examined and adjusted by the orthotist
- AFOs must be used with shoes which are deep and wide enough to accommodate them
- They fit quite well in sneakers although they might be used with other types of shoes as well
- Use shoes with the same heel height in order not to alter gait biomechanics while wearing a brace
- Shoes should be in good condition as worn out shoes may affect the gait pattern and lead to reduced brace effectiveness
- **Some people do not want to wear ankle braces despite medical recommendation:**
- In these circumstances, the use of footwear that crosses the ankle and is snug, such as lace-up boots, high-top sneakers, or even cowboy boots, can help provide at least some support to the ankle

Types of AFO

- AFOs ,generally made of either plastic or carbon fiber, with the latter being a lighter-weight option
- For people with mild foot drop, dorsiflexion assist orthoses may suffice
- These braces are lightweight and incorporate a spring that generates a dorsiflexion assist moment
- Another option for mild foot drop is the posterior leaf spring (PLS) AFO
- This is an orthosis with medial and lateral trim lines placed posterior to the malleoli
- These braces are somewhat flexible and allow some plantar flexion to occur during heel strike
- Because of their flexibility, they might not be the best choice for patients with increased tone.
- Hinged (articulated) AFOs include an ankle joint and are appropriate for patients with moderate weakness of ankle dorsiflexion

- Transferring from sit to stand and negotiating stairs is easier with a hinged AFO than with a solid model, but good quadriceps strength is needed to use them
- A plantar flexion stop can be incorporated into the design of a hinged AFO to prevent plantar flexion beyond a certain angle, which might be useful when spasticity is a problem
- Solid AFOs provide immobilization of the ankle-foot complex and are therefore used for people with significant distal weakness and resulting medial and lateral instability of the ankle
- However, because of the fixed ankle position, sit-to-stand transfers and climbing stairs and inclines are difficult

- The angle at the ankle of a solid AFO can be set in a few degrees of plantar flexion
- This modification enhances knee stability and may be useful in patients with quadriceps weakness and knee buckling
- Addition of an anterior (pretibial shell) might also help to counter the tendency to knee buckling
- On the other hand, setting the angle in a few degrees of dorsiflexion can help limit hyperextension at the knee (genu recurvatum)
- If the AFO is set in dorsiflexion, the patient must have sufficient quadriceps control to compensate for the increased knee flexion moment during the loading phase of gait

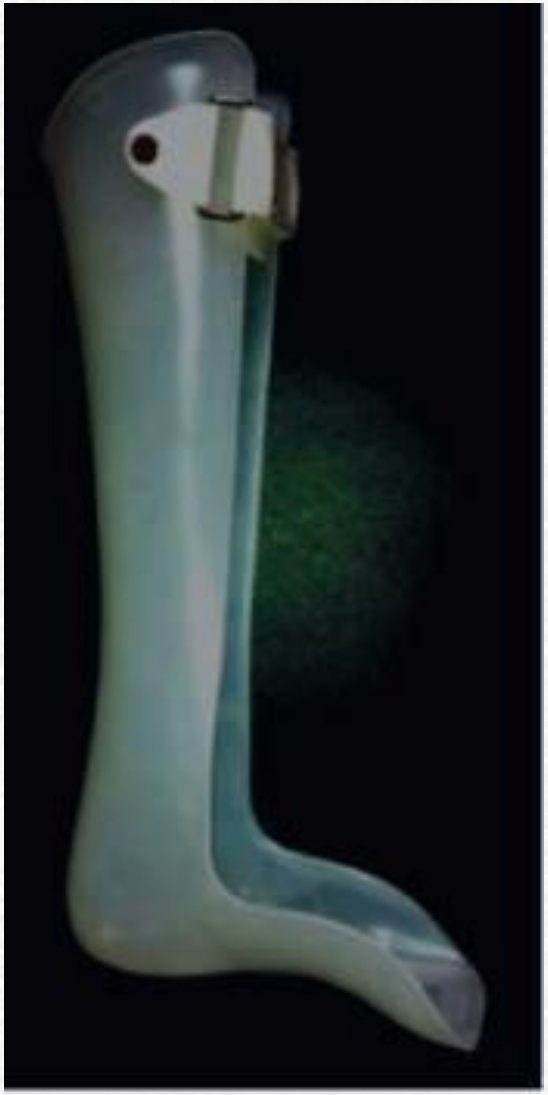
- In addition to improving gait efficiency, AFOs can also be used at night to help to prevent or minimize progressive equinus contractures in patients with significant ankle dorsiflexion weakness or increased lower extremity tone
- Nighttime AFOs can be either resting AFOs (static braces that keep the ankle aligned in a neutral position) or dynamic AFOs (which provide a low-load prolonged-duration stretch to the gastrocnemius–soleus complex)
- In individuals with quadriceps weakness, a different type of brace that might be tried to provide knee stability is the knee-ankle-foot orthosis (KAFO)
- Many KAFOs are too heavy for practical use by individuals with progressive neuromuscular weakness. However, they have been successfully used in polio patients and may assist with ambulation in selected patients with other neuromuscular conditions such as IBM

