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August 2017



ITW update: Etiological clues, collaborative care

Growth plates and injury in skeletally immature athletes

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- Dyslexia linked to poor balance
- Keys to parental clubfoot compliance
- Weak hip muscles and ankle sprain

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15 Growth plates and injury in skeletally immature athletes

In this follow-up to "Growth-plate injuries: A diagnostic challenge," (May, page 15) we continue our look at physeal trauma, exploring growth-plate issues in anterior cruciate ligament reconstruction, and further examining these injuries' impact on the knees, ankles, and feet of youth athletes.

By Shalmali Pal

From the editor: Healthcare, mobility, and liberty



With weekly and sometimes daily chaos coming out of Washington, DC—and with the collapse of the latest efforts at healthcare reform that promised to compromise or take care away from millions of people, many of them children with ongoing lower extremity conditions—it might be tempting for healthcare providers to take their eye off the ball. Don't do it. The voices of providers and their patients contributed largely to the last defeat of Republican-sponsored reforms.

The American Orthotic & Prosthetic Association and the Amputee Coalition, for example, held a news conference in late June outlining three priority issues for their patients who, they noted, are at risk for losing "care and the mobility and liberty that comes with that care." (See "Amputee groups air ACA reform concerns," *LER*, July 2017, page 61.)

A direct threat to children's healthcare is up next. Authorization of the Children's Health Insurance Program (CHIP), a long-standing bipartisan program that provides low-cost coverage for six million children whose families earn too much to qualify for Medicaid, but who cannot afford private insurance, expires in September.

Some lawmakers are considering a CHIP reauthorization bill as a potential vehicle for broader healthcare policy changes—including elements of repeal and replace, and with that, a possible reduction to Medicaid.

Failure to reauthorize the bill—or attaching other harmful legislation—will restrict children's access to specialty care like O&P and physical therapy services. Children are among the most vulnerable of patients, but, with the right care, have many potentially mobile, healthy years in front of them.

As healthcare providers, you have an influential voice, and know firsthand that mobile, healthy children not only have a far higher quality of life, they are also more likely to become employed adults who contribute to the economic success of their communities and the country.

Use your voice to help ensure all your patients can continue to access the care that provides them maximal independence and liberty in the form of mobility.

Emily Delzell, *Senior Editor*



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Dyslexia affects ability to adjust to impaired sensory feedback

Kids struggle to maintain balance

By Katie Bell

Children with dyslexia are unable to compensate with other available inputs when sensory feedback to the soles of their feet, their vision, or both is less informative, resulting in poor postural stability, according to research from Paris, France, which may have implications in training to help these children improve their use of sensory inputs.

The study set out to test the influence of foot soles and visual information on the postural control of 24 children with dyslexia (mean age 9.3 years) and compare their data with those of 24 gender- and aged-matched children without dyslexia. The participants were not receiving any drug treatment and did not have an orthopedic anomaly or a personal history of vestibular or visual deficit or neurological or psychiatric disorders.

Investigators used a platform with two dynamometric clogs to measure postural stability with and without 4-mm foam placed under the participants' feet and with their eyes open and closed. Specifically, the researchers measured the surface area, length, and mean velocity of the center of pressure (CoP), while the Romberg Quotient (RQ), which is the ratio between the surface area of the CoP with eyes closed and eyes open, was calculated with and without foam.

The results showed the surface area, length, and mean velocity of the CoP were greater in the children with dyslexia compared to those without dyslexia, predominantly during the foam and eyes-closed conditions.

Lead author Nathalie Goulème, PhD, a researcher at the Université Paris Diderot Robert Debré Hôpital, remarked, "To improve postural control, in clinic we can suggest exercises on a platform where children have to maintain their stability depending on environmental condition [eyes closed, support unstable, with optokinetic stimulation]. Thus, children with disorders could improve their integration weighting sensorial input and using the better sen-

sory strategy."

Goulème further noted that visual feedback placed in front of a child, on a screen, while they maintain their stability could improve their ability to know their oscillations and control them. She added that, "More usually, I need to suggest to a child and his family to try sport/games/leisure activities [requiring] hand-eye coordination and involving equilibrium."

sory strategy."

