International Journal of Physical Education, Sports and Health 2016; 3(6): 183-186

P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (ISRA): 5.38
IJPESH 2016; 3(6): 183-186

www.kheljournal.com
Received: 01-09-2016
Accepted: 02-10-2016

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Effect of Static and dynamic ankle foot Orthoses on Tendo Achilles tightness in subject with diplegic spastic cerebral palsy- A hypothetical literature review

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Abstract
Background Spastic diplegia is a form of cerebral palsy (CP) that is a chronic neuromuscular condition of hypertonia and spasticity manifested as an especially high and constant tightness or stiffness in the muscles of the lower extremities of the human body, usually those of the legs, hips and pelvis. An ankle-foot orthosis (AFO) is an orthosis or brace that encumbers the ankle and foot which is the most frequently used orthosis in case of diplegic cerebral palsy. Objective of the study was to review the effect of static and dynamic AFO on Tendo Achilles (TA) tightness in subjects with diplegic spastic cerebral palsy. Methods Total of 20 articles reviewed aiming to know the effect of either static or dynamic orthosis which can help to reduce TA tightness among diplegic subjects. Conclusion Thus based on the various results achieved in the previous studies, this literature review concluded that both static and dynamic ankle foot orthoses are equally important in rehabilitating a child with TA tightness in diplegic cerebral palsy, static AFOs assist mainly in stability component whereas dynamic AFOs help in maintaining both mobility and stability of ankle joint.

Keywords: Diplegic spastic cerebral palsy, AFO, TA tightness

1. Introduction
Cerebral Palsy is considered a neurological disorder caused by a non-progressive brain injury or malformation that occurs while the child's brain is under development which primarily affects body movement and muscle coordination.[1] Cerebral Palsy affects body movement, muscle control, muscle coordination, muscle tone, reflex, posture and balance. It can also impact fine motor skills, gross motor skills and oral motor functioning. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, cognition, communication, perception, and/or behavior, and/or by a seizure disorder [2]. Spastic diplegia, historically known as Little's Disease, is a form of cerebral palsy (CP) that is a chronic neuromuscular condition of hypertonia and spasticity manifested as an especially high and constant tightness or stiffness in the muscles of the lower extremities of the human body, usually those of the legs, hips and pelvis. Spastic diplegia cerebral palsy patients have more extensive involvement of the lower extremity than the upper extremity. This allows most people with spastic diplegia cerebral palsy to eventually walk. The gait of a person with spastic diplegia cerebral palsy is typically characterized by a crouched gait. Toe walking and flexed knees are common attributes and can be corrected with proper treatment and gait analysis.[3] Approximately 2 in 1,000 live born children suffer from CP. Globally, the reported incidence and prevalence of CP varies by region, population, age, and severity, which may limit the generalizability of population-based results. Around 77% of Cerebral Palsy is Spastic Diplegic type. [4] In many cases, the cause of cerebral palsy is unknown. Possible causes include genetic abnormalities, congenital brain malformations, maternal infections or fevers, fetal injury, twins or multiple births, low birth weight, infertility treatments, birth complications, Rh incompatibility, premature birth, Assisted reproductive technology (ART) infertility treatments, medical conditions of the mother, exposure to toxic substances, breech presentation, low Apgar score [5-9] Achilles tendon shortening is a feature of many neurological conditions affecting the central or peripheral nervous system including cerebral palsy.

Achilles tendon spasticity or contracture in diplegic CP is one of the major causes of gait abnormality as equinus gait or toe walking. The management of Achilles Tendon tightness in cerebral palsy should involve multiple disciplines including physiotherapy, orthotics, and gait analysis in addition to the orthopedic surgeon.[10] An orthosis (plural: orthoses) is an externally applied device used to modify the structural and functional characteristics of the neuromuscular and skeletal system; control, guide, limit and/or immobilize an extremity, joint or body segment for a particular reason.[11] An ankle-foot orthosis (AFO) is an orthosis or brace that encumbers the ankle and foot which is the most frequently used orthosis in case of diplegic cerebral palsy. AFOs are externally applied and intended to control position and motion of the ankle, compensate for weakness, or correct deformities. AFOs can be used to support weak limbs, or to position a limb with contracted muscles into a more normal position. [12] Objective of this study is to review the effect of static v/s dynamic afos on ta tightness in subject with diplegic spastic cerebral palsy.