Carbon fiber dorsiflexion assist orthosis

Plastic posterior leaf spring (PLS)

Carbon fiber PLS AFO

Plastic solid AFO



Two different models of floor reaction orthoses (FROs)

Mobility Aids / Assistive Devices

- Types: canes, crutches, and walkers
- Indications:
- lower limb weakness
- balance problems
- to increase patient safety and promote independent ambulation
- These assistive devices effects:
- widen the base of support
- offload a weak limb
- Factors in prescription:
- degree of weakness/imbalance in the lower limbs
- strength in the trunk and upper extremities
- grip strength
- tone and ROM
- sensory problems
- Clinical Points:
- work with a PT to choose the most appropriate walking aid
- A few sessions of gait training with the new device

Canes

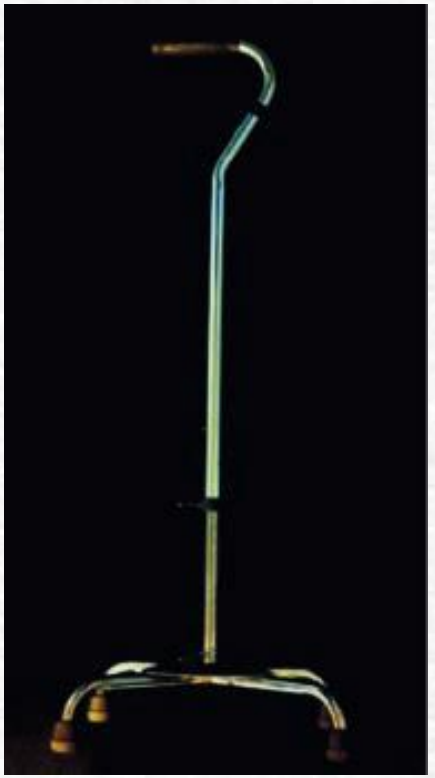
- provide the least amount of support
- usually recommended for people with only mild lower extremity impairment
- requires good upper limb strength
- The total length of a cane:
- should equal the distance from the upper border of the greater trochanter to the bottom of the heel of the shoe
- The patient should be able to stand with the cane with the elbow flexed at 20 degrees and both shoulders level.