Additionally, the results showed the RQ was smaller in the children with dyslexia than in participants without dyslexia, indicating children with dyslexia have more trouble with balance than children without dyslexia under both eyes-open and eyes-closed conditions. The RQ was also greater without foam than with foam in both groups, but more so in children with dyslexia, and the authors noted the cutaneous inputs of the foot soles can involve a change in the integration of visual inputs.

The authors suggested the impairment of the cerebellar integration of all the sensorial inputs is responsible for the postural deficits evident in children with dyslexia, and that the use of visual inputs by these children could be disturbed by an alteration in somatosensory input integration.

Goulème said that, along with training by stimulation, "most of the time, children can have prismatic treatment, proprioceptive features on orthoses for the foot sole, advice for daily life leg, training to improve attention, exercises for posture!" She added that dyslexia is a heterogeneous disorder and that adapting treatment to



French investigators used this platform to measure postural stability in kids with dyslexia under several sensory-perturbing conditions. (Photo courtesy of Nathalie Goulème, PhD.)


the individual child is paramount.

She noted that everyone has to maintain their stability during a simultaneous task, such as reading. "Consequently, if only maintaining postural control is difficult and involves a high level of energy, attention will be shared and unfortunately learning can be decreased or slower," she said.

The authors, who published their findings in July in *Gait & Posture*, recommend further research to explore the children's ability to weigh sensory inputs by cerebellum adaptation.

Lisa Selby-Silverstein, PT, PhD, NCS, physical therapist at Rainbow Rehab in Marlton and Mount Holly, NJ, and professor of physical therapy at Neumann University, in Ashton, PA, said, "Most of these children are not getting PT for balance difficulties as access to that care depends on awareness and advocacy by the adults around these children. It also will depend on an understanding by the therapists receiving that referral of the issues at hand."

Selby-Silverstein, who is also a member of the American Physical Therapy Association's Foot and Ankle Special Interest Group, further noted she likes to encourage physical therapy aimed at optimizing the child's tolerance and total body alignment in custom-casted foot orthoses to improve their foot alignment and decrease foot deformity, both of which are likely to contribute to improved balance.

"In light of this research, however, it would be important to see if firm contoured inserts would improve balance rather than impair balance as the four-millimeter flat foam did," Selby-Silverstein added. 

Katie Bell is a freelance writer based in New York City.

Source:

Goulème N, Villeneuve P, Gérard CL, et al. Influence of both cutaneous input from the foot soles and visual information on the control of postural stability in

Parents say comfort, easy use are clubfoot compliance keys

All devices present challenges

By Hank Black

A recently developed pediatric orthosis for Ponseti night bracing received positive ratings from parents in a small Swedish study of children with idiopathic clubfoot who had compliance problems or relapse with one of two earlier bracing devices, a foot abduction brace (FAB) or a dynamic knee ankle foot orthosis (KAFO).

Noncompliance with the four-year nighttime Ponseti bracing protocol is the principal cause of relapse following initial correction with serial manipulation, casting and, in some cases, Achilles tenotomy. The protocol generally calls for FAB or KAFO wear 23 hours a day for the first three months after final cast removal, and 12 to 14 hours of nighttime wear thereafter.

The study, presented in a poster session at the 16th International Society for Prosthetics and Orthotics (ISPO) World Congress, held May 8 to 11 in Cape Town, South Africa, evaluated parental satisfaction with a dynamic AFO that supports both subtalar and tibiotalar joint functions.

Poster lead author Hanna Steiman-Engblom, CPO, MSc, said, "When we use the dynamic AFO device, it is when there are problems with compliance with the Ponseti bar or KAFO."

The dynamic AFO simultaneously dorsiflexes and abducts the foot and supports fully functional triplane foot motion. As a night brace, it provides a long-duration, low-intensity stretch to the Achilles tendon and medial soft tissues, and can be worn unilaterally, according to its UK manufacturer.

