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Lower Limb Orthotics: An Overview

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ABSTRACT

Lower limb orthoses are used to assist gait, reduce pain, decrease weight bearing control movement, control movement and minimize progression of the deformity skills and assist ambulatory patients in achieving near-to-normal gait patterns in walking. Assistive devices can be advised with lower limb orthoses to help the patients ambulate more efficiently.
Orthotic management should be specific to the disorders. The placement of orthotic joints should approximate anatomical joints. Most orthoses utilize a three-point force system to ensure proper positioning of the lower limb within the orthoses.
Based on a comprehensive history and physical examination, a clear understanding of the patient's disease process is the foundation for concluding an appropriate prescription. An effective prescription for orthotic treatment summarizes the medical issues related to the patients, details the biomechanical functions desired, and specifies critical technical attributes of the desired orthosis.
No single material is a panacea, despite publicity for exotic materials. The selection of an appropriate material for a specific orthosis requires understanding the fundamental principles of engineering mechanics and materials, improving mechanical properties by heat treatment, and similar means, design, and structure. Sound clinical judgment, combined with consciousness fitting and adjustment of well-designed orthoses, remains the hallmark of orthotic treatment. International standards for terminology should be used to describe orthoses to ensure clarity and precision in prescriptions.
Two auxiliary functions minimize the physical strain of walking: shock absorption and energy conservation. An optimum orthosis should be a replica of a mechanical system that can store these functions. This article overviews lower limb orthoses in classification, design, and construction and their biomechanical implications in usage in patients.

Keywords: Orthotics, Lower Limb Orthoses, orthosis, patients, functions, walking, prescription.

INTRODUCTION

The Greek word "ortho," which means to make straight, is the origin of the term "orthosis." The word 'orthotics' has come to mean the science and practice of applying externally worn devices that perform a variety of mechanical functions viz. improving the activity by controlling motion, providing support by stabilized gait, to lessen pain by transferring the load to another part, to correct flexible deformity, to prevent the development of fixed deformities, to the body or body parts to which they are applied. (2) An *orthosis* is described as "an externally applied device used to modify the structural and functional characteristics of the neuromuscular and skeletal systems". One of the most often recommended biomechanical aids for people with neuromuscular deficits is a lower limb orthosis (LLO), which comes in different variants. The prevalence of lower limb devices in clinical practice reflects both the strong desire of the majority of people with physical disabilities to obtain independent mobility in the community and the fact that current orthotic technology frequently restores gross physical functions like standing and walking with a satisfactory level of talent. Orthoses are named by the first letter of the joints or anatomical segments that they span. Lower limb orthoses are categorized as follows: AFO (Ankle-foot orthosis), FO (Foot orthosis), KAFO (Knee-ankle-foot orthosis), KO (Knee orthosis), HKO (Hip-knee orthosis), HKAFO (Hip-knee-ankle-foot orthosis) and HpO (Hip orthosis) (3, 4)

The main groups of functions which orthoses may be intended to perform are as follows:

1. Support. For example, to relieve weight from some of the skeletons of the lower limb with a knee-ankle-foot orthosis.
2. Limitation of movement. For example, a knee orthosis to prevent hyperextension.
3. Correction of deformity. For example, over corrective shoe (foot orthosis) in the case of CTEV.
4. Assistance to movement. For example, an ankle-foot orthosis with spring to assist dorsiflexion.

An orthosis mustn't result in over bracing, it should not hinder remaining function may more than necessary as it compensates for a deficiency. Many orthoses combine several functions, for instance, a knee-ankle-foot orthosis for a limb resulting from a history of poliomyelitis will give support, will limit movement at the knee and perhaps the ankle, it may help to correct a varus ankle and have a spring to assist dorsiflexion.

Almost invariably orthoses have to strike a balance between the often-conflicting requirements of function, cosmesis, and acceptability. The ideal orthosis is, of course, invisible and weightless but its desired function. Consideration must be given to the patient's diagnosis of impairment, range of motion, tone, strength, dexterity, cognition, sensation, compliance, edema, walking pattern, and pain to choose the best orthosis for them. Orthoses need, too, to be provided or replaced quickly, to be hygienic, safe, and reliable.

