Recent Research on Dynamic Orthoses

(Current – 2002)

Kim K, Kang JY, Jang DH. **Relationship between mobility and self-care activity in children with cerebral palsy**. *Annals of Rehabilitation Medicine* (2): 266-272 (April 2017; journal article).
Key outcomes: Mobility is a significant factor in self-care activities of children with CP aged ≥7 years. A rehabilitation program aimed at improving mobility is crucial, since it forms the basis for further improvements in self-care activity, leading to significant improvements in the quality of life.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5426278/

Herrin K. and Geil M. **A comparison of orthoses in the treatment of idiopathic toe walking: A randomized controlled trial.** *Prosthetics and Orthotics International* (2016, volume 40(2) 262-269, original research report).
Key outcomes: This study suggests that sequential orthotic treatment for children with idiopathic toe walking (ITW) may be beneficial. Initial treatment could include a less restrictive orthosis like a foot orthosis (FO); if this is unsuccessful within a set timeframe, then the patient may require a more restrictive form of treatment such as an ankle–foot orthosis (AFO).
https://www.ncbi.nlm.nih.gov/pubmed/25628380

Manousaki A, Czuba T, Hägglund G, Mattsson L, Andriesse H. **Evaluation of gait, relapse and compliance in clubfoot treatment with custom-made orthoses**, *Gait & Posture* 50: 8-13 (2016; journal article)
Key outcomes: The use of dynamic custom-made orthoses in clubfoot treatment was analyzed. No relapse occurred during the four years of orthosis treatment. Gait was similar to gait after treatment with the standard Foot Abduction Orthosis. High compliance with the orthoses was observed. The dynamic orthosis is a good alternative in clubfoot treatment.
http://www.gaitposture.com/article/S0966-6362(16)30481-7/abstract

Wren T, Dryden J, Mueske N, Dennis S, Bitte S, Rethlefsen S. **Comparison of 2 Orthotic Approaches in Children With Cerebral Palsy.** *Pediatric Physical Therapy (Fall 2015, Volume 27, Issue 3, p 218-226; research article)*
Key outcomes: To compare dynamic ankle-foot orthoses (DAFOs) and adjustable dynamic response (ADR) ankle-foot orthoses (AFOs) in children with cerebral palsy.
https://www.ingentaconnect.com/content/wk/pep/2015/00000027/00000003/art00002

Dalvand H, Dehghan L, Awat F, Seyed AH, Amirsalari, S. **The Impacts of Hinged and Solid Ankle-Foot Orthoses on Standing and Walking in Children with Spastic Diplegia.**
Iranian Journal of Child Neurology. 2013 Autumn; 7(4): 12-19. (2013; journal article).
Key outcomes: Gross motor function was improved in all groups; however, hinged AFOs appear to improve the gross motor function better than solid AFOs and control groups.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3943047/

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Bennett B, Russell S, Abel M. **The effects of ankle foot orthoses on energy recovery and work during gait in children with cerebral palsy.** *Clinical Biomechanics* (Bristol, Avon) March 2012; 27 (3) 287-291 (2012; journal article).
Key outcomes: Ankle foot orthoses can reduce the work to walk in children with cerebral palsy.
http://www.clinbiomech.com/article/S0268-0033(11)00244-0/abstract

Geil M, and Herrin K. **Is a rigid footplate as effective as an articulated AFO in controlling idiopathic toe walking?**
AAOP Annual Meeting, Atlanta, GA (2012; presentation summary).
Key outcomes: Orthoses are effective in prevention of toe walking at initial contact in children with ITW. AFOs and FOs produce different effects on gait in these children and may have different implications for long-term carryover from treatment.
Further research needed: Results are preliminary; bigger sample size.
http://www.oandp.org/jpo/

Herrin K, Barner K, Geil M. **Clinical outcomes after orthotic treatment of idiopathic toe walking: AFO vs. FO**.
AAOP Annual Meeting, Atlanta, GA (2012; presentation summary).
Key outcomes: Both treatments of idiopathic toe walking, AFO and FO, increase patient speed, while an AFO may lead to greater parent satisfaction and quicker reductions in time spent toe walking than the FO.
Further research needed: Bigger sample size.
http://www.oandp.org/jpo/