Gait training with a cane

- generally carried in the hand opposite to the most affected leg
- can be used on stairs.
- One should lead with the stronger limb on flat ground and when ascending stairs, and with the more affected limb when descending stairs **("up with the good and down with the bad")**
- Patients might need to negotiate stairs on an angle and one step at a time depending on the degree of leg weakness.
- Canes come in a variety of styles and sizes of hand grips.
- Offset canes have a flat handle which can be built up allowing for better grip. This is beneficial for people with hand muscle weakness.
- Quad canes provide greater stability than traditional straight canes, but are heavier to lift, which limits their use in individuals with generalized progressive weakness

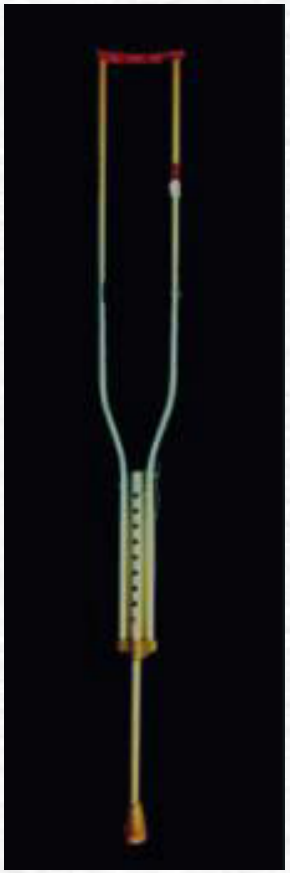
Types of Cane

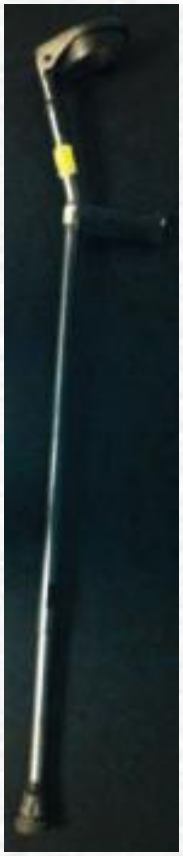
- Canes come in a variety of styles and sizes of hand grips
- Offset canes:
- have a flat handle which can be built up allowing for better grip
- beneficial for people with hand muscle weakness.
- Quad canes:
- provide greater stability than traditional straight canes
- heavier to lift, which limits their use in individuals with generalized progressive weakness



Crutches

- Three **types** :
- Axillary
- Forearm (also known as Canadian or Lofstrand crutches):
- Have a forearm cuff, which can free hands for use during standing
- Platform:
- useful when clinical conditions of the forearm, wrist, or hand prevent safe or comfortable weight bearing, such as in the presence of a wrist fracture or weakness of grasp
- Crutches use requires:
- high degree of upper body strength, coordination, and energy.





Walkers

- Provide the maximum stability because of their wide base of support
- Are bulky and may be cumbersome in confined spaces
- Various types of walkers:
- standard
- two-wheeled
- four-wheeled
- with seating surfaces
- Having a seat surface available increases the patient's independence if endurance is a problem.
- They may also be fitted with a shopping basket or a food tray.
- Standard versus Wheeled walkers:
- Standard walkers need to be lifted which can fatigue the upper limbs.
- Wheeled walkers do not need to be lifted and are preferred in people with generalized weakness as long as they can safely maneuver them.
- Four-wheeled walkers should be equipped with brakes for safety.
- Push-down brakes secure a walker when the patient loads his or her weight on the walker and are preferred over squeeze brakes for patients with hand weakness

Walkers

- Standard walker
- Two-wheeled walker
- Four-wheeled walker with seating surface and brakes (rollator)

ADAPTIVE EQUIPMENT AND ENVIRONMENTAL MODIFICATIONS FOR DAILY LIVING

Activities of daily living include

- Basic ADLs:
- - eating
- - grooming
- - bathing
- - dressing
- - toileting
- Instrumental ADLs:
- **consist of more complex tasks such as**
- - working
- - driving
- - shopping
- - homemaking
- - childcare

Adaptive Devices

- to enhance the independence of people with muscle weakness in their daily living
- the expertise of physical and OTs is often needed to help patients navigate through the different options
- cost of many of these devices is not covered by insurance