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 joints e.g., rheumatoid arthritis, ligament injuries
- Orthopedic conditions e.g., trauma, sports, work-related injuries
- Correct abnormal foot posture e.g. functional foot orthosis

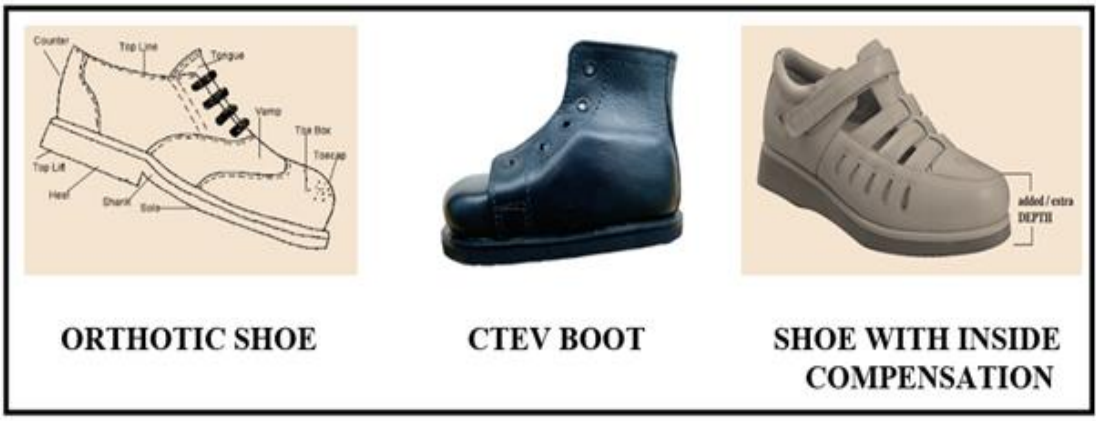
Biomechanical Principles of Lower Extremity Orthoses: Every orthosis employs force on the limb to achieve the objectives of its design. For correct alignment of the lower limb within the orthosis, the majority of orthoses use a three-point force system. (1) The best conditions for the effectiveness and comfort of orthosis are:

- The forces are distributed over large surface areas to minimize pressure on the skin and soft tissue.
- The forces are applied in such a way that a large moment arm reduces the amount of force needed to control the joint.
- The sum of the primary force and opposing counter forces of each control system equals zero.

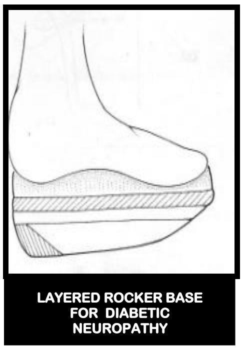
The concepts of fit and alignment are inseparable. Alignment deals with the angular relationship of the orthotic components to each other and the reference line. Fit deals with the relationship between orthosis, anatomical landmarks, and body contours. The three-point pressure control system, flexible material, dynamic or static stabilization, and tissue tolerance to shear stress and compression should all be taken into account when prescribing orthotics. Metal (stainless steel and aluminium alloys), plastics (thermosetting), leather (cattle hide), rubber, synthetic fabrics, or any combination may be used to make orthoses.

DESCRIPTION OF LOWER LIMB ORTHOSES:

Shoes: are the vital basis of lower limb orthosis. To fit properly, they need to be at least 1cm longer than the longest toe and contour to the foot appropriately. There are upper and lower parts of the shoe. The shank, sole, ball, heel, and toe springs are all found in the lower portions. The vamp, heel counter, toe box, throat, and tongue are among the upper parts. Shoes may be altered to shift weight away from painful parts to lessen the strain on sensitive areas.