National Guideline Clearinghouse. **Guideline summary: Evidence-based care guideline for management of idiopathic toe walking in children and young adults ages 2 through 21 years.**
National Guideline Clearinghouse [Website]. Rockville (MD): Agency for Healthcare Research and Quality (cited 2012 May 01).
https://cascadedafo.com/library/documents/idiopathic-toe-walking-study

Slijper A, Danielsson A, Willen C. **Ambulatory Function and Perception of Confidence in Persons with Stroke with a Custom-Made Hinged versus Standard Ankle Foot Orthosis.**
Rehabilitation Research and Practice, 206495 (2012; journal article).
Key outcomes: Wearing a DAFO resulted in longer walking distance and faster stair climbing compared to walking with a C-AFO. Eleven of twelve participants felt more confident with the DAFO, which may be more important than speed and distance and the most important reason for prescribing an AFO.
http://www.hindawi.com/journals/rerp/2012/206495/

Ross C.G., and Shore S. **The effect of gross motor therapy and orthotic intervention in children with hypotonia and flexible flatfeet.** *Journal of Prosthetics and Orthotics*, 23(3): 149-154 (2011; journal article).
Key Outcomes: Although gross motor therapy alone may have improved some gait parameters toward age-appropriate norms in young children with hypotonia and flatfeet, the addition of orthoses also significantly modified the arch index, possibly preventing long-term complications.
http://copypage.net/assets/the-effect-of-gross-motor-therapy-and-orthotic-intervention-in-children-with-hypotonia-and-flexible-flatfeet-by-ross-and-shore.pdf

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Nolan KK, Savalia KK, Yarossi M, Elovic EP. **Evaluation of a dynamic ankle foot orthosis in hemiplegic gait: A case report**. *NeuroRehabiliation* 27(4):343-50 (2010; journal article).
Key outcomes: The dynamic AFO had a positive effect on the participant's overall gait which included improved temporal-spatial parameters and gait velocity which is likely due to a decrease in the overall energy cost of walking. Kinematic angles at the hip were most notably affected by brace utilization and this effect should be more fully explored.
Further research needed: Larger sample utilizing dynamic AFOs is indicated to explore the generalizability of these findings and to determine the potential utility of these braces as an alternative to the traditionally prescribed solid AFO.
https://www.ncbi.nlm.nih.gov/pubmed/21160124

Rha DW, Kim DJ, Park ES. **Effect of hinged ankle-foot orthoses on standing balance control in children with bilateral spastic cerebral palsy**. *Yonsei Medical Journal* 51(5):746-52 (2010; journal article).
Key outcomes: 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.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2908864/

Garg S, Porter K. **Improved bracing compliance in children with clubfeet using a dynamic orthosis**. *Journal of Children's Orthopaedics* 3(4):271-276 (2009; journal article).
Key outcomes: The dynamic foot abduction brace results in improved compliance, fewer recurrences, fewer skin complications, and reduced rates of surgery in idiopathic clubfoot than the traditional brace after non-operative correction with the Ponseti method.
https://www.ncbi.nlm.nih.gov/pubmed/19495824

Rogozinski BM, Davids JR, Davis RB 3rd, Jameson GG, Blackhurst DW. **The efficacy of the floor-reaction ankle-foot orthosis in children with cerebral palsy**. *The Journal of Bone and Joint Surgery, American Edition* 91(10):2440-7 (2009; journal article).
Key outcomes: The floor-reaction ankle-foot orthosis is effective in restricting sagittal plane ankle motion during the stance phase of gait in patients with cerebral palsy. As a result, improvements in knee extension and the sagittal plane knee extensor moment in stance phase are achieved.
https://www.ncbi.nlm.nih.gov/pubmed/19797580

Smith PA, Hassani S, Graf A, Flanagan A, Reiners K, Kuo KN, Roh JY, Harris GF. **Brace evaluation in children with diplegic cerebral palsy with a jump gait pattern**. *The Journal of Bone and Joint Surgery, American Edition* 91(2):356-65 (2009; journal article).
Key outcomes: Our data suggest that gait improves with brace wear in children with cerebral palsy with a level-I Gross Motor Function Classification System score. The Pediatric Outcomes Data Collection Instrument and the Gross Motor Function Measure were not sensitive to brace treatment in the population studied. The hinged and dynamic braces were equally effective for improving ankle kinematics and kinetics in these relatively highly functioning children with cerebral palsy.
https://europepmc.org/abstract/med/19181980

