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february 2014

New flatfoot data rekindle debate over role of obesity

Strength training improves function in children with CP

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- Long-term clubfoot outcomes
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- Variable ankle function in CMT
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news

features

From the editor: Shaping the future

One of the most rewarding aspects of pediatric lower extremity care is the knowledge that early intervention can have a positive effect on a child's entire adult life—a theme that is repeated throughout this special publication dedicated to lower extremity pediatrics.

In some cases, the upside of early intervention is readily apparent. For example, new research demonstrates that children with clubfoot who are treated with the Ponseti method have significantly better functional outcomes as adults than those treated with surgery. Research also suggests that children with meniscal tears who are treated within three months of injury are more likely to have tears that can be repaired rather than removed, thus significantly reducing the risk of early onset knee osteoarthritis.

In other cases, the picture is less clear. Experts have yet to reach a consensus as to whether early intervention in children with flexible flatfoot might spare those children from more serious issues as adults—a debate that becomes even more complicated when the issue of childhood obesity is added to the mix. Early intervention in a child with Charcot-Marie-Tooth (CMT) disease can positively affect that child's gait pattern for years to come, but only if the treating clinician is aware that not all gait impairments in patients with CMT are the same.

Improving a child's pain and function for now is a worthwhile goal. Improving a child's pain and function for a lifetime is even better. That's why we've created *LER: Pediatrics*, a quarterly publication dedicated to pediatric lower extremity care and filled with the type of evidence-based information you need for both short- and long-term clinical success in treating your littlest patients. Let us know what you think.

Jordana Bieze Foster, *Editor*

Ponseti method surpasses surgery for long-term clubfoot outcomes

But both groups fall short of controls

By Samantha Rosenblum

Children treated for clubfoot with the Ponseti method have less pain and fewer gait impairments as adults than those treated with surgery, according to research from Shriners Hospital for Children in Chicago.

In 42 adults aged between 19 and 35 years who were treated for clubfoot as infants (24 surgically, 18 using the Ponseti method) between 1983 and 1987, researchers compared the long-term results of each procedure in terms of foot function, foot biomechanics, and quality of life; they also compared the clubfoot patients to a control group of individuals with no history of clubfoot.

Both treatment groups had strength and motion deficits compared with the control group, but the group treated with the Ponseti method had better outcomes than the surgical group in many areas.

For example, individuals in the Ponseti group demonstrated significantly greater ankle plantar flexion range of motion (ROM), greater ankle plantar flexor and evertor strength, and a lower incidence of osteoarthritis in the ankle and foot. Additionally, the researchers found significantly higher pain levels in the surgical group than in the Ponseti group, as well as significantly reduced gait speed and stride length and more time spent in double support.

Overall, the study supports efforts to correct clubfoot with the Ponseti method, which minimizes surgery to joints to promote ROM and strength—essential elements of adult functioning in the years after treatment. The findings were epublished in November 2013 *Clinical Orthopedics and Related Research*.

Children in the Ponseti group began receiving treatment an average of 12.4 days after birth. The Ponseti method, developed by Ignacio Ponseti, MD, consists of manipulation of the foot and casting. Casts are changed weekly with gradually increasing correction and, at the final stage (after about four weeks), surgeons do a heel cord tenotomy to achieve a plantigrade position of the ankle and foot, according to Peter Smith, MD, principal investigator of the study and an orthopedic surgeon at Shriners Hospital for Children in Chicago. Patients then underwent abduction bracing with a Denis-Browne bar and straight laced shoes, which they wore full time for two months, followed by nighttime use for four years.

Children in the surgical group had been treated with conventional casting and had an inadequate response or were approaching age 18 months (the cut-off age for corrective surgery), and subsequently underwent surgery, a comprehensive clubfoot release with a Cincinnati incision.

Despite the growing popularity and positive outcomes associated with the Ponseti method, there are some situations in which surgery might still be used. According to John Herzenberg, MD, director of Pediatric Orthopedics at Sinai Hospital and director of the International Center for Limb Lengthening, both in Baltimore, MD, parents must play a large role in treatment for the Ponseti method to work effectively.

> The study supports clubfoot correction with the Ponseti method, which minimizes surgery to joints to promote ROM and strength.

"Less parent participation and compliance is needed for surgery than the Ponseti approach," Herzenberg said. "The Ponseti approach consists of three years of casting by the physician and then four years of bracing, which has to be supervised daily by the parents. Some parents are not able to maintain this protocol, for a variety of reasons."

Herzenberg cited social and economic barriers as issues that can adversely affect compliance.

The study's limitations may have had substantial effects on the data collected.

Photo courtesy of MD Orthopaedics.

Most importantly, there exists a strong possibility of selection bias, as all patients in the study who underwent Ponseti method therapy received that treatment at the University of Iowa Hospital and Clinics in Iowa City, where surgeons have used the Ponseti method for decades. All individuals in the surgery group were treated at the Shriners Hospital for Children in Chicago, where surgery was the standard of care at the time for patients in whom conventional casting failed. The Ponseti method is now the standard clubfoot treatment at Shriners.

Clubfoot patients treated in more recent years have likely benefited from advances in treatment protocols, Smith said.

"We are always trying to speed correction and prevent recurrence through better casting and bracing, and it is definitely a field that is improving," he said. "We think the outcomes are a bit better, particularly in achieving initial correction of the foot into an abducted position to prevent recurrence and meticulous detail to bracing. But there is still an intrinsic nature of clubfoot that we don't understand that seems to result in diminished strength and motion to a varying degree—even with the best current techniques." ler

Samantha Rosenblum is a journalism student at Northwestern University in Evanston, IL.