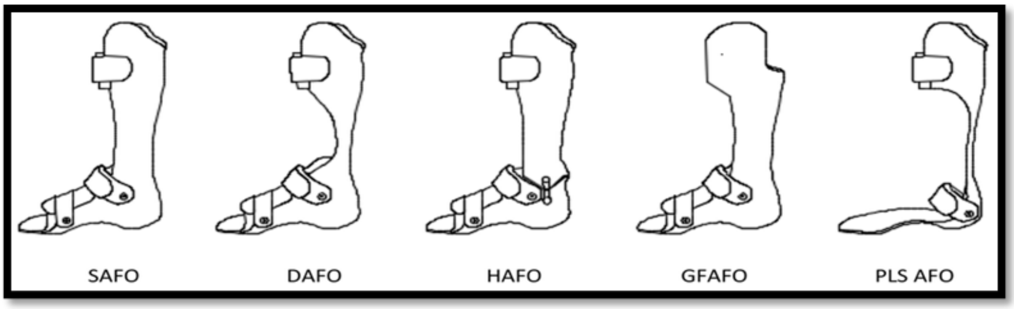


Foot orthoses (FOs): The foot orthosis stretches from the back of the foot to a point immediately beyond the metatarsal heads. To restore normalized lower limb biomechanics, this device is utilized to fit the abnormal foot. Conceptually, there are three major kinds of FOs- i) soft or accommodative devices, ii) semirigid or intermediate devices, and, iii) rigid or corrective devices. One of the most common reasons for needing to alter the weight distribution is neuropathic ulceration in, for example, leprosy, diabetes, and spina bifida. In these cases, it is not simply a matter of altering the static weight distribution but also of reducing pathological subcutaneous shearing. The normal metatarsal head rolls within the more superficial tissue during the stance phase of gait. The neuropathic subcutaneous tissue is scarred and thinned and cannot sustain normal rolling. The orthotic solution to reduce this shearing is to transfer the rolling elsewhere and keep the forces on the plantar surface as near as possible at right angles to the skin.



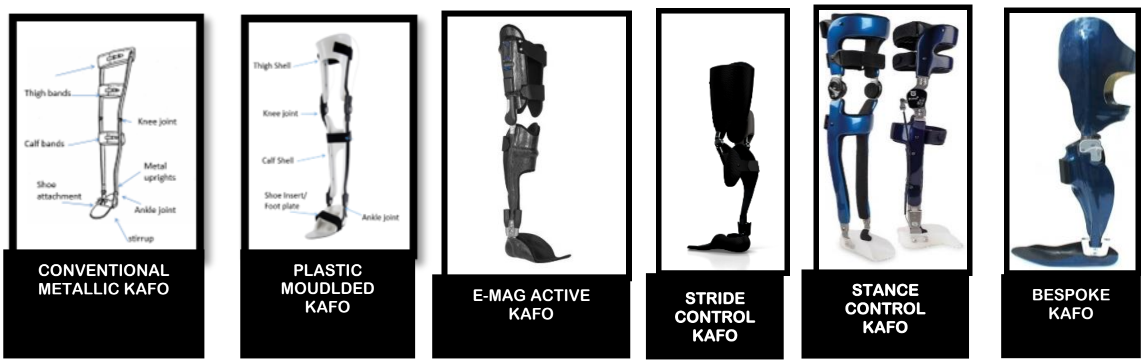
Ankle-foot orthoses (AFOs): are used to decrease weight and repair abnormalities. The usual mechanical demands on AFOs are to i) control lateral instability at the ankle, subtalar, or midtarsal joints; ii) limit plantar- and dorsiflexion; iii) take some weight under the knee and transfer it to below the foot. In a broad range of disorders, including spastic diplegia caused by cerebral palsy, spastic hemiplegia from cerebral infarction, and lower motor neuron weakness from poliomyelitis, an AFO has been demonstrated to lessen the ambulation energy cost.

The conventional device allows some ankle movement in the single 'iron' on the appropriate side with a T-strap (control varus or valgus at the ankle). Different types of plastic AFOs are hinged AFO, solid AFO, PLS (posterior leaf spring), spiral AFO, AFO with flange, BiCAAL AFO, PTB, and TRAFO (tone-reducing AFO) orthosis.