Balaban B, Yasar E, Dal U, Yazicioglu K, Mohur H, Kalvon TA. **The effect of hinged ankle-foot orthosis on gait and energy expenditure in spastic hemiplegic cerebral palsy.** *Disability and Rehabilitation* 29(2):139-44 (2007; journal article).
Key outcomes: The hinged AFO is useful in controlling dynamic equinus deformity and reducing the energy expenditure of gait in children with hemiplegic spastic cerebral palsy.
http://www.tandfonline.com/doi/abs/10.1080/17483100600876740?journalCode=idre20

George D, and Elchert L. **The influence of foot orthoses on the function of a child with developmental delay**.
Pediatric Physical Therapy 19:332-336 (2007; journal article).
Key outcomes: Five items from the Peabody Developmental Motor Scale II (rise to stand, standing, lowering, cruising, and stepping forward) were tracked over three weeks, under three conditions: with shoes and orthoses, shoes only, and barefoot. The ability to perform these items was improved when wearing shoes and orthoses.
Further research needed: Future study needed of the modified stabilizing foot splint as an intervention.
https://www.ncbi.nlm.nih.gov/pubmed/18004202

Bjornson KF, Schmale GA, Adamczyk-Foster A, McLaughlin J. **The effect of dynamic ankle foot orthoses on function in children with cerebral palsy**. *Journal of Pediatric Orthopedics* 26:6 773-776 (2006; journal article).
Key outcomes: Immediate, significant improvements in crawling/kneeling, standing, walking/running, jumping functions of young CP patients who are independent walkers. Free PF with pronation-supination control improved gross motor skills.
Further research needed: Long-term effect; influence of DAFO on motor skills as child develops; larger study samples; context of child's day-to-day life; measure effects from multiple perspectives of child, parent, school staff, as well as more objective measures.
https://insights.ovid.com/crossref?an=01241398-200611000-00016

Pitetti K, Wondra V. **Dynamic foot orthosis and motor skills of delayed children**.
Journal of Prosthetics and Orthotics 17: 21-24 (2005; journal article).
Key outcomes: DFOs improved significantly balance and locomotor skills in all patients.
http://www.oandp.org/jpo/

Wondra V, Pitetti K. **Comparison of two dynamic foot orthoses on children with delayed gross locomotor skills**.
ACPOC Conference, Orlando, Fla. (2005; presentation summary).
Key outcomes: Significant gross motor skill improvements in both groups. PattiBob showed significant improvements in age equivalent scores.
http://www.acpoc.org/

Wondra V, Pitetti K. **Dynamic foot orthosis: product production vs. clinical application vs. documented research**.
ACPOC 11:3 6-10 (2005; editorial).
Key outcomes: Differing timelines of orthosis production, clinical work, and research+
http://www.acpoc.org/

Martin K. **Effects of supramalleolar orthoses on postural stability in children with Down syndrome**.
Developmental Medicine & Child Neurology 2004, 46: 406-411 (2004; journal article).
Key outcomes: Flexible SMOs have a positive effect on postural stability. Supports hypothesis that orthoses create an improved biomechanical alignment that allows muscles to work in a more appropriate length-tension relationship.
Further research needed: Other age groups; hypotonia of any origin; need more work on the influence of joint laxity; comparison of other SMO types.
https://www.ncbi.nlm.nih.gov/pubmed/15174532

Rodda, J.M., Graham, H.K., Carson, L., Galea, P., Wolfe, R. **Sagittal Gait Patterns in Spastic Diplegia**.
The Journal of Bone and Joint Surgery 86.2 (2004): 251-58 Web.
Key outcomes: A simple classification of sagittal gait patterns based on a combination of pattern recognition and kinematic data resulting from a cross-section study of 187 children with spastic diplegia who attended a gait laboratory, followed by a longitudinal study of 34 children who were followed for more than one year.
http://bjj.boneandjoint.org.uk/content/86-B/2/251

Guichet J et al. **Effect of the foot on the mechanical alignment of the lower limbs**.
Clinical Orthopedics & Related Research 415(1):193-210 (2003; journal article).
Key outcomes: The foot in the radiographic measurement of limb alignment may increase validity of surgical planning for correction of malalignment and for evaluation of degenerative arthritis risk at the knee level.
https://www.ncbi.nlm.nih.gov/pubmed/14612646