Self-Feeding and Meal Preparation Devices

- Eating utensils can be modified to facilitate holding in the presence of hand weakness:
- Increasing the diameter of the handle on spoons, forks, and knives (as well as other daily tools such as writing instruments and grooming tools) improves grip
- Using large handled tools
- Cover regular utensil handles with cylindrical foam
- Bendable utensils are also available.
- A spoon might be bent so that it faces the user to compensate for weakness of wrist flexion and supination
- Rocker knives (or using a pizza cutter instead of a knife) make it easier to cut food
- One can also use a cutting board with nails driven through it to hold food for chopping
- Light-weight drinking cups, straw holders, and long straws to decrease the distance between hand and mouth assist with drinking

Adaptive devices for feeding

- scoop plate (*yellow*)
- rocker knife
- fork whose handle has been enlarged by soft foam tubing,
- plate guard which has been attached to a regular plate (*white*)
- long straw

Universal Cuff

- designed to provide individuals with little to no finger control the ability to hold objects
- A strap that one wears around the palm of the hand
- When the patient's grip strength is severe enough to prevent him/her from holding any eating utensils
- Has a pocket that can hold a variety of tools
- Once centered over the palm, the device contains a pocket that can hold different types of tools including silverware, toothbrushes, brushes, and writing tools
- the universal cuff can be modified to provide support to a weak wrist



- Using scoop dishes and plate guards helps prevent the food from falling off the side of a plate
- Nonslip matting or using plates with suction bottoms keeps the plate from moving around on a table
- Adaptive tools to open jars and cans are available
- Reachers and grabbers help people get items from an upper cupboard and pick up objects from the floor
- A mobile arm support, attached to either a table or a wheelchair, can compensate for proximal arm weakness:
- it will hold up the arm against gravity and help bring food to the mouth.
- This set-up can also be used for other activities such as turning the pages of a book and grooming.

Rehabilitation Approach for Common Complaints

Pain and Management

- Lower limb muscle imbalance and abnormal gait may lead to low back and hip pain
- Weakness of the hip girdle extensors results in hyperlordosis as a compensatory posture to maintain the center of gravity during ambulation
- While this posture has an effective function during gait, it may also exacerbate low back pain
- Management:
- different interventions might be appropriate.
- depends on the experience of the PT, physiatrist, and pain specialist
- LSOs might be used for support in cases of back pain
- **Physical modalities such as:**
- cold
- heat
- massage
- TENS

Contracture and prevention

- As weakness progresses, patients may lose the ability to ambulate.
- People who spend many hours a day in a wheelchair or in bed are at risk for developing hip and knee flexion contractures.
- These contractures are associated with further functional decline, pain, and difficulties with dressing and personal hygiene.
- Prevention of contracture:
- - Proper positioning
- - Braces
- - ROM exercises

Strategies for fall prevention in the early course of the disease

- Behavior modification and energy conservation techniques
- to take rest breaks to avoid fatigue
- use carts instead of carrying luggage or other objects
- negotiate stairs on an angle and one step at a time
- A home safety evaluation and management:
- removing carpeting, sharp edges
- using appropriate footwear and night lights
- installing grab bars
- Education for patients and their caregivers on safe transfer techniques
- exercise
- lower limb orthoses (AFOs) may make ambulation more efficient and decrease risk of falling

Strategies for fall prevention in the late course of the disease

- Using mobility aids such as:
- canes
- walkers
- wheelchairs
- safety and fall prevention is a crucial component of any rehabilitation program

Orthotic Management
Off Loading
in Diabetic Foot

Preventive Care

- Primary goal of treatment is prevention
- **Component of prevention:**
- - risk determination
- - prescription of appropriate footwear
- - education
- - regular follow up

Protective Sensation

- Amount of sensation necessary to protect from tissue trauma
- Filament is held perpendicularly to the skin surface and pressure is applied until the filament buckles
- **Using set of 3 monofilaments:**
- (4.17=1 g) ,
- (5.07=10 g) ,
- (6.1=75 g)
- The ability to perceive the 5.07= 10 g monofilament is consistent with presence of protective sensation