Investigators placed the 40 parent participants into two groups: those whose children had worn an FAB (n = 13) or those who wore a KAFO (n = 27). All parents completed the 12-item Quebec User Evaluation of Satisfaction with assistive Technology (QUEST) questionnaire to rate satisfaction with the dynamic AFO. They also were asked to choose the three items that were most important for satisfaction.

"Overall, both parental groups evaluated their satisfaction with the device as 'good,'" said Steiman-Engblom, who noted

the study didn't assess parental satisfaction with the previous braces. "We can't generalize from the results due to the small sample, of course, but this seems to provide an optional design that may be suitable for relapsed patients," she said.

Steiman-Engblom is a prosthetist-orthotist in the orthopedic workshop TeamOlmed in Stockholm, Sweden, and conducted her study at the Karolinska Institutet, also in Stockholm.

"Getting parents to maintain years of nighttime bracing is the biggest Ponseti method challenge." —Raymond Pye

Both parent groups named comfort, effectiveness, and ease of use as the three most important QUEST items. Steiman-Engblom said, "QUEST is generic for assistive devices and not specific for orthoses. If there were a questionnaire specific for orthosis and children the validity would be higher."

Reasons for noncompliance and recurrence differ to some extent between developed countries like Sweden and less developed areas, say experts like Raymond Pye of Seattle-based nonprofit Mobility Outreach International (MOI).

Those reasons tend to involve cultural issues and clinician-patient communication more than brace design, though patients in less-developed areas could benefit from advanced bracing technology if it were more widely available, Pye said.

Pye is MOI's director of program quality and emerging programs. He manages the organization's clubfoot program in Haiti and also monitors FAB manufacturing quality for MOI partners in low-income countries.


He said there are unique challenges in



The dynamic AFO used in the Swedish study (above), provides a durable low-intensity stretch to the Achilles tendon and medial soft tissues, and can be worn unilaterally. (Photo courtesy MD Orthopaedics.)

more rural areas, such as when female elders in a village apply social pressure on young parents not to follow a prescribed bracing protocol for their child. "In certain places, there is a kind of group pressure on some parents to take the brace off early," he said. "The foot may look almost normal after the first month of bracing and the elders or relatives say, 'See you don't even need to use the brace, it doesn't matter.' But, of course, relapse is slow but steady, and more than ninety percent of clubfoot recurs [when protocols aren't followed]."

But, in some ways, parents are the same the world over. "I think the time and effort given by clinicians is similar in the US and in emerging nations as they help parents fit their child," Pye said. "Getting the parents to maintain the nighttime fitting of the brace for three or four years is the biggest challenge in the Ponseti method. Clinicians even in the US tell me they have to remind the parents, literally every time they come in to the clinic, to fit the brace well."

Pye said it's difficult to compare the sophisticated device used in the Swedish study with the locally sourced braces MOI uses and teaches the manufacturing of in its grassroots efforts. For one thing, the cost of the former is in at least three figures, while that of the FAB MOI uses can be in the single digits. Advantages of the dynamic AFO, in addition to its high-tech ability to adjust width and degree of shoe angle, he said, include the extra clamping above the ankle which, he said, "would help when a child can't keep the brace on very well at night." 

Hank Black is a freelance writer in Birmingham, AL.

Source:

Steiman-Engblom H, Villiard L. Parental satisfaction with the use of an ADM-device for children with idiopathic clubfoot. Presented at the 16th International Society for Prosthetics and Orthotics World Congress, Cape Town, South Africa, May 11-14, 2017.

Weak hip extensors contribute to ankle sprains in soccer players

Findings support use of strengthening

By Jill R. Dorson

Hip strengthening may be as important for preventing lateral ankle sprains in youth soccer players as it is in adults, according to a recent Belgian study.

Researchers from the University of Ghent found that 12 of 133 (9%) male youth soccer players, ranging in age from 10 to 16 years, sustained ankle injuries over a three-year reporting period.

