Orthotics for children with hypotonia: does research literature support various views on bracing for children with low muscle tone?

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Pediatric physical therapists often recommend foot orthoses (FOs) for children with abnormal foot, ankle, and/or knee biomechanics. Origins of dysfunction include weakness, hypertonicity, spasticity, clonus, ligamentous laxity, and/or joint dysfunction.

One area of continued controversy is the need for bracing in children with low muscle tone, including those with Down syndrome (DS). Some therapists maintain that as soon as a toddler with hypotonia begins to pull to stand and bear weight through their feet, they should be offered orthotic support. They believe that once overstretched, ligaments cannot recover and the child is set up for lifelong instability of the foot, especially the midfoot. Others believe that only the arch or midfoot needs support and that the toes should always remain free. The most conservative view holds that the orthotics themselves interfere with arch development and will result in a weak, malformed foot. Is there support in the literature for any of these approaches?

RIGID FULL-FOOT SUPPORTS

This category would include full-length shoe inserts--from flat to supramalleolar and everything in between.

The least restrictive models are premade with plain foam or laminated foam with plastic, and they are usually recommended for children who need moderate biomechanical support and/or sensory feedback. The submalleolar (or UCB) option provides more control and is generally used for younger children or those with fleshy feet that are fully correctable but have flat arches and low tone. The supramalleolar orthosis (SMO) controls severe pronation and supination, and it is good for toddlers moving from floor activities to standing and walking. SMOs can be used with more straps for further stability and control, or elastic or fewer straps to progress the child.

A common strategy is to get a child a taller brace with more straps and then remove the straps and cut the brace down as the child gains stability and strength.

Martin (1) published a study looking at the effects of SMOs on postural stability in children with DS. This study explored the effects of a flexible SMO, indicated to decrease pronation associated with hypotonia, on postural stability in children with DS. Seventeen children, ranging in age from 3 years 6 months to 8 years, were tested three times in a 10-week period (weeks 1, 3, and 10) using the Standing and the Walking, Running, and Jumping dimensions of the Gross Motor Function Measure (GMFM), and the Balance subtest of the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP). Range-of-motion measurements were used to explore the influence of joint laxity.

Significant improvement was found with SMOs compared with shoes only in the Standing dimension ($p=0.001$) and the Walking, Running, and Jumping dimension ($p=0.0001$) of the GMFM, both at the time of fitting (week 3) and after 7 weeks of wearing SMOs (week 10). For the BOTMP Balance subtest, significant improvement ($p=0.027$) was seen only at the end of the 7-week study period. The amount of joint laxity did not influence response to orthotic intervention. This study showed that young children with DS showed immediate and longer-term (after 7 weeks of use) improvement in postural stability with the use of flexible SMOs.

Selby-Silverstein, Hillstrom, and Palisano (2) studied the effect of foot orthoses on standing foot posture and gait of young children with DS. The gait of children with DS wearing sneakers was compared to those with and without FOs, and also was compared to the gait of children without disabilities. During gait, the transverse-plane foot angle decreased, indicating more internal rotation with FOs. Trial-to-trial variability of the pronation-supination index, foot-length contact, transverse-plane foot angle, and walking speed all decreased with FO use. Trial-to-trial variability of normalized peak ankle movement, and of phase of peak ankle movement, increased when the children wore FOs.

In 2004, Rome and Brown (3) showed that the use of FOs in normal adults may improve postural control by stabilizing the rear foot and thus maintaining balance.

Buccieri (4) published a case report about the use of orthoses and early-intervention physical therapy to minimize hyperpronation and promote functional skills in a child with gross motor delays. A 25-month-old girl with a 6-month gross motor delay had excessive pronation of both feet. Physical therapy included fabrication of FOs to improve foot alignment and weekly facilitation of strength, coordination, and balance; and family-education activities. The Peabody Developmental Gross Motor Scales revealed a 12-month gain in gross motor skills in 5 months. The author

concluded that physical therapy to facilitate normal foot alignment, trunk control, strength, balance, and coordination may have promoted this child's acquisition of age-appropriate gross motor skills.

