Annals of Physical and Rehabilitation Medicine xxx (2017) xxx–xxx

Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com

Review

Efficacy of ankle foot orthoses types on walking in children with cerebral palsy: A systematic review

Atefeh Aboutorabi [a,b], Mokhtar Arazpour [a,b,*], Monireh Ahmadi Bani [b], Hassan Saeedi [c], John S. Head [d]

[a] Pediatric Neurorehabilitation Research Center, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran
[b] Department of Orthotics and Prosthetics, University of Social Welfare and Rehabilitation Sciences, Tehran, Islamic Republic of Iran
[c] Department of Orthotics and Prosthetics, Iran University of Medical Sciences, Tehran, Islamic Republic of Iran
[d] Institute for Health & Social Care Research (IHSCR), Faculty of Health & Social Care, University of Salford, Salford, UK

ARTICLE INFO

Article history:
Received 31 January 2017
Accepted 27 May 2017

Keywords:
Ankle foot orthoses
Orthosis
AFO
Gait
Children with cerebral palsy
CP

ABSTRACT

Background: Ankle foot orthoses (AFOs) are orthotic devices that can be used to normalize the walking pattern of children with cerebral palsy (CP). One of the aims of orthotic management is to produce a more normal gait pattern by positioning joints in the proper position to reduce pathological reflex or spasticity.
Objective: To conduct a systematic review of the literature and establish the effect of treatment with various types of AFOs on gait patterns of children with CP.
Methods: PubMed, Scopus, ISI Web of knowledge, Cochrane Library, EMBASE and Google Scholar were searched for articles published between 2007 and 2015 of studies of children with CP wearing the following AFOs: hinged (HAFO), solid (SAFO), floor reaction (FRO), posterior leaf spring (PLS) and dynamic (DAFO). Studies that combined treatment options were excluded. Outcomes investigated were a change in gait pattern and subsequent walking ability. The PEDro scale used to assess the methodological quality of relevant studies.
Results: We included 17 studies investigating a total of 1139 children with CP. The PEDro score was poor for most studies (3/10). Only 4 studies, of 209 children in total, were randomized controlled trials, for a good PEDro score (5, 7, 9/10) and an appropriate level of evidence. One study used a case-based series and the remainder a cross-sectional design. In general, the use of AFOs improved speed and stride length. The HAFO was effective for improving gait parameters and decreasing energy expenditure with hemiplegic CP as compared with the barefoot condition. It also improved stride length, speed of walking, single limb support and gait symmetry with hemiplegic CP. The plastic SAFO and FRO were effective in reducing energy expenditure with diplegic CP. With diplegic CP, the HAFO and SAFO improved gross motor function.
Conclusion: For children with CP, use of specific types of AFOs improved gait parameters, including ankle and knee range of motion, walking speed and stride length. AFOs reduced energy expenditure in children with spastic CP. However, further studies with good PEDro scores are required for more conclusive evidence regarding the effectiveness of AFOs in children with CP.

1. Introduction

Efficient and effective walking is an important treatment goal for children with cerebral palsy (CP) because mobility is associated with functional independence and participation of the child in society [1]. Orthotic management is a significant and useful treatment option for a number of conditions that affect gait and posture and usually forms part of an overall rehabilitation program established for patients with CP. To improve gait parameters and normalize movement patterns with spastic CP, a variety of orthotic devices are used [2]. In children with CP, the aim of orthotic management in the form of ankle foot orthoses (AFOs) is to produce a more normal gait pattern by positioning peripheral joints in a way that reduces pathological reflex patterns or by blocking pathological movement of the joints [2]. A wide variety of

* Corresponding author. Department of Orthotics and Prosthetics, University of Social Welfare and Rehabilitation Science, Kodakyar st., Daneshjo Blvd., Evin, Tehran, 1985713834, Iran. Fax: +98 21 22 18 00 49.
E-mail address: m.arazpour@yahoo.com (M. Arazpour).

http://dx.doi.org/10.1016/j.rehab.2017.05.004
1877-0657/

AFOs are used in clinical practice; they are characterized by their design and their constituent materials, enabling different levels of stiffness and ankle control. The most frequently prescribed are the solid AFO (SAFO), dynamic AFO (DAFO), floor reaction orthosis (FRO), posterior leaf spring (PLS) or hinged AFO (HAFO) with a plantarflexion limitation facility.

AFOs are designed to improve the efficiency of gait of children with CP [3] and provide a positive effect on gait kinetics and kinematics [4,5] as well as decrease the energy expenditure of walking [6–8] and enhance the attainment of functional skills [6]. These positive effects on gait include increased active ankle range of motion (ROM) [9,10] and maximum knee extension [11], stride length and walking speed [9,12]. However, a previous literature review [13] reported that the quality of the studies was too low to accurately determine the efficacy of AFOs on gait of children with CP.