2. Methods

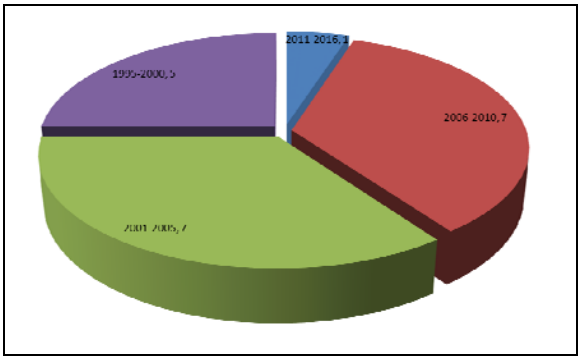
In this study there were 20 articles reviewed on the basis of level of evidence, type of study, year of publication and their conclusion with the aim of finding effect of static and dynamic AFO on TA tightness in case of diplegic spastic CP. Number of articles over the years were reviewed among which few favour the use of static AFO while few are in favour of dynamic AFO. Search criteria were static and dynamic ankle foot orthotics and ankle or TA tightness, searching citation were PubMed, CINHAL. Inclusion criteria for selecting article were study should aim to know the effect of either static or dynamic orthosis which can help to reduce TA tightness among diplegic subjects.

3. Results and Discussion

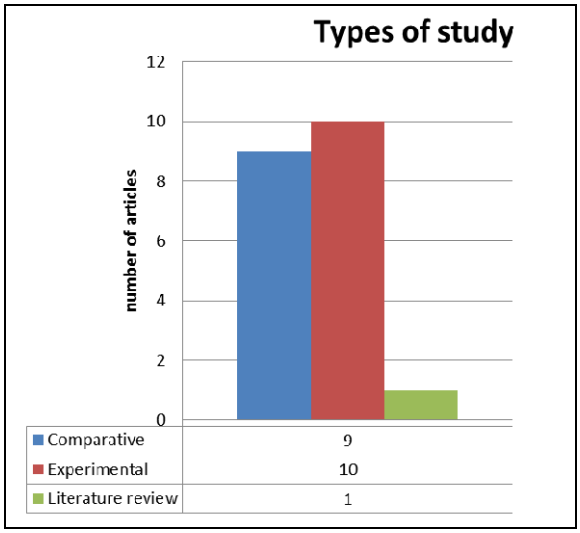
3.1 Result

Author	Year	Aim	Conclusion
Bradford C. Bennett *et al.*	2012	To analyse the effect of ankle foot orthoses on energy recovery and work during gait in children with cerebral palsy	AFO can reduce the work to walk.[13]
Dong-wook Rha *et al.*	2010	To identify the characteristics of static standing balance and its postural control mechanisms during quiet side-by-side standing and the changes in these measures whilst wearing hinged ankle-foot orthoses (AFOs) in children with bilateral spastic cerebral palsy (CP)	Hinged AFOs for children with CP may be helpful in improving the postural control mechanisms but not the postural stability in quiet side-by-side standing.[14]
Erbil Dursun *et al.*	2009	To evaluate the effectiveness of Ankle-Foot Orthoses (AFOs) on gait function in patients with spastic cerebral palsy for whom orthoses were indicated to control dynamic equines deformity	Cerebral palsied children with dynamic equines deformities can benefit from AFOs for ambulation.[15]
Dr Birol Balaban *et al.*	2009	To assess the effectiveness of a hinged ankle-foot orthoses on gait impairments and energy expenditure in children with hemiplegic cerebral palsy (CP)	hinged AFO is useful in controlling dynamic equinus deformity and reducing the energy expenditure of gait in children with hemiplegic spastic cerebral palsy.[16]
Brehm *et al.*	2008	To determine the effect of ankle-foot orthoses on walking efficiency and gait in a heterogeneous group of children with cerebral palsy, using barefoot walking as the control condition	The improvements in efficiency were reflected in changes of stance and swing phase knee motion, i.e. those children whose knee flexion angle improved toward the typical normal range demonstrated a decrease in energy cost of walking, and vice versa.[17]
Figueiredo *et al.*	2008	To perform a literature review evaluating the quality of research on the influence of ankle-foot orthoses (AFOs) on gait in children with cerebral palsy	The result showed on the basis of PEDro level of evidence that two between-group and 18 within-group studies met the inclusion criteria indicating a low level of evidence. Between-group studies each scored 4 on the PEDro Scale, and 17 within-group studies scored 3 and 1 scored 2, indicating low quality. Standard terminology for AFOs was not used and only 6 studies described functional status using appropriate instruments.[18]
Shlomo Hayek *et al.*	2007	To evaluate the efficacy of ankle foot orthoses (AFOs) prescribed in the community for children with cerebral palsy	The use of AFOs improves spatio-temporal gait parameters and gait stability in children with spastic cerebral palsy.[19]
Bjornson *et al.*	2006	To analyse the effect of dynamic ankle foot orthoses on function in children with cerebral palsy	Young children who are independent walkers seem to benefit greater from the DAFOs with free plantarflexion than do children using assistive devices.[20]
W.K. Lam *et al.*	2005	To evaluate the biomechanical and electromyographic effects of conventional ankle foot orthoses (AFOs) and dynamic ankle foot orthoses (DAFOs) on gait in patients with spastic cerebral palsy (CP)	DAFOs allowed a significantly larger total ankle range of motion than the AFOs. However, AFOs significantly reduced the MF while DAFOs did not.[21]
Sandra A. Radtka *et al.*	2005	To compare the effects of solid and hinged ankle-foot orthoses (AFOs) on the gait of children with spastic diplegic cerebral palsy (CP) who ambulate with excessive ankle plantar flexion during stance	Both orthoses increased stride length, reduced abnormal ankle plantar flexion during initial contact, midstance and terminal stance (TST), and increased ankle plantar flexor moments closer to normal during TST.[22]
Cathleen.E Buckon *et al.*	2004	To compare the functional efficacy of three commonly prescribed ankle–foot orthosis (AFO) configurations (solid	Constraining ankle motion by using a PLS or SAFO should be considered for most, but not all,