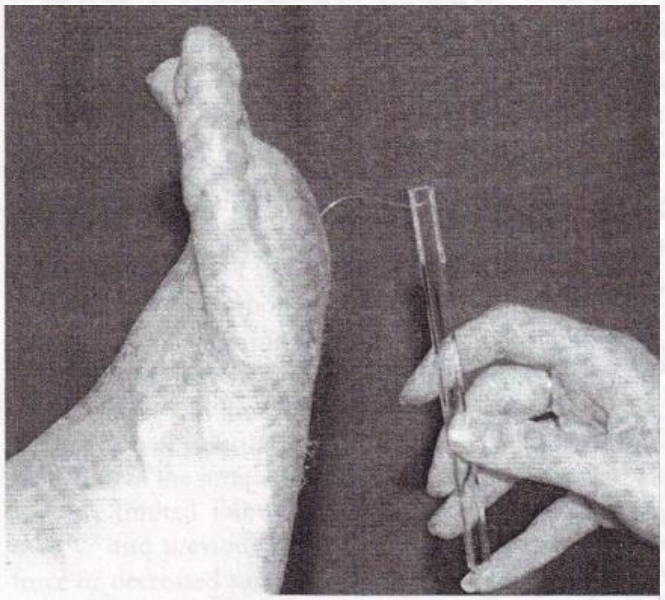


Figure 21-2

A monofilament is used to test protective sensation on the so of the foot. The filament is held perpendicularly to the skin surface, and pressure is applied until the monofilament buckles. The number associated with the smallest-diameter filament perceived at each site is recorded.

Diabetic foot risk classification

- 0 no neuropathy / Lack of protective sensation
- 1 with neuropathy , no deformity or PVD
- 2 with neuropathy and deformity or PVD
- 3 history of ulceration or amputation

Risk 0= no neuropathy

- No special footwear
- **Proper shoe fit**
- Contours of the shoe match the contours of the foot
- Widest part of foot in the widest part of the shoe
- ½ inch distance between longest toe and shoe

Risk 1 =with neuropathy, no deformity or PVD

- Not require specialty footwear
- Proper she fit
- Wear shoes with **soft soles**
- Add a thin non mold soft insole to cushion high pressure areas
- Shoes to be avoided:
- - shoes with narrow toes
- - shoes with thongs
- - high heeled shoes