After adjusting for body weight and strength of other hip muscles, the authors found that players with greater hip extension strength than the cohort average had a significantly lower risk of a lateral ankle sprain than those with weaker hip extensors (hazard ratio of .3). Mean survival time—or the time span for which a player remained injury free—was up to 10% longer for players whose hip extension strength was higher than the group average.

The findings, published in the *American Journal of Sports Medicine (AJSM)* in November 2016, echo those of a study of 210 male semiprofessional Iranian soccer players that was presented at the 2016 meeting of the American College of Sports Medicine in Boston.

In that study, conducted jointly by researchers from the University of Isfahan in Iran and the University of Southern California (USC) in Los Angeles, 11.9% of players sustained lateral ankle sprains, and isometric hip abductor weakness was associated with a higher incidence of lateral ankle sprains.

In contrast with the Isfahan-USC study, hip abductor strength was not significantly associated with ankle sprain risk in the Belgian study of youth athletes. However, both studies underscore the growing recognition among researchers and clinicians that hip strength can contribute to ankle sprain risk in soccer players of varying ages.

“Basically, the theory is when the hip muscles are weak, two things happen—the foot and ankle muscles overcompensate, and you alter your trunk position lie, lean toward the weak side. The idea is that the foot and ankle muscles overcompensate and allow the ankle to roll,” said Chris Powers, PT, PhD, owner of Movement Perform-

ance Institute in Los Angeles and a faculty member in the Department of Physical Therapy at USC. “Hip weakness and altered trunk motions change the biomechanics of the ankle.”

Khalil Khayambashi, PT, PhD, a professor in the Department of Sports Sciences at the University of Isfahan, implemented and oversaw the data collection for the Isfahan-USC study.

“The hip is the focal point between the heavier trunk and upper and lower extremities,” Khayambashi said. “To have good balance, superior hip muscle strength is mandatory.”

The Belgian authors hypothesized that the ability to attenuate impact during

“Hip weakness and altered trunk motions change the biomechanics of ankle.”

— Chris Powers, PT, PhD

high-velocity maneuvers may be limited or inadequate in youth soccer players with poor hip extension strength, and that this limitation may be exacerbated under fatigued conditions.

The authors of both studies suggested hip-strengthening exercises can be integrated into soccer training programs to help reduce ankle sprain risk. Simple exercises to improve hip strength that could easily be added to soccer training programs include lunges and resistance-band exercises.

Interestingly, the findings of the two soccer studies appear to contrast with those of a 2006 *AJSM* study of high school athletes from multiple sports, in which three measures of hip strength (hip abduction, hip adduction, hip flexion strength) were not significantly associated with ankle sprain risk over a two-year period.


That study, conducted at the Nicholas Institute of Sports Medicine and Athletic



Trauma (NISMAT) in New York, included 169 high school athletes (68 girls) representing football, boys and girls basketball, boys and girls soccer, and girls gymnastics; all were involved in strength training.

The ages of the athletes in the NISMAT study ranged from 14 to 18 years. In the Belgian study, though the ages of the athletes in the study population ranged from 10 to 16 years, there were no ankle sprains in the youngest athletes (aged 10 to 12 years). Still, the older mean age of the players in the NISMAT study could have contributed to the difference in findings between the two studies, according to Tim Tyler, MS, PT, ACT, owner of PRO Sports Physical Therapy in Westchester, NY, and a coauthor of the NISMAT study.

“We looked at not only soccer players, but other athletes, too,” said Tyler, who added that he found the Belgian findings surprising. “In such a young population—of young adolescent kids who might not be fully developed—I’m wondering if they really have hip weakness or poor neuromuscular control of the muscles?”

The experts also noted the mechanisms contributing to ankle sprain are likely multifactorial. As just one example, all three studies reported a direct relationship between an athlete’s weight and the risk of ankle sprain; the heavier the athlete, the more likely he or she is to sustain an ankle sprain. 

Jill R. Dorson is a freelance writer based in San Diego, CA.

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ITW update: Etiological clues, collaborative care

Researchers still haven't unraveled the 'I' in ITW, or idiopathic toe walking, but studies continue to point to neurodevelopmental and genetic links. Here, we review recent literature and experts explain how they assess patients' history and biomechanics for information to guide treatment.