Kates (5) performed a single-subject design study on a 4-year-old child with DS and hypotonia, comparing two types of supramalleolar orthoses and a control baseline of not wearing orthoses. One type of orthoses featured a gait-plate design at the toe to control toeing-out, and a rigid, carbon fiber laminate on the bottom. The other type of orthoses featured a regular toe design. The gait-plate design of orthoses with the rigid bottom was associated with an increased step length and speed of walking compared with either the orthoses with the regular toe design without the rigid bottom or the baseline of not wearing orthoses.

Grossman (6) studied four subjects between the ages of 2.5 and 5.5 years, comparing hand-fabricated, soft plastic, submalleolar orthoses (made of Pelite and moleskin) to the condition of not wearing orthoses. A study of footprints, called pedographs, demonstrated improvement in three of the four subjects in the areas of decreased toeing-out and increased step length. Younger children with mild flat feet demonstrated greater change than older children with moderate flat feet.

Leung, Mak, and Evans (7) conducted biomedical gait evaluation of the immediate effect of orthotic treatment for flexible flat foot. A motion-analysis system with two video cameras placed on the lateral and rear sides of the subjects in the study, together with one force platform, was used to investigate the immediate effects of the orthotic treatment. The force platform collected force data and the two cameras captured 2D displacement data of the lower limb. Eight subjects, all having an arch index larger than 3.0, participated in the study. The results showed changes in displacement data with relatively little change in the collected force data. The modified UCBL shoe insert significantly affected the orientation and movements of the subtalar joint, ankle joint, and knee joint. These immediate effects reduced the degree and duration of abnormal pronation during the stance phase, and thus had the potential for decreasing strain in the plantar ligaments and reducing abnormal tibial rotation, which may be therapeutic for the foot.

TOES-FREE OPTIONS

New options in braces allow patients' toes to be free and experience normal sensory input. These orthotics are usually made from extremely thin and flexible plastic that is tightened around the foot, compressing the soft tissue, and neutral positioning is the intended result. The trimlines of these orthotics are proximal to the first metatarsal head, which may encourage push-off and allow squatting, jumping, running, and standing on toes. The lateral side is cut back behind the fifth toe. This

may help to control lateral deviation of the forefoot and lock the foot into a rigid lever-arm during pushoff. These braces are not custom made and do not require casting. They are soft and support the midfoot and hindfoot while allowing some movement.

Therapists who choose this brace believe that it allows the foot to "sense" movement and respond appropriately. They believe that joint receptors will function normally, which will encourage more natural development of balance reactions. Therapists say the children have improved endurance and develop better balance responses, although their evidence is anecdotal reports and none have been published.

NO ORTHOTICS

On a recent visit to the orthopedist, I accompanied a child with gross motor-developmental delays and severe pronation. The physician argued that there was no such thing as "navicular subluxation" and that the child would be just fine without intervention. Sadly, I lost this argument with the physician because I did not have the evidence to support my case. The child remains "clumsy" with poor balance reactions at age 4. Since this visit, I have found Assessment of the position of the navicular by three-dimensional magnetic resonance imaging in infant foot deformities," by Cahuzac. (8) I will never know if the orthotics could have changed her outcome.

I do believe that there is enough evidence to support consideration of use of orthotics in children with DS. If a child who is beginning to ambulate has severe or moderate pronation, a trial with an orthotic is indicated. A simple video of the child accomplishing simple functional tasks with and without the orthotics should be made. Play the tapes for another therapist and see if they can tell the difference. Ultimately, a gait analysis would be ideal, but most therapists do not have access or funding for this kind of assessment.

In conclusion, there are not enough studies to enable therapists to evaluate the effectiveness of bracing for toddlers with DS. This is yet another example of how clinical therapists can change practice patterns by publishing the results of their interventions. The question of orthotics seems so simple, yet there is no clear answer. Let's continue to assess our interventions and share those results in journals and at conferences. If we can establish the best assessment tools, use them appropriately and at predetermined intervals, and modify our interventions based on this information, our pediatric patients should have improved outcomes.

[Editor's Note: References for this article can be found in the online version at PTProductsOnline.com.]

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