Risk 2,3 =with neuropathy, deformity or PVD, history of ulceration or amputation

- Special footwear,
- in-depth or custom-molded
- molded accommodative insoles

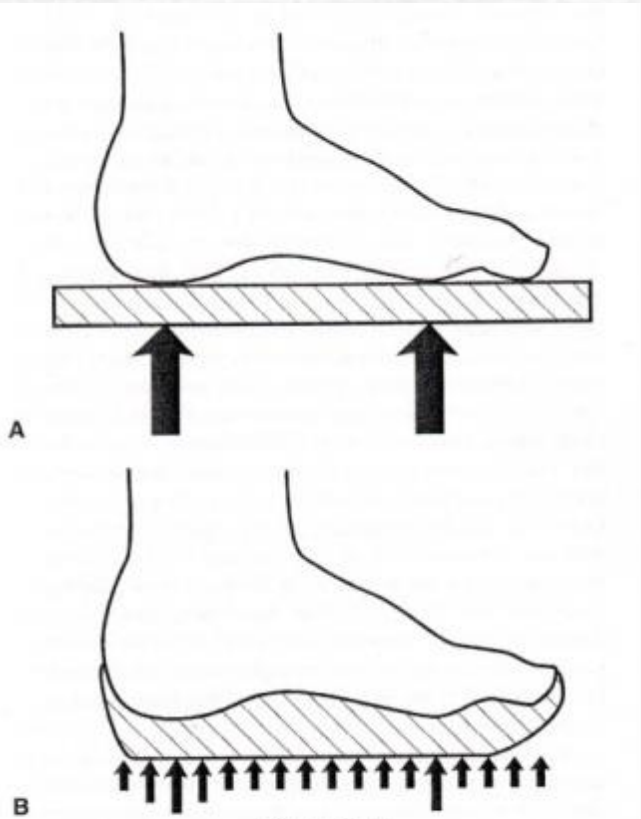


Figure 21-24

***A,** A nonmolded insert can cushion high areas of the foot for patients without protective sensation in risk category 1. **B,** For those in risk categories 2 and 3, a molded insert further decreases pressure at vulnerable locations by increasing the weight-bearing area.*

Biomechanical goals in diabetic shoe

- Proper distribution of pressure under plantar surface
- Pressure relief from high pressure area
- Shock absorption
- Reduction of shearing and friction forces
- Reduction in vertical and horizontal movement of foot inside the shoe
- Limitation in joint movements
- Accommodation with deformities

General properties of diabetic shoes

High toe box or In depth shoe

Long medial counter

Blucher opening

Shock absorbing sole

Low heel

Heat moldable upper

Modifications

- Rocker sole
- Extended steel shank
- Total contact insole

Foot Ulceration

Pressure reduction process in diabetic foot ulcer

- Non weight bearing
- Total contact casting
- Walking splint
- Removable cast walkers
- Half shoes
- Felted foam relief pads
- Cutout sandals

Non Weight Bearing

- To eliminate all forces from the plantar surface of the foot
- Only in the uncontrolled infection or acute ischemia when other medical and surgical intervention is necessary

Total contact casting

- To reduce vertical and shear force on the foot
- By distributing weight bearing over all areas of the foot and leg
- Immobilization of the ankle in the cast eliminate push off phase of gait which is associated with high peak pressure
- Average healing time is 36-43 days

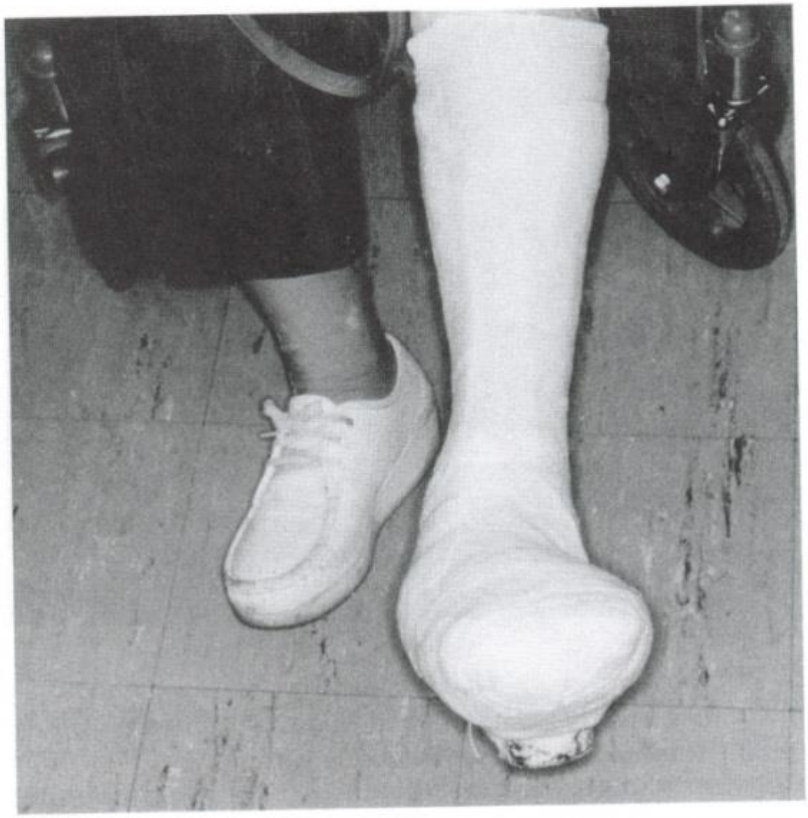


FIGURE 20-16

Total contact cast.

