

A Review of the Literature Pertaining to KAFOs and HKAFOs for Ambulation

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ABSTRACT

The purpose of this review is to evaluate the scientific literature regarding the clinical use of knee-ankle-foot orthoses (KAFOs) and hip-knee-ankle-foot orthoses (HKAFOs) for ambulation to establish what is known and what requires further research to optimize the application of these orthoses. A search of the literature was carried out using a number of computerized databases. Based on their abstracts, publications were included and ranked when they were written in English and evaluated some aspect of ambulation with [H]KAFOs (KAFO and HKAFO). A total of 240 articles were identified that met the inclusion and exclusion criteria; however, there were only two systematic reviews and two randomized control trials located. A selection of recent cross-sectional studies and non-systematic reviews were also considered. The results of this review indicate that, while a reasonable amount of literature has been written regarding [H]KAFOs, the level of evidence regarding the use of [H]KAFOs for ambulation is generally low. There was some evidence (grade C recommendation) that use of HKAFOs diminishes with time in both adults and children with paraplegia and that when orthoses are used they are used mostly for therapeutic purposes. There was also some evidence that regardless of orthotic device used walking speed is slow and energy cost high in people with paraplegia. The main limitation of most studies of [H]KAFOs for ambulation was small sample size and inadequate study design.

KEY INDEXING TERMS: ambulation, hip-knee-ankle-foot orthosis, knee-ankle-foot orthosis, orthotic devices, reciprocating gait orthosis

This review evaluates the scientific literature regarding the clinical use of knee-ankle-foot orthoses (KAFOs) and hip-knee-ankle-foot orthoses (HKAFOs) for ambulation to establish what is known and what requires further research to optimize the application of these orthoses. This review includes unilateral and bilateral KAFOs, as well as those that are incorporated into more proximal lower limb orthoses such as HKAFOs and the various reciprocating gait orthoses (RGOs). The focus is on custom-made devices intended for long-term use and not prefabricated items that are worn for less than 1 year. Orthoses whose primary function is not to enhance ambulation, such as fracture braces and post-operative immobilization devices, are excluded from this review.

BACKGROUND

KAFOs are used when mechanical control of the knee joint is required in weight-bearing due to weak or absent muscle function or joint deformity. As the name implies, KAFOs

physically encompass the foot, ankle, and knee, providing direct control of each of those joints. KAFOs can be worn unilaterally or bilaterally as required. Hip stability is not provided by the orthosis but can be augmented when necessary by shifting the trunk center of mass posteriorly so that the ground reaction force is oriented posterior to the hip joints, creating tension in the anterior Y ligament of the hip joint and internally stabilizing the hip joints. This posture allows for stable standing in adults but is not recommended for children as the Y ligament is not yet mature.

There are many variations of KAFO design, usually a result of the varying location and combination of horizontal bands.¹ Lehmann et al.¹ showed that most of the band variations on KAFOs, including the posterior low thigh, posterior calf, and suprapatellar band, are often unnecessary. This led to the development of the Scott-Craig Orthosis² that incorporated only a rigid posterior thigh band and a rigid anterior tibial band, thus decreasing the weight of the orthosis, an important design consideration when dealing with extensive lower limb muscle weakness or paralysis. Extending the shoe plate beyond the metatarsal heads and reinforcing the lateral supports from stirrup to sole plate also provided a more stable base of support. Off-set knee joints with bale locks and a solid ankle set in 5 to 10 degrees of dorsiflexion were also used. Nene et al.³ noted that this was the most commonly prescribed orthosis for paraplegic patients.

For many years, the available technology meant that the mechanical knee joint was either entirely locked or entirely unlocked. Eccentric or off-set knee joints that remain unlocked rely on alignment of the knee, hip, and trunk to orient

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