		[SAFO], hinged [HAFO], and posterior leaf spring [PLS])	children with spastic diplegia.[23]
Eun Sook Park *et al.*	2004	To investigate the effectiveness of the hinged ankle-foot orthosis (AFO) on sit-to-stand (STS) transfers in children with spastic cerebral palsy	A hinged AFO is beneficial for STS transfer activity for children with spastic diplegia.[24]
Annika Näslund *et al.*	2003	To explore how the parents of children with diplegic cerebral palsy experience the use of DAFOs	DAFOs may (according to parents) be regarded as a suitable complement to other treatments in children with diplegic cerebral palsy.[25]
Jacqueline Romkes *et al.*	2002	To compare a dynamic and a hinged ankle-foot orthosis by gait analysis in patients with hemiplegic cerebral palsy	The d-AFO did not improve gait significantly whereas the h-AFO did.[26]
Hank White *et al.*	2002	To determine the effect clinically prescribed ankle–foot orthoses (AFOs) have on the temporal-spatial parameters of gait, as compared with barefoot walking in children with cerebral palsy	the temporal and spatial gait parameters of velocity, stride length, step length, and single limb stance were significantly increased with the use of AFOs versus barefoot walking.[27]
Crenshaw *et al.*	2000	To analyse the effects of tone-reducing features in ankle-foot orthotics (AFOs) on the gait of eight children (ages 4–11 years) with spastic diplegic cerebral palsy	Most significant differences were at the ankle, between free-ankle and plantar flexion-limiting conditions.[28]
Rethlefsen *et al.*	1999	To inteprete the effects of fixed and articulated ankle-foot orthoses on gait patterns in subjects with cerebral palsy	AAFOs are appropriate for subjects with varying degrees of calf spasticity, as long as adequate passive range of motion is available.[29]
Mark F. Abel *et al.*	1998	To evaluate the effectiveness of ankle-foot orthoses (AFOs) in spastic diplegic cerebral palsy patients for whom orthoses were indicated to control equinus or pes planovalgus deformities.	AFOs enhanced gait function in diplegic subjects.[30]
Sandra A Radtka *et al.*	1997	To compare the effects of dynamic ankle-foot orthoses (DAFOs) with a plantar-flexion stop, polypropylene solid ankle-foot orthoses (AFOs), and no AFOs on the gait of children with cerebral palsy (CP)	Both orthoses increased stride length, decreased cadence, and reduced excessive ankle plantar flexion when compared with no orthoses.[31]
Carlson *et al.*	1997	To compare the effects of a fixed ankle-foot orthosis (AFO), a supramalleolar orthosis (SMO), and a no-brace condition, but including shoes	Neither brace changed stride length and walking speed, AFOs did offer some biomechanical benefits to the child with spastic diplegia, whereas SMOs appeared to have very little measurable effect.[32]



Reviewed articles (year published)



Reviewed articles (Types of Study)

3.2 Discussion

Aim of this current literature review was to find out effect of static and dynamic ankle foot orthoses on ankle tightness in diplegic spastic cerebral palsy. Total of 20 studies were reviewed among which few studies support static AFOs and few studies support dynamic AFOs. Static AFOs give more stability component than mobility whereas in case of dynamic AFOs both mobility and stability of ankle were maintained. TA tightness due to spasticity was considerably reduced after application of static AFOs rather than dynamic AFOs. But for chronic diplegic cases, dynamic AFO was more useful as it assists in mobility part which in turn helps in improving walking parameters. Thus, in this study there was a hypothetical situation to say whether static or dynamic AFOs are more useful to reduce TA tightness but both are equally important in case of diplegic spastic cerebral palsy.

4. Conclusion

Supporting evidence from the literature though seemed to be controversial in certain areas; the study concluded that both static and dynamic ankle foot orthosis are equally important in rehabilitating a child with TA tightness in diplegic cerebral palsy; where static AFOs assist mainly in stability component than mobility component whereas dynamic AFOs help both in maintaining mobility and stability of ankle joint.

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