Walking splint

- Alternative for TCC
- Fabrication like the TCC but with removing anterior part and reinforcement posterior part
- Elastic bandage are used to secure the foot and leg

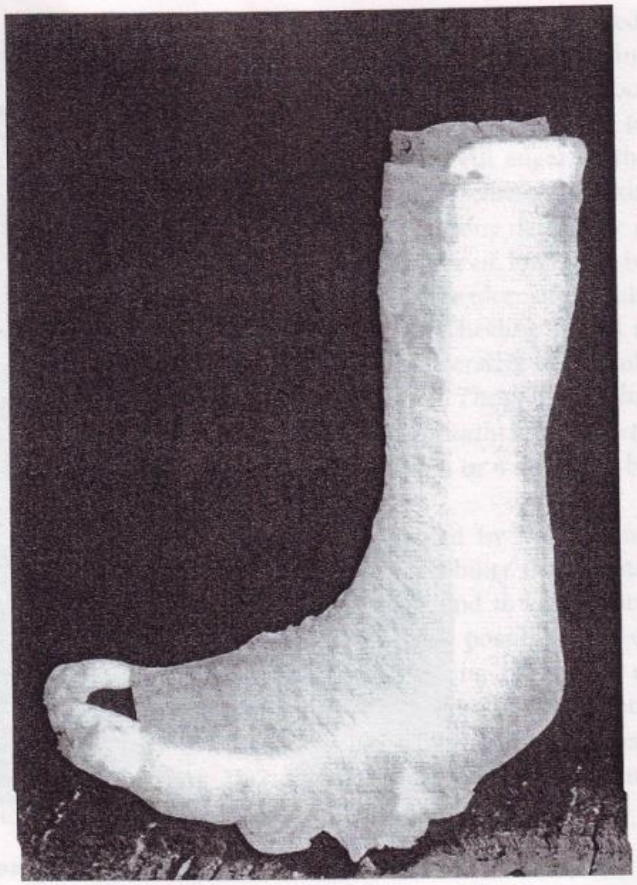


Figure 21-18

The walking splint (an alternative to a total contact cast) is held on the wearer's limb with an elastic wrap.

Removable Cast Walkers

- An orthotic device with double uprights fixed at a 90 degree angle to a rocker soled walking platform
- Reduce plantar pressure
- Prefabricated/a custom molded insert can be added

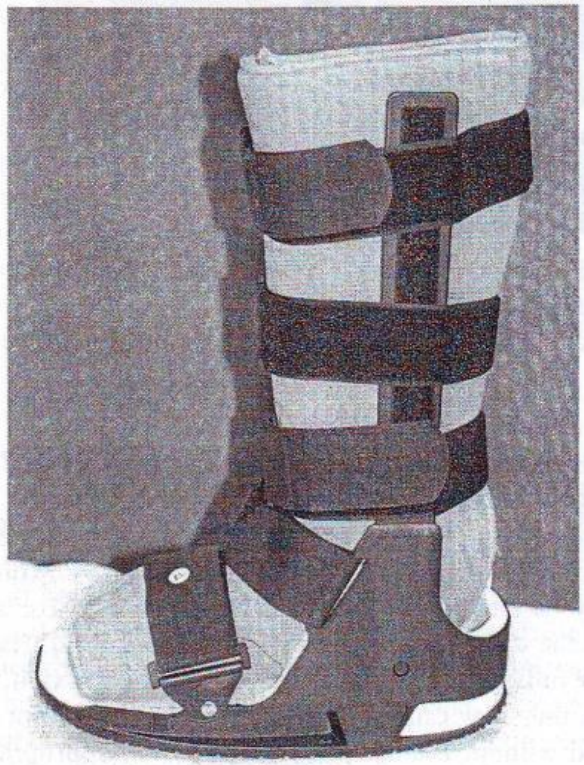


Figure 21-19
Example of a removable cast walker.