Source:
Smith PA, Kuo KN, Graf AN, et al. Long-term results of comprehensive clubfoot release versus the Ponseti method: Which is better? Clin Orthop Relat Res 2013 Nov 19. [Epub ahead of print]

Ankle dorsiflexion patterns vary in Charcot-Marie-Tooth disease

Data support case-by-case approach

By Larry Hand

Gait patterns can vary significantly among young patients with Charcot-Marie-Tooth disease (CMT), and pathomechanics can vary even between limbs in one child, according to a recent study published in *Gait & Posture*.

This underscores the need for lower extremity practitioners to evaluate each child's gait individually rather than rely on a textbook definition of CMT, according to study author Sylvia Õunpuu, MSc, director of research at the Center for Motion Analysis at Connecticut Children's Medical Center in Farmington.

Õunpuu and colleagues retrospectively analyzed 33 children and adolescents (aged 12 ± 4 years) with CMT who underwent motion analysis and clinical examination while being evaluated for orthopedic surgery between 1990 and 2011. They compared data on patients with CMT with data on an age-matched control group of typically developing children.

Delayed peak dorsiflexion in terminal stance was seen in 59 of 66 limbs, and in some cases was the only gait abnormality found. This suggests delayed peak dorsiflexion may be the first gait-related sign of CMT, representing a major finding, according to Õunpuu.

Although the authors considered patient data initially as a single group, the evidence led them to subsequently divide patients into three subgroups based on peak ankle dorsiflexion in terminal stance, which is affected by plantar flexor length, plantar flexor strength, and cavus foot posture. Nineteen patients (30 limbs) had typical peak ankle dorsiflexion, eight patients (13 limbs) had less than typical dorsiflexion, and 14 patients (23 limbs) had excessive dorsiflexion. The findings were published in the September 2013 issue of *Gait & Posture*.

"One of the primary messages from this paper is that the orthopedic textbooks generally describe CMT as a certain set of conditions and, therefore, a certain set of treatments," Õunpuu said. "CMT presents in many different ways and the degree of severity differs from patient to patient; therefore, treatment differs from patient to patient."

In addition, gait pathomechanics may be asymmetrical in patients with CMT, she added, with some patients having one limb in the typical peak ankle dorsiflexion subgroup and the other limb in a different subgroup.

"Understanding that, and understanding maximum ankle dorsiflexion during gait and the extent of cavus deformity and plantar flexor strength and how these findings interact in each patient is really important for making an appropriate decision around treatment," she said.

> Delayed peak dorsiflexion, which was seen in almost all study participants, may be the first gait-related sign of Charcot-Marie-Tooth.

Ankle foot orthoses (AFOs) and other interventions can be used to address cavus foot presentation, excessive ankle dorsiflexion due to plantar flexor weakness, and plantar flexion contracture that results in limited dorsiflexion. However, clinicians need to be aware that overcorrection can create a new set of gait-related issues, the authors noted, and specified that surgical lengthening of the plantar flexors is not recommended.

"Two important goals an AFO should achieve are, first, to limit excessive dorsiflexion and allow weight bearing on the distal portion of the foot to provide more stability, and, second, to control cavovarus foot presentation to prevent plantar flexion contraction," said Sean McKale, CO, LO, practice manager of Midwest Orthotic and Technology Center in Chicago, and a member of the Charcot-Marie-Tooth Association (CMTA) advisory board.

Photo courtesy of the CMTA.

"This may be why we generally have had more success with ground reaction style and carbon fiber AFOs, and working with manufacturers to customize a stiffness profile for a particular individual. Additionally, using casting techniques and extrinsic lateral forefoot posting to maintain neutral coronal foot position has always been important to improve balance and distribute weight more evenly across the forefoot," he said.

Practitioners are often better able to address gait-related CMT issues when treating patients as children than as adults, said David Misener, CPO, of Clinical Prosthetics and Orthotics in Albany, NY, who is also on the CMTA advisory board.

"Typically you're able to push children a little bit harder," Misener said. "Their bodies are little bit more elastic than adults' and you can be a little bit more aggressive. Typically there are fewer psychosocial issues for children, and they are more willing to wear a device."

Larry Hand is a writer in Massachusetts.

Source:
Õunpuu S, Garibay E, Solomito M, et al. A comprehensive evaluation of the variation in ankle function during gait in children and youth with Charcot-Marie-Tooth disease. Gait Posture 2013;38(4):900-906.

Ankle weights improve walking in children with Down syndrome

Load may help engage plantar flexors

By Larry Hand

Adding an ankle load during treadmill walking significantly improves gait kinetics in children with Down syndrome (DS), possibly due to greater contributions from the ankle plantar flexors, according to a study from Georgia State University in Atlanta.

Jianhua Wu, PhD, assistant professor of kinesiology and health at Georgia State and coauthor Toyin Ajisafe, a graduate student, investigated effects of walking speed and external ankle load on the kinetic patterns of treadmill walking in preadolescents with DS and a comparable group of typically developing children.

Ten children with DS and 10 typically developing children (eight boys in each group; average age 9 years) participated in treadmill tests performed at two speeds (75% and 100% of preferred walking speed) and two ankle-load conditions (no ankle load or with ankle loads equal to 2% of the participant's body weight). The added ankle load, applied using 1.25-lb weights from a sporting goods store, was intended to create a 39% increase in the moment of inertia for each leg at the hip joint.

