

LOWER LIMB ORTHOSES: A REVIEW

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Introduction

The word orthosis is derived from the Greek word "ortho", which means to make straight. Orthoses straighten bones, but they also prevent deformities, enhance walking, assist with daily activities, alleviate pain, protect limbs, promote osteogenesis, strengthen the limbs and spine¹. An orthosis is defined as a device that is attached or applied to the external surface of the body to improve function, restrict or enforce motion or support of a body segment². A lower limb orthosis is an external device applied or attached to a lower body segment to improve function by controlling motion, providing support through stabilizing gait, reducing pain through transferring load to another area, correcting flexible deformities, and preventing progression of fixed deformities³. The lower limb orthosis are classified as follows: Shoes, Foot Orthosis (FO), Ankle Foot Orthosis (AFO), Knee Ankle Foot Orthosis (KAFO), Knee Orthosis, Trunk Hip Knee Ankle Foot Orthosis (THKAFO)⁴. In the musculoskeletal disability most common disability is locomotor disability. 12% of men and 14% women have locomotor disability, of which one in 4 men and one in 3 women have serious locomotor disability. To determine the appropriate orthotic for a patient requires consideration of several factors including diagnosis of disability, range of motion, strength, tone, cognition, dexterity, compliance, sensation, edema, gait pattern, and pain⁵.

Key words: orthoses; lower limb; disability

Indications for an orthosis

- Support flail joint (flaccid lower-motor neuron paralysis) e.g. poliomyelitis, spina bifida, amyotrophic lateral sclerosis peripheral neuropathy
- Control spastic joint (spastic upper motor neuron paralysis) e.g. stroke, cerebral palsy, spinal cord injury, head injury
- Protect painful or lax joint e.g. rheumatoid arthritis, ligament injuries

- Orthopedic condition e.g. trauma, sports injuries, work related injuries
- Correct abnormal foot posture e.g. functional foot orthoses

Contraindication for Orthoses

- Skin infection
- Muscle power is very much affected by the weight of the orthosis.
- In case of severe deformity which cannot be accommodated in the orthosis.
- limitation of movement at other normal joint.
- Lack of motivation or other psychological problems.
- Very young or very old persons.
- Where the orthoses interfere grossly with clothing or limit ones style of living.

Principle : a lower limb orthosis should be used only for specific management of a selected disorder. The orthotic joints should be aligned at the approximate anatomic joints. Most orthoses use a 3-point system to ensure proper positioning of the lower limb inside the orthosis. The orthosis selected should be simple, lightweight, strong, durable, and cosmetically acceptable. Considerations for orthotic prescription should include the 3-point pressure control system, static or dynamic stabilization, flexible material, and tissue tolerance to compression and shear force⁶.

Construction of lower limb orthoses : an orthosis can be constructed from metal, plastic, leather, synthetic fabrics, or any combination.

- **Plastics :** thermosetting materials can be molded into permanent shape after heating. They soften when heated and harden when cooled and do not return to their original consistency even after being reheated.
- **Leather :** such as cattle hide, is used for shoe construction because it conducts heat and absorbs water well.
- **Rubber :** has tough resiliency and shock absorbing qualities. Used for padding in body

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jackets and limb orthoses.

- **Metal** : metals (stainless steel and aluminum alloys) are adjustable, but are heavy and not cosmetically pleasing. Can be used for joint components, metal uprights, springs, and bearings.

Description of orthoses

Shoes : are the important foundation of the lower limb orthosis. They should be at least 1 cm longer than the longest toe and correspond to the shape of the feet⁶. The shoe can be divided into lower and upper parts. The lower parts consist of the sole, shank, ball, toe spring, and heel. The upper parts include the quarter, heel counter, vamp, toe box, tongue, and throat. Shoes can be modified to reduce pressure on sensitive areas by redistributing weight toward pain-free areas⁷.

Foot orthosis : The foot orthosis extends from the posterior border of the foot to a point just posterior to the metatarsal heads. This device is used to accommodate the abnormal foot to help restore more normalized lower limb biomechanics.