Half shoes/ wedged sandal

- For problems of forefoot
- Modification of shoe with wedge/body weight shift back

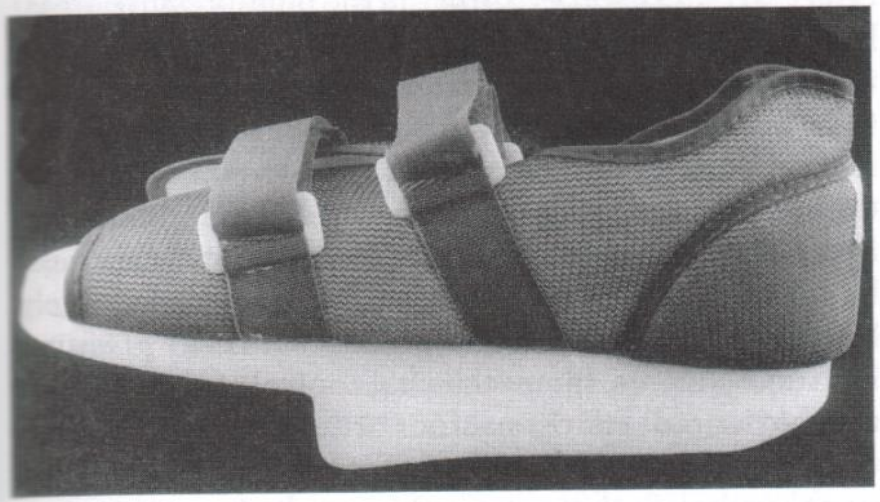


FIGURE 20-20

Wedged sandal.

Felted foam relief pads

- Alternative to pressure reduction
- A custom fit piece of ¼ in felt backed foam is adhered to the plantar surface
- U shaped aperture is cut in the foam to reduce pressure around the ulcer

FIGURE 20-17
Felted foam pressure relief pad.

Cutout sandals

- The foot bed of a custom-molded plastazote sandal is completely cut out in the area of the ulcer , leaving the outer sole intact

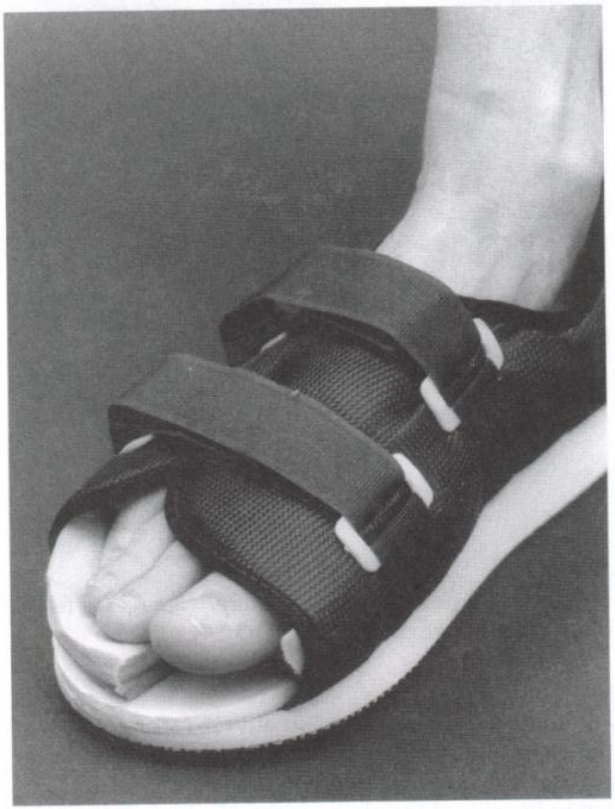


FIGURE 20-18
Custom-molded insert cutout to relieve pressure on plantar surface of hallux.