The researchers instructed children to walk on the treadmill without placing their hands on the handrails, and provided verbal encouragement to the children with DS as needed during the tests. The researchers used a seven-camera motion capture system to collect kinetic and kinematic data, but, for this study, analyzed only the kinetic data.

Compared with the typically developing children, the children with DS had a shorter duration of propulsion during push off, a smaller second ground reaction force (GRF) peak and vertical propulsive impulse, a higher loading rate, and a lower unloading rate. The magnitude of the second GRF peak in the children with DS was smaller than body weight, a characteristic that is associated with typically developing children at younger ages, who tend to use the hip extensor muscles during push off rather than the ankle plantar flexor muscles.

Walking at a faster speed helped the children with DS improve the duration of propulsion, vertical propulsive impulse, and unloading rate, but the second GRF peak actually decreased further. However, the added external ankle load helped increase the second GRF peak as well as the vertical propulsive impulse, suggesting that the weights helped the children engage the ankle plantar flexors even at faster speeds. The findings were published in January by *Gait & Posture*.

"Inclusion of external ankle load may be a promising approach to strengthening leg muscles and eliciting a more powerful push off in persons with DS," the authors wrote.

> The added external ankle load helped increase the second GRF peak as well as the vertical propulsive impulse.

"Children with DS had little experience walking on a treadmill before this study," Wu said. "However, the majority of them successfully walked on a treadmill at two speeds, slow and fast. It was surprising to their parents that their child could walk on a treadmill without holding the handrails. I think, with careful administration and appropriate monitoring, we can use certain paradigms such as treadmill walking to expand the motor repertoire of children with DS."

This could help children with DS on more than a physical level, Wu said.

"A higher level of motor capability will certainly get children with DS more engaged in physical activity and sports. This may benefit children with DS not only at the physical health level, but also at the psychological and mental levels," he said.

Photo courtesy of SureStep.

Kathryn Martin, PT, DHS, professor and Doctor of Physical Therapy program director at the Krannert School of Physical Therapy at the University of Indianapolis in Indiana, said the study highlights one possible way to improve strength and increase physical activity in children with DS.

"In my opinion, we cannot correct hypotonia or ligamentous laxity, but we can improve strength. Improving strength should help minimize compensations. Adding ankle load is one way to improve strength," Martin said.

However, she noted that the effective use of treadmill technology in this patient population may be challenging for some clinicians.

"Children with DS always have some degree of intellectual disability," she said. "Motivating them to walk on a treadmill may be more challenging than for typically developing kids, as the task may just not be meaningful to a child with DS. Physical therapists have to find ways to make these kinds of activities fun in order to encourage a child with DS to participate."

Larry Hand is a writer in Massachusetts.

Source:
Wu J, Ajisafe T. Kinetic patterns of treadmill walking in preadolescents with and without Down syndrome. Gait Posture 2014;39(1):241-246.

In youth athletes, repair after meniscal injury poses challenge

Obesity, gender affect tear complexity

By P.K. Daniel

Adolescents and children suffer more complex meniscus injuries that are often less repairable than previously reported, according to a study published in the December 2013 issue of the *American Journal of Sports Medicine (AJSM)*.

The study included 293 patients aged between 10 and 19 years who underwent arthroscopic meniscus surgery. Nearly all were active in sports, but factors contributing to greater complexity of the meniscal tears—which can adversely affect repairability—were obesity and male gender.

"Both obesity and boyhood carry an increased capacity for tear potential," said study author Eric Edmonds, MD, who specializes in orthopedic surgery at Rady Children's Specialists of San Diego in California.

Meniscal repair has demonstrated better long-term outcomes over partial meniscectomy in adults. A 2010 study showed no evidence of osteoarthritic advancement in 80.8% of patients a mean of 8.8 years after repair compared with 40% after meniscectomy.

"We recommend repair, if we can," said Kelly Vanderhave, MD, who specializes in pediatric orthopedic surgery at Carolinas HealthCare System in Charlotte, NC. "Previous studies have shown that, if you take it out, you advance arthritis pretty quickly. If it's at all repairable, I repair it."

In the *AJSM* study, adolescent boys had a lower repair rate (41%) than adolescent girls (56%). Nearly one-third (32%) of the boys had complex tears, compared with just 20% of the girls studied, which also translated to lower repair rates among boys. Patients with complex tears also had a significantly higher body mass index than those with noncomplex tears (27.4 vs 25.1), though the study did not examine the relationship between body mass index and repair rates.

Meniscal injuries often present with other acute injuries such as anterior cruciate ligament (ACL) tears, chondral injuries, and tibial fractures. Although the correlation hasn't been studied specifically, it's likely that, just as pediatric anterior cruciate ligament (ACL) injury rates are on the rise, so too are pediatric meniscal injuries, Vanderhave said.

"They tend to go together," Vanderhave said. "I think kids' activity levels have increased overall. The number of sports injuries I see now is ten times what I saw ten years ago."

Not all of the meniscal tears in the *AJSM* study were associated with ACL or other ligament injuries. The presence of ligament injury didn't affect meniscal repair rates, said study coauthor Andrew T. Pennock, MD, who also specializes in orthopedic surgery at Rady Children's Specialists of San Diego.