By Larry Hand

What's the best way to manage pediatric patients with idiopathic toe walking (ITW)? That remains the question as too few researchers delve into why some children develop ITW and some don't.

"There's just little information out there on efficacies of treatments," Kevin C. Matthews, CO/LO, of Advanced Orthopedic Designs, San Antonio, TX, told *LER: Pediatrics*. "It's an area that deserves further study. Hopefully, someone will do a [retrospective] study of different treatments and long-term outcomes, and whether parents were satisfied with the care received."

Although some research has trickled in since *LER: Pediatrics* last covered the topic in 2014 (See "Toe walking researchers revisit idiopathic label," November 2014, page 15), evidence on the efficacy of ITW treatments, from physical therapy to surgery, is still lacking. One barrier is that the cause of much toe walking is still unknown.

"The 'I' is the most pressing need [in ITW research today]. The condition needs to move beyond the idiopathic status," said Mark Geil, PhD, chair of the Department of Kinesiology and Health and director of the Center for Pediatric Locomotion Sciences at Georgia State University in Atlanta. "Our treatments are attempting to control a problem without knowing the cause. We're treating symptoms."

In response, some researchers are boring into potential neurodevelopmental issues.

In a study published in 2016 in *Neurologia*,¹ researchers suggested ITW as a potential marker of neurodevelopmental impairment. Researchers compared neurodevelopmental characteristics, ITW risk factors, and scores on the Child Neuropsychological Maturity Questionnaire (CUMANIN) between a group of 56 children with ITW aged 3 to 6 years and an age-matched 40-child control group.

The percentage of patients with a family history and biological risk factors was higher in the ITW group, and parents of ITW patients reported significantly poorer motor coordination in their children. These patients also scored significantly lower on CUMANIN subscales of memory and psychomotricity, as well as on verbal, non-verbal, and overall development.

"Kids who don't outgrow ITW may face serial casting and surgery when the condition should be treatable earlier, at a more fundamental level."

—Mark Geil, PhD

"At this moment, only well-known pathologies [such as cerebral palsy or neuromuscular dystrophia] are considered as a neurological diagnosis. These pathologies are clearly diagnosed by means of specific neuroimaging or laboratory evaluations," said study first author Patricia Martín-Casas, PhD, coordinator of physiotherapy at the Complutense University of Madrid in Spain.

"But some authors, and also our investigation team, consider also the possibility of a nondiagnosed minimal cerebral dysfunction causing toe walking in some cases," she continued. "This can only be diagnosed by [methods] such as functional magnetic resonance imaging, not easily used, or by clinical evaluation with specific tests or questionnaires, such as CUMANIN."

ITW has also been linked with language disorders and autism,² and recently with attention deficit disorder and hyperactivity (ADHD). A study from Spain, published in July in *Anales de Pediatría*, noted a high frequency of ITW in children with ADHD.³ Of the 312 children (mean age 11 years) 20.8% had ITW and 49.2% (32) of those had Achilles tendon shortening. The researchers found significant associations between having ITW and sociability disorders, absence of pain in the legs, and a family history of ITW.

Martín-Casas' research and that of others has led her to expand her objective evaluation of children with ITW, she said, noting she's heightened her focus in physiotherapy treatment on developmental problems and multisensory integration. She also advocates bringing together different disciplines for the best outcomes.

A case study presented last year at the Association of Children's Prosthetic-Orthotic Clinics annual meeting outlined the benefits of pairing the expertise of a physical therapist with that of an

orthotist in the treatment of a kindergarten-age boy with ITW and severe equinus contractures.⁴ At the start of treatment his dorsiflexion range of motion (DF-ROM) was -40° bilaterally and he could walk only on his toes.