The aim of this study was to conduct a systematic review of the recent literature to determine the effect of different AFO types on the gait parameters of children with CP. We aimed to determine whether AFOs have a positive effect on the gait parameters of children with CP and whether these results are supported by high-quality studies.

2. Methodology

2.1. Eligibility criteria

Articles were selected by using the Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) method [14]. Inclusion criteria were studies that evaluated the effect of any type of AFO on the gait of children with CP. Exclusion criteria were studies that did not examine AFOs as a therapeutic intervention or examined other types of treatment such as foot orthoses, robotic-assisted training botulinum toxin, functional electrical stimulation or surgery in conjunction with AFOs. Only outcome measures related to gait and functional ability were considered in this review.

2.2. Information sources

We searched for articles published from 2007 to 2015 in the databases PubMed, Scopus, ISI Web of Knowledge, Cochrane Library, EMBASE and Google Scholar and also ClinicalTrials.gov for finding randomized controlled trial (RCT) study designs. The review strategy involved checking the title and abstracts of articles for the inclusion criteria. Abstract-only reports were not considered because of limited information to determine the specific quality of the studies.

2.3. Search strategy

The search strategy was based on the population intervention comparison outcome (PICO) method with selected keywords joined by the words "OR", "AND" and "NOT". The keywords, from the MeSH database in MEDLINE were ankle foot orthoses, AFO, gait, children, CP, cerebral palsy and walking. For the keyword orthoses, a truncation of the root "orth" (e.g., orthosis, orthoses, orthotic devices) was also used. The date of the last search was January 29, 2016.

2.4. Study selection

Studies with the following in the title or abstract were eligible: (1) participants were children with CP, (2) the intervention included AFOs, (3) the outcome measures included gait parameters, and (4) statistical analyses were reported. The full text of all studies was obtained; the studies are checked more than once against the inclusion criteria, and then assessed for methodological quality. Study designs included RCTs, prospective and retrospective studies that included within- and/or between-group comparisons or cross-sectional studies. Titles and/or abstracts of studies were retrieved, then the full text of studies that met the criteria were independently assessed by 2 review team members.

2.5. Assessing risk of bias in included studies

The quality of studies was assessed by using the Physiotherapy Evidence Database (PEDro) scale [15], with the level of evidence for each selected study assessed according to the criteria suggested by Law and Philp [16], which limited the impact of bias in this process. High scores represented high quality, and this process was conducted independently by 2 reviewers.

2.6. Data collection and synthesis

Collated data included general information such as author name(s), date of publication, subject demographics, study design, intervention characteristics, outcome measures and key results. Key outcomes were described in accordance with the International Classification of Functioning, Children and Youth version (ICF-CY) [17]. The review findings were synthesized qualitatively by methodological (study design, outcomes) and clinical (participant and intervention characteristics) heterogeneity. The individual *P*-values for accepted significance levels in studies are shown in Table 2.

3. Results

3.1. Study selection

We initially identified 62 studies and excluded 25 on the basis of their title and keywords. A further screening to evaluate the relevance of the abstract and the aim of each study excluded 23 further studies. In total, 17 studies met our inclusion criteria (Fig. 1).

Four studies involved RCTs or controlled clinical trials and had level II evidence [18–21]. The remainder had a cross-sectional design with within- and/or between-group comparisons. The PEDro scoring details and level of evidence of included studies are in Table 1.

3.2. Study characteristics

3.2.1. Characteristics of participants

A total of 1139 participants were examined in the selected studies: 893 with spastic diplegia, 128 spastic hemiplegia, 7 spastic triplegia, 59 quadriplegia, and 9 a mixed type. One child had athetoid CP and 4 children had dyskinesia. The studies included 38 healthy controls. The mean sample size was 66 (range 10–378) with mean age 7.58 years (range 1–18) (Table 2).

3.2.2. Types of interventions

Because of the different terms used to describe the same type of AFOs and other descriptors, summarizing results was difficult. Therefore, we used the following terminology defined by Alexander and Xing to define the AFO types [22]; solid AFO (SAFO) refers to solid polyethylene AFO (PAFO) or metallic AFO [5], rigid AFO [4,10], fixed AFO [23], or solid AFO [7,12,19,24,25]. Hinged AFO (HAFO) refers to hinged AFO [8,12,19,20,24,26] or articulated AFO [5,10]. Posterior leaf spring AFO (PLS) refers to posterior leaf spring and spring-type AFO [7,9,24]. Dynamic AFO (DAFO) refers to DAFO [21]. Floor reaction AFO (FRO) refers to FRO [11,27] or ground

Please cite this article in press as: Aboutorabi A, et al. Efficacy of ankle foot orthoses types on walking in children with cerebral palsy: A systematic review. Ann Phys Rehabil Med (2017), http://dx.doi.org/10.1016/j.rehab.2017.05.004