However, the authors did find that earlier treatment may increase the likelihood of repair in younger patients. Those treated within three months of injury were most likely to have repair, at a rate of 56%, compared with only 42% who were treated more than six months after injury. The repair rate for adolescents was even more dramatic, dropping from 58% at three months to 37% at six months.

> Young athletes, particularly adolescents, treated within three months of surgery were most likely to be eligible for meniscal repair.

Pennock noted a variety of reasons why surgeries are sometimes deferred, but delayed presentation led the list.

"Some are delayed presentation—the football player who didn't want to come in midseason—some are patients who underwent a nonoperative course that failed, and others are delays in the workup, including a referral to the orthopedic surgeon, an MRI, and surgical booking or authorization," he said.


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Such delays increase the likelihood that a young, active patient will do further damage to the initial injury.

"Kids are very determined and resilient," Edmonds said. "They often push through injuries because they don't have the life experience to understand that you cannot just bounce back from all booboos. In that process, they continue to extend the injury past its original configuration. This can change from fixable to nonfixable."

The surgical approach was typically determined by the type of the meniscal tear, in conjunction with the tear location, patient age, and chronicity of the tear. In the vast majority, surgeons did a partial meniscectomy if a repair was not possible.

"The reparability of the meniscus tear was determined by the surgeon at the time of surgery," said Pennock. "In general, less complex tears in the red-white or red-red zone [at the outer edge of the meniscus] have the best healing potential and are the most likely to be repaired."

P.K. Daniel is a freelance writer and editor based in San Diego, CA.

Sources:

Shieh A, Bastrom T, Roocroft J, et al. Meniscus tear patterns in relation to skeletal immaturity: children versus adolescents. Am J Sports Med 2013;41(12):2779-2783.

Stein T, Mehling AP, Welsch F, et al. Long-term outcome after arthroscopic meniscal repair versus arthroscopic partial meniscectomy for traumatic meniscal tears. Am J Sports Med 2010;38(8):1542-1548.

New flatfoot data rekindle debate over role of obesity

Australian researchers found no correlation between body mass index and prevalence of pediatric flatfoot, but used a different methodology than previous studies that reached an opposite conclusion. The conflicting results have revitalized the ongoing debate on this topic.

By Cary Groner

Over the years, researchers have claimed to discover significant correlations between childhood obesity and pediatric flatfoot. One well-known study by Pfeiffer et al, for example, examined 835 children aged 3 to 6 years and concluded that flatfoot prevalence was influenced by three factors: age (flatfoot was more common in younger children), gender (boys had a higher prevalence), and weight (42% of normal-weight kids had flat feet vs 51% and 62% of those who were overweight and obese, respectively).[1] Other studies have reached similar conclusions.

Recent research has called such findings into question, however, and resurrected the controversy about which children should be treated. In a paper presented at the 2013 Australasian Podiatry Council Conference in Sydney last June[2] and currently in press with the *Journal of Foot and Ankle Research*, Angela Evans, PhD, examined body mass index (BMI) and foot posture index (FPI) scores for 698 children and found no correlation between BMI and flatfoot prevalence. The work expanded on an earlier study reporting similar findings in 140 children.[3]

"These studies conflict with previous studies that found a correlation, even though intuitively that correlation makes sense," acknowledged Evans, who has a private practice in Adelaide, Australia, and a research position at La Trobe University in Melbourne. "Part of the problem may be that most of those studies used a footprint-based method of assessing foot posture."

Footprint measures raise an obvious question in the case of obese children: are the feet flatter or merely fatter? That is, when more adipose tissue is compressed under the child's weight, does this merely create the impression of a flatter foot? The question has provoked significant debate—not only regarding the value of different assessment methods, but also in terms of its clinical implications.

Footprint measures raise an obvious question in the case of obese children: are the feet flatter or merely fatter?

Continued from page 9

The evidence

The evidence supporting the link between weight and flatfoot isn't copious, but much of it seems plausible enough. For example, in a paper that appeared in 2006 in the journal *Obesity*, Australian researchers compared the feet of 19 overweight or obese preschool children with those of 19 controls matched for age, height, and sex. They concluded that there was no difference between groups in the thickness of the midfoot plantar fat pad, which was measured with ultrasound. But the heavier kids had a significantly lower plantar arch height, assessed via plantar footprints.[4] Although footprints themselves may not offer a particularly robust evaluation tool, when the fat pad variable is accounted for, they seem more persuasive—or might, perhaps, in a larger sample size.

Another small study, this one from the US, reported similar findings in 2012, noting that obese children had less ankle dorsiflexion, resulting in longer foot contact time during stance, as well as significantly more flexible feet and greater arch drop.[5]

Some studies have been done in older children, which can complicate the comparison of results because their feet have had more time to develop. Nevertheless, a 2007 study of 200 Scottish children aged 9 to 12 years reported that foot length and width were greater, while navicular height was lower, in the heavier children.[6] And a 2009 study from Spain evaluated foot arch types in 58 obese youths aged 9 to 16.5 years using both footprints and lateral weight-bearing radiographs, compared to the same number of normal-weight controls. Both measures found a lowering of the medial longitudinal arch in the obese children.[7]

A particularly interesting study was conducted in Spain and published in the *European Journal of Pediatrics* last year.[8] Researchers used a 3D digital scanner to evaluate the foot morphology of 1032 schoolchildren aged 6 to 12 years, and reported that the arches of the obese children didn't develop as fast as those of the normal-weight kids. A closer look at the reported data reveals odd contradictions, however. For example, the arch height of normal-weight children increased at an annual rate of 4.8%, whereas for obese children the rate was 3.7%. That fits the pattern; however, the rate for overweight kids, who were assessed separately from the obese ones, had a rate of 6.1%—higher than that of the normal-weight children.