Treatment over about eight months included bilateral ankle foot orthoses, shoes modified with 35° heel wedges, and serial casting. The physical therapist and orthotist assessed him every other week, and the orthotist adjusted the wedges every two to four weeks, decreasing them by 5° to 10°, and increasing the dorsiflexion angle. After six months, the boy had increased stability and could run, stand on one foot, and skip. His DF-ROM increased to -15° on the right side and -25° on the left. He then underwent seven weeks of serial casting; his DF-ROM improved to 0° on the right side and -3° on the left, and he could walk heel to toe with and without orthoses and could run and jump.⁴

"I would like to [call] for a real multidisciplinary approach to these children, as toe walking is a sign of many present and future difficulties," Martín-Casas said.

Diagnosis through exclusion

"An assessment of the biomechanics of the foot and leg is fundamental, and health professionals must also exclude any neurological causes of toe walking gait through extensive assessment and history taking," Cylie M. Williams, PhD, senior research fellow in physiotherapy at Monash University in Australia, told *LER: Pediatrics* by email. "This includes questions about family history of neurological conditions, identifying any risk factors from prenatal and postnatal trauma, or identifying developmental concerns."

In a study published last year,⁵ Williams and colleagues studied



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birth characteristics in a population of 95 children with ITW (mean age 5.8 years). Children with ITW had greater rates of prematurity and admission to a special care nursery or neonatal intensive care unit, as well as lower birth weights, compared with normative children included in Australian perinatal statistical data.

In a German study, also published in 2016,⁶ researchers tested clinical examination methods designed to evaluate ITW in 836 children. Children with ITW and a positive family predisposition had more severe cases of toe walking than children with ITW and no family history.

"Where there is any red flag for a neurological reason, a health professional should refer the child for further assessment from someone with more extensive experience," Williams said.

Varied paths to treatment

Treatment for ITW is varied, Williams said, and it should proceed even without a lot of evidence.

"There are many treatments being used to treat idiopathic toe walking. These may include orthotics, motor planning, even stretches, that have limited evidence to support being recommended," she said. "We need to remember that no evidence should not be confused with lack of evidence. Just because there is a lack of evidence, it doesn't mean things should not be used."

Botulinum toxin A (Botox) is one treatment that has been tried with mixed results.⁷ In a recent randomized controlled trial in Finland,⁸ for example, researchers evaluated whether adding Botox to conservative treatment enhanced the ability of toe-walking children aged 2 to 9 years to walk normally. Two years after treatment, the injections hadn't significantly improved children's ability to walk with

a flat foot or with a heel strike.

In a study⁹ of another proposed treatment, Williams and colleagues found whole body vibration was associated with immediate improvement in heel contact and ankle ROM in children with ITW aged 4 to 10 years. Benefits, however, were not sustained longer than 20 minutes postintervention.

She noted other approaches involve ankle foot orthoses (AFOs) combined with modified footwear or full-length carbon-fiber footplates or orthoses.

"These work through slightly different mechanisms, but the aim is to limit the child going up on their tiptoes," Williams said. "It is reasonable to think that in the long term, this may have some motor planning impact and may reduce any ankle equinus. However, the long-term success is unknown. The choice between the different types of orthotics appears to be based on knowledge, access, and preference of the health professional."

She stresses the importance of providers being clear in their communications with parents about the understood efficacy of various treatments.

"Health professionals need to ensure they don't create a level of expected outcomes that may not be achieved. Where there is a financial investment by parents in dollars and time, health professionals must ensure parents understand their options," she said.

Decision making

Matthews takes a practical approach to evaluating first-time patients.

"As long as a child doesn't have abnormal tone—meaning it's simply idiopathic toe walking and not cerebral palsy or something

Continued on page 12



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Geil and Herrin found that a foot orthosis with attached rigid carbon-fiber footplate (left) didn't control ITW as well as an articulated AFO (right); the less-restrictive device, however, was better accepted by children and their parents, and had similar out-of-brace effects. (Photos courtesy of Kinsey Herrin, MSPO, LPO, CPO.)

like that—I basically evaluate the range of motion, and if I'm able to achieve at least ten degrees of dorsiflexion through passive range of motion, then they're a candidate for bracing," he explained. "If they have adequate range of motion, then I'll put them in a brace with a plantar flexion stop."