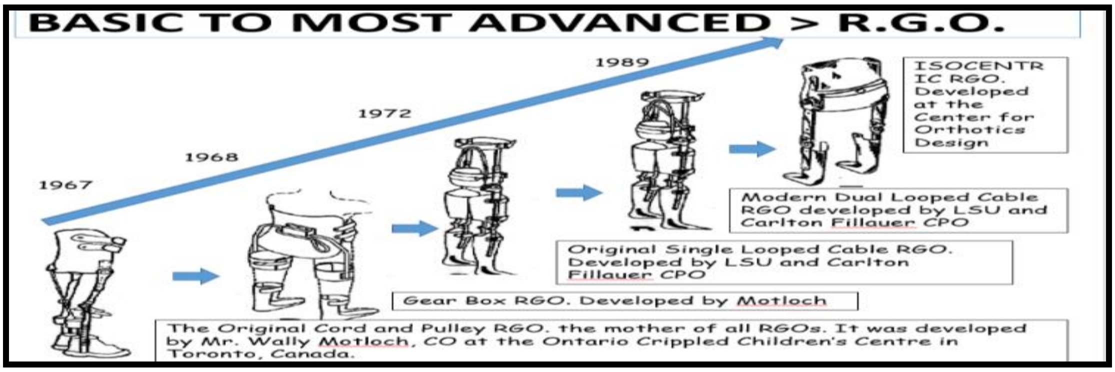


Knee orthoses (KO): Knee orthoses relieve weight from the knee joint. The main requirements of KOs are for stabilization – or preventing unwanted movement. Knee orthoses are grouped by their intended function: prophylactic (developed to lower the chances of knee injury for the people who participate in high-risk activities or have a history of knee dysfunction, rehabilitative (utilized to safeguard an injured or surgically treated knee until sufficient tissue healing has taken place), functional knee orthoses (maintain biomechanical stability throughout regular activities when ligaments are incapable of performing so - Lenox Hill Derotation knee brace). Patellofemoral knee braces are designed to improve patella tracking and minimize pain in the anterior knee. The role of unloader knee braces is to lessen the compressive load on the tibiofemoral joint and lessen the pain associated with osteoarthritis.

KAFOs (Knee-ankle-foot orthoses): These are designed to substitute biomechanical deficiencies in the foot, ankle, and knee. KAFOs may be manufactured of plastic and plastic-metal or plastic and plastic-leather and can be worn unilaterally (for those with polio who only have one affected limb) or bilaterally (for people with myelomeningocele or SCI). Among the metal designs are the Craig-Scott metal KAFO, the single upright metal KAFO (only lateral upright), the ischial weight bearing KAFO, the double upright metal KAFO, and the fracture braces (KAFO with thigh or calf shell, FESKAFO) (sequence and pattern of muscle activation by portable stimulators). The supracondylar plastic-metal KAFO, supracondylar plastic KAFO, as well as plastic shells with metal uprights KAFO are examples of plastic designs that are recommended for a close fit and maximal control of the foot (if the angular deformity is less than 15 degrees and shortening is less than 5cm). A new form of orthosis called the SCKAFO (Stance-control Knee-Ankle-Foot orthosis) has been developed that allows unrestricted knee mobility during the swing phase when avoiding knee flexion during stance.



HKAFO (Hip-knee-ankle foot orthoses): Paralytic conditions that affect some of the trunks and abdominal muscles, as well as the legs, will need orthoses with connections across the hip, knee, and foot. Examples are those required for spina bifida and low spinal cord lesions. Pelvic bands raise the energy requirement for ambulation. The functional requirement is to hold the pelvis in a roughly neutral position, keep the knees extended, stabilize the feet and ankles, prevent the hips from adducting and assist the reciprocal motion of the legs either by gravity or by the connection of a reciprocating linkage between the legs. Two quite well-tried orthoses which meet these demands are the hip guidance orthosis (HGO) which stemmed from work at Oswestry and the RGO or “Reciprocal gait orthosis” which was designed at Louisiana State University. A more recently developed orthosis for the same purpose is the Steeper ARGO or advanced RGO. It has a linkage between the hip joint and knee joint which offers assisted standing from sitting.



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Conflict of Interest: None

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