Measurements

Clinicians and researchers can be forgiven for scratching their heads when faced with such data. Many now tend to draw conclusions tentatively, if at all. Angela Evans's papers provide an example of how quickly things can shift, in fact.

In terms of her own research, she attributes the change of perspective to use of the FPI.

"The difference in our study that really stood out was the way we assessed foot posture," she said. "We know that the FPI is fairly reliable; it has tested validity and is widely used clinically. So when we found these differences [vs previous research], we wondered what was going on. Our first study was small, but in the second one we got the same results in about seven hundred kids. There was not an association between increasing body mass and the rate of flat feet when measured by the FPI."

Evans doubts the validity of footprint-based evaluations, and

notes that even radiographic findings are problematic because there aren't a lot of normative data to compare them with (not to mention the ethical issues that would be associated with subjecting schoolchildren to mass x-ray screening to gather those data).

But how about the FPI itself? Is it a valid assessment tool in obese children?

Anthony Redmond, MD, a researcher at the University of Leeds in the UK, who was largely responsible for developing and validating the FPI, told *LER* via email that it was originally designed as a measure for pediatric foot posture and was carefully validated in that role.[9]

"Re: childhood obesity, that is a different story altogether," Redmond wrote. "[There are] problems with the use of footprint measures…and to some degree the same applies to the FPI and to any external measures of foot posture. Where the research question relates specifically to obesity, in my view the only valid measures of posture/alignment will be those that use internal imaging to visualise bone alignment directly." Examples of such imaging modalities would include x-ray, magnetic resonance imaging, computed tomography, or radiostereometric analysis.

"I don't think technically I absolutely agree," Evans responded, when read this email. "The point is that the different measures have shown conflicting results. The FPI is widely used by clinicians, and I don't think they have any sense of it being restricted regarding the incidence of childhood obesity."

Clinical implications

Better clinical practice is, after all, the main point of sorting out such matters.

"Childhood obesity is terribly concerning from a wider health perspective," Evans continued. "How much we need to worry about its relationship to foot posture is still undetermined, however, and I'm concerned that overdiagnosis may lead to unnecessary intervention."

In the experience of Alan Ng, DPM, who practices with Advanced Orthopedics and Sports Medicine Specialists in Denver, CO, pediatric flatfoot has more to do with genetics than overweight.

"I lean toward agreeing with Evans on this issue, because in the kids I see, biomechanics are primarily based on genetics," he said. "Later in life, if they maintain an elevated BMI, they may develop flatfoot secondary to overload and posterior tibial tendon dysfunction. But at that early stage, I don't think childhood obesity really leads to flatfoot."

Regardless of the patient's weight, Ng decides whether to treat based on symptoms—and not just pain.

"If they come in complaining of tripping, or that they get too fatigued doing athletics at school, we assess them," he said.

High on his list is checking for a secondary accessory ossicle or an os tibiale externum on the medial aspect of the navicular.

"They can have symptoms when they have a connection between that bone and the navicular, and the area gets irritated," he explained.

Edwin Harris, DPM, associate professor of orthopedics and rehabilitation at Loyola University Medical Center in Maywood, IL, concurred with Ng about obesity and flatfoot.

"I tend to agree with the conclusions that increased BMI probably doesn't correlate with pronated feet," he said. "My patients include just as many skinny kids as obese kids, though it is harder to manage obese kids with orthotic devices."

Continued on page 12

Continued from page 11

Harris pointed out that most of the literature relating BMI and flatfoot focus on arch height—which, as noted, is difficult to quantify clinically.

"There are no proven ways of measuring it unless you do it radiographically," he said. "People say they're going to measure the distance between the navicular and the floor, but I'm not sure how precise that measurement is, or whether I could duplicate it, due to all the variables."

Harris also noted that researchers and clinicians are working without a particularly good definition of what constitutes flatfoot.

"It's really a three-plane deformity, but most of the articles look at it only in the sagittal plane," he explained. "That's not really a good indicator of what's going on."

He, too, limits his treatment to those with symptoms, including pain in the arch.

"Pronated feet have a whole slew of morbidities other than obesity," he said. "Some children are hypotonic or have other risk factors for muscle imbalance. But when they complain of pain, I listen to them and look at them carefully."

Russell Volpe, DPM, who practices in Manhattan and is a professor of orthopedics and pediatrics at the New York College of Podiatric Medicine, said that the relationship between obesity and pediatric flatfoot is more complicated than simple cause and effect.

"Inactivity contributes to obesity, so we want to keep kids as active as possible," he said. "From the podiatric perspective, if they have flatter, more pronated feet, and if that contributes to inactivity, then we have a vicious cycle that might lead to significant disability and worsening of obesity over time, which would be well worth avoiding."

Asked whether only symptomatic children would likely curtain their activities, however, Volpe dissented.

"I'm not ready to concede that only symptomatic kids become less active," he said. "There is such a thing as a presymptomatic child, and those of us treating children with flat feet need to be mindful of that. When we identify those, we need to do something to help them function better. Most of the time, when an older child or an adult comes to us with a mechanical foot problem, it's been years in the making."

Volpe considers BMI just one among a host of factors that help determine a clinical pathway.