Louis J. DeCaro, DPM, a pediatric specialist in Massachusetts and president of the American College of Foot and Ankle Pediatrics, has a three-component process for making treatment decisions.

"Number one is history," he said. "The history should include questions that are focused on neurological concerns as well as sensory processing disorders. The second component of the exam is to measure the equinus of the patient correctly. A lot of times equinus measurement is not done correctly."

The third component is a gait study, paying close attention to vision.

"You can change the field of vision of the patient and see if that affects the toe walking, as well as looking at the foot type and seeing if the patient is toe walking because of compensatory measures for forefoot biomechanics," DeCaro said.

"Toe walking is either from neuromuscular issues, equinus, vision, or forefoot varus that's premature, where the patient has to come up on their toes for balance, or just general weakness of the body and the patient has to come up on their toes," he added. "If the reason for toe walking is forefoot varus, orthotics can be very effective."

They may also assist with sensory processing, he said. "If you're trying to train the brain to [help the heel] come down, you can put a full carbon-fiber plate extension on the orthotic, as well if they're coming up on their toes because of the amount of pronation or abduction or forefoot varus."

Orthoses: Which one?

Sometimes selecting a proper orthosis can be a real process.

Georgia State's Mark Geil and Kinsey Herrin, MSPO, LPO, CPO,

of Ortho Pro Associates in Miami, FL, conducted a nonblinded randomized trial¹⁰ comparing the effects of an articulated AFO versus a rigid carbon-fiber footplate attached to a custom foot orthosis with attached rigid carbon-fiber footplate attached to a cork base, layered with 1/8" Poron and 1/8" ethylene vinyl acetate.

Participants completed a 3D gait assessment and the L-test of Functional Mobility at baseline and after six weeks of treatment. Both groups significantly improved in heel-rise time compared with baseline, but when the orthoses came off, the orthosis group sustained improvements, while the AFO group did not.

"Both groups showed improvement versus baseline. The difference we observed was that the AFO group showed more improvement in-brace—the AFOs were one-hundred percent effective at preventing initial contact with the toe—but some of that improvement was lost when the brace was removed. That's important, because for these kids the orthosis is meant to be a short-term corrective treatment, not a permanent addition," Geil said.

"I think the difference in response was that, while the AFO provided excellent correction when worn, it was more restrictive than the foot orthosis, and once removed the children regressed a bit to the gait pattern they still preferred," he said. "The foot orthosis might have been providing more of a reminder to alter that pattern than complete control of the pattern."

Geil noted the six-week time frame was not ideal, but imposed by funding and other issues.

"It would make sense to assess the children over the duration of orthotic treatment," he said. "However, that time span might have drawbacks, as well. For example, we had one child who was 'fighting' the orthosis so much that he'd worn out the sole of his shoe by the end of our six-week trial. We believe that treatments for these children might need to be individualized quite a bit, so if a child is randomized into a treatment that doesn't match her needs, a long-term trial won't work."

Going forward

Said Matthews, “With idiopathic toe walking, there is no causal diagnosis, they just walk on their toes. If they’re three or four years old or older when they start toe walking, that’s an indicator that something else may be going on,”¹¹ and diagnostics to rule out neurologic issues should be pursued.”

Williams, in Australia, said she hasn’t changed very much in her treatment strategies, but she has “dramatically” changed her way of communicating.

“I feel I present a bigger picture of options but try not to overwhelm. When children with ITW also have extensive ankle equinus, I used to be less inclined to present surgical treatment as an option, preferring instead to steer them to serial casting. Now I present all options as equally viable, as in the absence of an effectiveness trial, we don’t know if surgery is more or less effective than casting,” she said, adding that the two treatments have different costs and timeframes that could lead parents to choose one over the other.

For mild equinus, some parents may opt for stretching exercises and a wait-and-see approach, Williams said. “Others may prefer balance work, exercises promoting weight shift, or use of orthotics in boots [conventional, heavy boots with a flat sole and minimal toe kick that accommodate a full-length orthosis].”