Naslund A, Tamm M, Ericsson A, Von Wendt, L. **Dynamic ankle-foot orthoses as part of treatment in children with spastic diplegia – parent's perceptions.** *Physiotherapy Research International*, 8 (2) 59-68 (2003; journal article).
Key outcomes: In clinical practice, DAFOs may (according to parents) be regarded as a suitable complement to other treatments in children with diplegic cerebral palsy.
http://onlinelibrary.wiley.com/doi/10.1002/pri.273/abstract

Wesdock K, and Edge A. **Effects of wedged shoes and ankle-foot orthoses on standing balance and knee extension in children with cerebral palsy who crouch**. *Pediatric Physical Therapy* 15(4):221-231 (2003; journal article).
https://www.ncbi.nlm.nih.gov/pubmed/17057458

Sienko S et al. **Stair locomotion in children with spastic hemiplegia: the impact of three different ankle foot orthosis (AFOs) configurations**. *Gait & Posture* 16(2):180-7 (2002; journal article).
Key outcomes: At the ankle, the hinged AFO provided the greatest amount of dorsiflexion during stance. All AFOs reduced plantarflexion in comparison to barefoot. The results of this study indicate that for children with spastic hemiplegia the use of an AFO did not impair stair ambulation.
http://www.gaitposture.com/article/S0966-6362(02)00002-4/fulltext

Yaguramaki N, and Kimura T. **Acquirement of stability and mobility in infant gait**.
Gait Posture 16(1):69-77 (2002; journal article).
Key outcomes: Lateral stability, which develops earlier than mobility, is the most important factor in gait development in infants.
http://www.gaitposture.com/article/S0966-6362(01)00205-3/fulltext

Ball KA, and Afheldt MJ. **Evolution of foot orthotics—part 2: Research reshapes long-standing theory**.
Journal of Manipulative and Physiological Therapeutics 25(2):125-24 (2002; journal article).
Key outcomes: Numerous studies show that patterns of rearfoot inversion/eversion cannot be characterized either by foot type or by orthotics use. Rather, subtle control of internal/external tibial rotation appears to be the most significant factor in maintaining proper supination/pronation mechanics. Recent evidence also suggests that proprioceptive influences play a large, and perhaps largely unexplored, role.
http://www.jmptonline.org/article/S0161-4754(02)18746-X/fulltext

Archived Research
(Prior to 2002)

Kuhn D R. et al. **Radiographic evaluation of weight-bearing orthotics and their effect on flexible pes planus**.
Journal of Manipulative and Physiological Therapeutics 22(4):221-6 (1999; journal article).
Key outcomes: Radiographic measurements indicated statistically significant improvements in weight-bearing foot alignment with the use of custom orthotics cast in weight-bearing.
https://www.sciencedirect.com/science/article/pii/S0161475499700485

Aharonson Z, Arcan M, and Steinback T. **Foot-ground pressure of flexible flatfoot in children with and without correction of calcaneovalgus**. *Clinical Orthopedics and Related Research* 278:177-182 (1992; journal article).
Key outcomes: Standing at ease, the children exerted most of their ground pressure by the posterior weight-bearing area (WBA). The rest was distributed between the middle and anterior WBAs, with the middle area usually exerting about 17%, and in extreme cases, as much as 30% of the total foot-ground pressure. Correcting valgus inclination of the calcaneus into neutral by inserting a leather wedge under the medial portion of the heel restored the longitudinal arch and the normal distribution of the foot-ground pressure of the standing child.
https://europepmc.org/abstract/med/1563152

Hylton, N. **Postural and functional impact of dynamic AFOs and FOs in a pediatric population**.
Journal of Prosthetics & Orthotics 1990,2:1 40-51 (1990; expository journal article).
Key outcomes: Though this article is not recent and does not report on research, it is a seminal piece that explains the origin and fundamentals of the DAFO concept.
http://journals.lww.com/jpojournal/Citation/1989/10000/Postural_and_Functional_Impact_of_Dynamic_AFOs_and.4.aspx

Aharonson Z, Voloshin A, Steinbach TV, Brull MA, and Farine I. **Normal foot–ground pressure pattern in children**. *Clinical Orthopedics and Related Research* 150:220-223 (1980; journal article).

Key outcomes: Standing at ease, the child with a normal foot exerts most of his ground pressure by the posterior weight-bearing area (WBA). The rest is distributed between the middle and anterior WBAs, with the middle portion exerting no more than 10% of the total foot–ground pressure.
https://www.ncbi.nlm.nih.gov/pubmed/7428224

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