"No kid is going to be in or out of the treatment group just because they're heavy," he said. "Obesity is interesting from a research, screening, and risk standpoint, but I'm not going to be the one saying, 'Give all the fat kids orthotics.' It's just one more thing on my list of reasons when I decide to intervene or not."

Volpe noted, moreover, that much of the discussion about obesity and flatfoot has turned on measurement.

"Angela points out that the footprint method is flawed; she hangs her hat on the FPI having normative value, and I'll give her that," he said. "But Tony Redmond now seems to be saying that the FPI is not the be-all and end-all, either. That Angela's studies haven't found a correlation may also be a measurement flaw, though in fairness to her, she acknowledges that in her conclusion. I'd be hard-pressed as a scientist and an academic to dismiss her work; I think it's worthy of our attention. But I think we need to look further; there's probably a bigger and better study to be done to see if we can settle this definitively."

More studies

As it happens, recent research has shed light on which patients with flexible flatfoot are most likely to become symptomatic. In a study conducted at Rady Children's Hospital in San Diego, researchers looked retrospectively at 135 patients, 45 of whom were asymptomatic. As assessed by standing anteroposterio and lateral radiographs, the authors concluded that lateral displacement of the navicular seemed to be related to symptom onset.[10]

"This may be an area we look at more carefully in the future, and it may start to simplify this whole debate," said Evans.

In the meantime, however, she and her colleagues are about to embark on further research at La Trobe. The study will compare footprint measures, FPI, and the results of external 3D digitized foot scanning to evaluate their relative strengths and weaknesses.

"We need to clarify this discordance," she said. "We're hoping that this independent 3D imaging will teach us more about both of those measures. It's quite exciting." ler

Cary Groner is a freelance writer in the San Francisco Bay Area.

References are available at lowerextremityreview.com, or by scanning the QR or tag codes at left.

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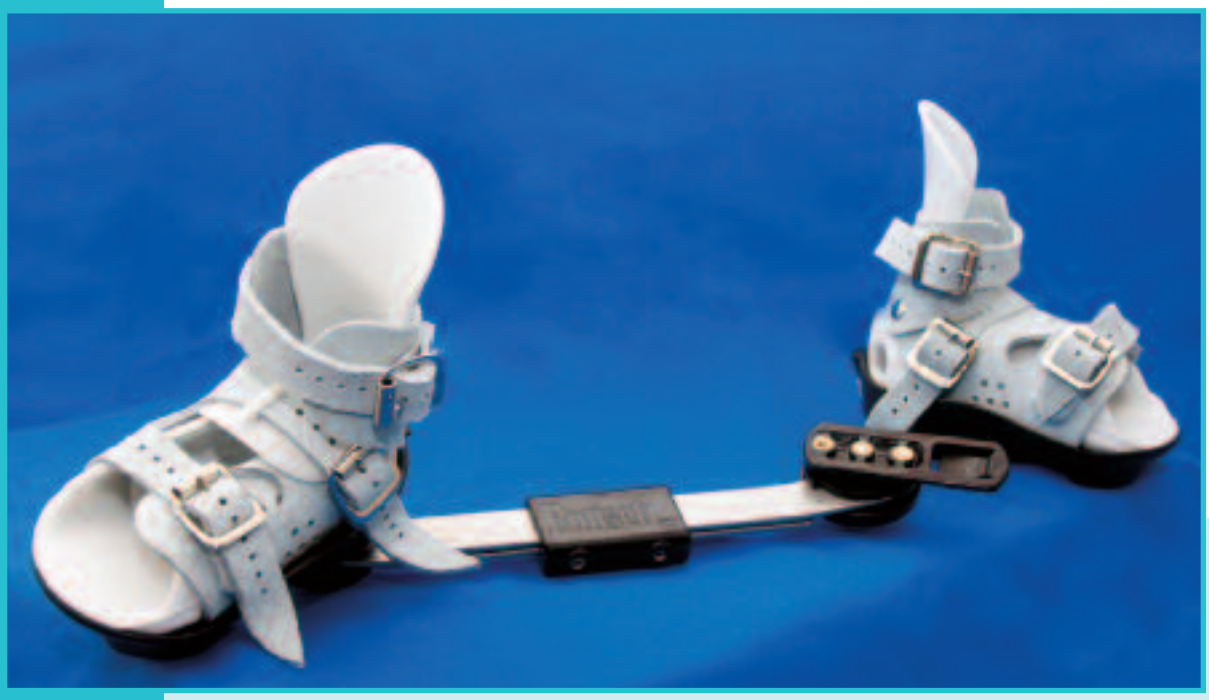

Standard AFO Pair with Ponseti® Bar

Our designs are constantly changing but our philosophy remains the same - the design of our AFO's must go beyond how it looks. Our designs are celebrated for the help and comfort given to our clubfoot patients.

We apply the latest technology and the most detailed craftsmanship to every aspect of every product we create. By working with the world's most prestigious doctors, our innovative designs are helping shape the future of clubfoot worldwide.

- John Mitchell, President

New Products

The Dorsi Ramp provides a safe and child friendly means of stretching the Achilles tendon and calf muscles for children from 18 months to 10 years of age.

The Black Robin AFO socks are a double layered sock made of cotton rich fabric for comfort and include anti-slip dots at heel and ball to grip outer layer to AFO and provide extra leg length to cover AFO. Available in 8 sizes for children from 0 to 6 years.

Photo courtesy of Kennedy Krieger Institute.

Strength training improves function in children with CP

Research suggests strength training can improve gait and function in children with cerebral palsy. But to be successful, experts say, the training needs to be part of a multifaceted rehabilitation program that accounts for more than the physical limitations imposed by the disease.