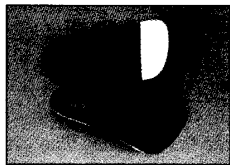


Fig 1 : Foot orthosis

Ankle Foot Orthoses(AFOs) : are used to prevent or correct deformities and reduce weight bearing. An AFO has been shown to reduce the energy cost of ambulation in a wide variety of conditions, such as spastic diplegia due to cerebral palsy, lower motor neuron weakness of poliomyelitis, and spastic hemiplegia in cerebral infarction^{6,7}.

Different types of plastic AFOs are: thermoplastic AFOs, posterior leaf spring (PLS), spiral AFO, hemispiral AFO, solid AFO, AFO with flange, hinged AFO, tone-reducing AFO (TRAFO).

Knee Ankle Foot Orthoses (KAFOs) : can be made of metal-leather and metal-plastic or plastic and plastic-metal. The metal design includes double upright metal KAFO (most common), single upright metal KAFO (lateral upright only), and Scott-Craig metal KAFO. The plastic designs are indicated for closer fit and maximum control of the foot, including supracondylar plastic KAFO,

supracondylar plastic-metal KAFO, and plastic shells with metal uprights KAFO.



Fig 2 : Spiral AFO (ankle foot orthosis)

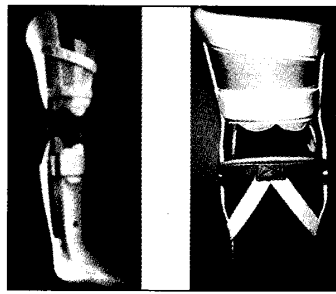


Fig 3 : Different knee orthoses

Knee orthosis : a knee orthosis (KO) only provides support or control of the knee but not of the foot and ankle. Different types of knee orthoses are: knee orthoses for patellofemoral disorder, knee orthoses for knee control in the sagittal plane, knee orthoses for knee control in the frontal plane, knee orthoses for axial rotation control. **Hip-Knee-Ankle Foot orthosis** : An HKAFO consists of a hip joint and pelvic band in addition to a KAFO. The orthotic hip joint is positioned with the patient sitting upright at 90°, while the orthotic knee joint is centered over the medial femoral condyle. Pelvic bands complicate dressing after toileting unless the orthosis is worn under all clothing. Pelvic bands increase the energy demands for ambulation¹⁶.

Trunk Hip Knee Ankle Foot Orthosis (THKAFO) : consists of a spinal orthosis in addition to a HKAFO for control of trunk motion and spinal alignment. A THKAFO is indicated in patients with paraplegia and is very difficult to don and doff⁶.

Different types of THKAFOs are : reciprocating gait orthosis (RGO), para walker parapodium, standing frame.

Common disease that causes lower limb functional disability :

Stroke : an AFO greatly improve gait mechanics and efficiency by preventing the passive or active plantar flexion in swing and stance phases⁸. With the use of AFO there is also less need for hip and knee flexion and pelvic elevation to gain foot clearance. An orthosis which can assist in knee extension improves stance stability during the period of decreased muscle tone⁹.

Cerebral palsy : AFOs can effectively improve the gait of some children with cerebral palsy and improve their gait efficiency^{10,11}.

Post polio syndrome : the use of the KAFO and cane not only stabilize the patients painful unstable knee but also reduce the patients energy expenditure of ambulation. With use of the KAFO and cane, energy expenditure is reduced by over 25% during ambulation¹².

Spinal cord injury : long leg braces (a variants of KAFO) is used to ambulate the lower limb paralytic patients. More recent designs of KAFOs allow for a reciprocal gait pattern^{13,14,15}.

Guillain-Barrié syndrome : Ankle foot orthosis (AFO) may be used for the lower limbs weakness^{15,16,17}.

Transverse myelitis : KAFOs may be used in paraplegia and AFOs may be used in foot drop¹⁴.

Amyotrophic lateral sclerosis :

KAFOs may be used to improve the locomotor function in patients with lower limb weakness¹⁸.

Foot drop (peroneal neuropathy) : the AFOs is commonly prescribed²⁰.

Conclusion : Orthosis is one of the most important components of rehabilitation of patients with locomotor disability. The number of patients attending in the Department of Physical Medicine & Rehabilitation in our country is increasing day by day, especially with lower limb functional disability. No study about role of orthosis in the management of lower limb functional disability under went in our country. So further study and research on this aspect will enrich our knowledge in patient's management in the area of rehabilitation.

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