By Shalmali Pal

The merits and drawbacks of strength training in children with spastic cerebral palsy (CP) have been the subject of debate, but Tyler Sexton, MD, has no doubts about its benefits.

Diagnosed with spastic diplegia, the most common form of CP, Sexton underwent 16 surgeries during his formative years, including selective dorsal rhizotomy at age 4 years, which helped him trade in a wheelchair for a walker; Achilles tendon lengthening; hamstring and adductor lengthening; and repairs to the lateral collateral ligament and meniscus in his left knee.

"I always kept up with my strength training and aggressive physical therapy [PT] before and after my various surgeries," Sexton explained. "I saw great improvement with strength training, specifically cycling. [It] was the best way to gain function and mobility. I rode a three-wheel bike and now I'm on a stationary bike. I still do this every day, and I'm 28."

Gaining strength, mobility, and function gave Sexton the ability to achieve his goals: weaning himself from his ankle foot orthoses (AFOs) by age 13 years, learning to drive a car, earning the title of scuba divemaster, and becoming a pediatrician who specializes in hyperbaric medicine.

Sexton, president and chief executive officer of Caribbean Hyperbaric Medicine in Zephyrhills, FL, and a clinical professor of hyperbaric medicine at the University of Southern Alabama in Mobile, now works with children with disabilities, including CP, and is an advocate for strength training.

"I believe it does help with mobility and spasticity," he said. "I know the literature hasn't always found that to be true, but...I believe in the ability of strength training in CP. In myself and my patients, I've seen an increase in range of motion, a decrease in pain in the hips and knees, and an increase in endurance."

> Many children with cerebral palsy have the same hopes and dreams as kids without CP, which can be an important consideration during training.

One piece of the puzzle

But Sexton, along with the other experts that *LER* spoke with, doesn't believe strength training (with diplegia or hemiplegia) is the ultimate panacea for gait and function issues in kids with CP. For

Continued from page 15

Figure 1. A teenage patient with CP performs lower body strength training. (Image courtesy of the Cerebral Palsy Alliance.)

strength training to be successful in this patient population, experts say, it needs to be part of a multifaceted rehabilitation program that takes into consideration more than the physical limitations imposed by the disease state.

"Children with CP are weak almost everywhere, so why not try to get them as strong as their able-bodied peers? Then get them to apply that strength and flexibility to whatever they want to do in their lives," commented Jack Engsberg, PhD, director of the Human Performance Lab at Washington University in St. Louis. "I think the same principles for strength training that apply to people without disabilities apply to those with disabilities. But you have to consider what the disabilities are, and design a program based upon that."

The goal of strength training in children with CP is not to produce the same results as body builders, stressed Christopher Joseph, MSPT, director of PT at the Kennedy Krieger Institute in Baltimore.

"We are looking to strengthen them within their abilities," Joseph said.

Orthopedic surgeon Lance Silverman, MD, of Silverman Foot & Ankle in Edina, MN, said he is a believer in postsurgical PT in general, but cautioned, "Strength training by itself is a mistake because it will only strengthen the dysfunction instead of properly correcting the problem."

A sound strength-training regimen will correct dysfunctional movement and then work to improve functional movement, Silverman explained.

"It is the same process that would be used with a healthy population; it's just more challenging to do correctly with CP patients," he said.

Patient selection

Study results for strength training in children CP have been mixed.[1-6] Authors of a 2012 meta-analysis[7] concluded that, while some individuals benefit from progressive strength training, it's unlikely to be the optimal therapy for all patients with CP.

Engsberg, who is also a professor of occupational therapy, neurosurgery, and orthopedics, suggested the studies that did not show a good result from strength training did not aim for enough of a strength increase.

"These kids are already at thirty percent in terms of strength versus able-bodied kids, so a ten percent increase isn't going to really benefit them," he said. "You want to show a dramatic change in the strength component—sixty percent or more—so you have to tailor the training accordingly."

But the experts agreed with the meta-analysis authors that patient selection is key. For example, kids with a Gross Motor Function Classification System (GMCFS) score of IV or V—in which independent mobility is either very limited or nonexistent—may not be good candidates for strength training.

"If I have a patient who I do not expect to walk after surgery, then I'm less likely to say that strength training is worthwhile," Silverman said. "If I have a patient who I expect to have a productive gait after surgery, but is having a difficult time with balance and coordination, then I think strength training has value."

The International Classification of Functioning, Health and Disability (ICF) has become a common tool for assessing disability, and ultimately, a child's capacity for strengthening.

"The ICF considers the body structures and function aspect of a health condition/disability, the impact on activity, and the impact on participation," explained Prue Golland, a consultant in physiotherapy at the Cerebral Palsy Alliance in Allambie Heights in New South Wales, Australia, in an email. "In simple terms, muscle weakness is considered to occur at the body structures level whilst walking is at the activity level. The literature[8] suggests that interventions are generally effective at one level of the ICF only."

Age and CP-related cognitive deficits are also considerations with regard to the child's ability to follow directions.

Joseph explained that, at a very young age, most children with CP still learning effective motor patterns. If they struggle early on, that can lead to muscle weakness.

"When we start strengthening at an early age, we do it in a functional context. We'll load them with a weight or put them in a context where they have to carry most of their body weight," he said. "For instance, walking up steps. We may not start steps with a healthy eight-month-old because they can't walk, but we may start steps in an eight-month-old CP kid because we want to strengthen the thighs and calves, and have the child learn the correct motor pattern."

At the Cerebral Palsy Alliance, therapists reserve progressive resistance strength training for children older than 8 years; functional strength programs utilizing goal-directed therapy are used in younger children, Golland said.

Finally, Sexton said he does not advise strength training in children whose CP is complicated by severe cardiac abnormalities or bronchopulmonary dysplasia or in those with self-harming behavior.

Factors to consider

Strengthening programs are generally based on the guidelines from the American Academy of Pediatrics and the National Strength and Conditioning Association, Golland pointed out. But training approaches and protocols still need to be determined on a case-by-case basis.

At Kennedy Krieger, therapists use both the split treadmill and aquatherapy for strength training.

While motor activity is the primary aim of a split treadmill workout, it can offer some benefits for endurance and strengthening, Joseph said.

"Let's say the child is hemiparetic on the right side. I can set her up so that the treadmill is going at the normal speed—about 1.5 to 2.2 miles per hour for an average child—on the left side. On the right, I can speed the treadmill up so that she has to concentrate more on that right leg," he said.

A CP patient who has severe contraction and is unable to pas-

Continued on page 18

Continued from page 17

Figure 2. Tyler Sexton, MD, chats with a patient. (Photo by Bill Starling.)

sively move her limbs may not be a candidate for cycling therapy, Sexton said, and would be better served by aquatic therapy or even resistance band training.

Sexton said he believes an effective strength-training regimen will incorporate antispastic medication, such as onabotulinumtoxinA (Botox) and baclofen. However, he emphasized that dosing of antispastics must be titrated properly to help control spasticity without limiting the patient's ability to work their muscle groups and follow the training protocol.

Joseph concurred.

"Some kids use their spasticity and their muscle tone, even if it's low, to function," he said. "We don't want to completely take away their spasticity and that muscle tone."

AFOs can be a help or a hindrance, depending on the patient. Engsberg pointed out that, if a patient is wearing a rigid AFO but is trying to gain more ankle strength, then the AFO isn't going to help with the latter if it prevents ankle motion.

"However, if a child is unable to walk without the AFO, then perhaps the goal with ankle strengthening might be to transition away from the rigid AFO to a flexible one," he said.

And, even if an AFO does restrict ankle movement, the added stability may facilitate strengthening the muscles around the knee or hip, Golland said.

Joseph said that his group is getting away from orthoses in general and setting patients up with functional electrical stimulation (FES) units, in some cases while the patient is still wearing a postoperative cast.

"If we have concerns about the muscle getting weaker, we'll cut a window in the cast and apply the FES, working within the parameters set by the physician," Joseph said.

Time

One limitation of the published studies in this area is that the duration of strength training—generally around eight weeks—may not have been long enough for researchers to see visible functional improvements.

This is particularly true for patients who have recently undergone postoperative casting, Silverman said.

"It's going to be several weeks after surgery before a CP patient is going to be able to recoordinate the body. You have to keep that timeline in mind before you determine when to begin strength training and how long it should be done," he said.

Engsberg explained that a strength training protocol starts with learning proper technique, which in itself can take a couple of months.

"Then you start getting into the building of muscle mass," he said. "So strength training programs that only go for four or six weeks are not really getting into the two important components that make strength training worthwhile."

Rather than keeping a strict timeline for seeing results, the therapists at Kennedy Krieger follow the child's progress in terms of functional gains, bearing in mind that, the younger the child, the more time progress will require.

"If we have a CP child who walks at age two, we're going to work with them from twelve to sixteen months on strengthening in a functional context," Joseph said. "As they get older, then we may be able to focus on a more traditional strengthening protocol because they can follow directions better."

Sexton also emphasizes to his patients and their caregivers that they may not see the benefits of strength training in the short term.

"In the long run, they will have better mobility; they will have better range of motion. All of that is more likely to get them closer to their goals," he said.

Goals and motivation

Sexton pointed out that many children with CP have the same hopes and dreams as kids without CP, which can be an important consideration in training.

"I wanted to be [basketball player] Shaquille O'Neal when I was younger," he shared. "I remember the therapists would say to me, 'Come on, Shaq, let's do it,' when I tried to get out of the wheelchair and walk. Was that the only thing that got me out of the wheelchair? No, but finding out what motivates a kid with CP and incorporating that into the strength training protocol is very important."

For very young children who can't communicate their goals, "you have to follow their lead and engage them as they are moving. Find out what seems to interest them, whether it's walking the steps or being in the water," Joseph said.

For some CP patients—especially those with GMFCS classification I or II—the goal may not be to improve function, but simply to maintain it, Golland said.

"Does function mean walking, getting up from the floor, or climbing stairs? Or does it refer to someone's ability to reposition themselves in their wheelchair, or lean forward to assist a carer to reposition their clothing?"

Even small gains in strength may be empowering to a patient with CP.

"Let's say a CP child is going through a calisthenics-based strength training program, but they're only seeing a ten percent gain," Sexton said. "From a clinical perspective, that may not be meaningful. But maybe that small gain allows that kid to feel like he can go out for a walk with his dad or do some other activity."

Joseph noted that patient-centered quality of life is becoming essential for measuring the success of a training program.

"That kind of information about the child and his real-life situation can be much more useful [than more clinical measures] when I look at what is, and is not, working for the child," he said. ler

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References are available at lowerextremityreview.com, or by scanning the QR or tag codes at left.