Williams has a personal story. “It is difficult when you get the ‘What would you do?’ question. I’m the mother of a [child] who has been diagnosed with idiopathic toe walking. I get where they are, because as a family, we’ve been on the other end of it, but what I do is what works for my family. Even with all this knowledge, my 184-cm adolescent still toe walks at times but has no equinus. I’ve


almost tried every strategy under the sun, but I feel like I’m winning if we’ve minimized long-term impact.”

Williams and colleagues are currently conducting a survey of healthcare providers on ITW treatment strategies. Take the survey at tinyurl.com/y9a75nva.

Geil offered, “We also need better epidemiology. The numbers in the literature are all over the place. I believe the condition is more prevalent than many realize, and causes substantial long-term issues.”

Studies have reported an ITW prevalence ranging from 7% to 24% in pediatric populations,¹² while a large 2012 Swedish study found a prevalence of 4.9% in children aged 5.5 years.¹³ A 2016 literature review found a 2% prevalence in normally developing children aged 5.5 years and a 41% prevalence in children of the same age with a neuropsychiatric diagnosis or developmental delay.¹⁴

Geil offered this reflection on ITW.

“The comments from a single reviewer on one of my NIH proposals were telling. The criticism was not of the idea for the research, but for the very notion of studying this population. Essentially, the reviewer said, ‘Why study these children? They’ll just grow out of it.’ Many do, but the ones who don’t could face difficult serial casting and even surgery for a condition that should be treatable at a more fundamental level, and much earlier.” 

Larry Hand is a freelance writer in Massachusetts.

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Growth plates and injury in skeletally immature athletes

In this follow-up to “Growth-plate injuries: A diagnostic challenge,” (May, page 15) we continue our look at physeal trauma, exploring growth-plate issues in anterior cruciate ligament reconstruction, and further examining these injuries’ impact on the knees, ankles, and feet of youth athletes.

By Shalmali Pal

Surgeons are more likely to repair an injured anterior cruciate ligament (ACL) in young athletes than ever before, with studies showing the rate of reconstructions in skeletally immature knees tripling between 1990 and 2009.¹⁻⁴

“ACL reconstruction [ACLR] in children is an important intervention,” said Mark V. Paterno, PT, PhD, MBA, SCS, ATC, coordinator of Orthopaedic and Sports Physical Therapy in the Division of Occupational Therapy and Physical Therapy at Cincinnati Children’s Hospital Medical Center in Ohio. “With the increased incidence of ACL injury in skeletally immature patients, a reliable option to restore mechanical stability in the knee is needed. Previous data have demonstrated that continued giving way or functional instability places patients at risk for further meniscal and articular cartilage injury.⁵ Ultimately, this can lead to an early onset of osteoarthritis. If children suffer an ACL injury and continue to have giving way in their knee, they need to have some option to increase its stability.”

ACLR can disturb growth plates, which typically close when boys are aged 15.6 to 17.1 years and when girls are aged between 15 and 16.9 years.⁵ Possible complications of ACLR in skeletally immature patients include premature growth arrest, angular deformity, limb overgrowth, and leg length discrepancy.⁶ Children with 5 cm or more of future lower limb growth potential are at greatest risk of iatrogenic growth disturbance caused by violation of the growth plate, according to a 2016 magnetic resonance imaging (MRI)-based analysis of the tibial epiphysis in skeletally immature adolescents.⁶

Physeal-sparing ACLR techniques, typically all-epiphysis techniques in which graft tunnels are drilled to align anatomically and to avoid growth-plate disruption,⁵ are gaining acceptance as a surgical option for complete ACL tears in skeletally immature knees (Figure 1). Yet treating ACL injuries without adversely impacting the open physis can be a challenge even with these techniques.⁶⁻⁸

Nawabi et al, for example, studied 15 skeletally immature knees after all-epiphyseal ACLR on quantitative MRI 24 months postoper-

Children with 5 cm or more of future lower limb growth potential are at greatest risk of iatrogenic growth disturbance during procedures to reconstruct the ACL.

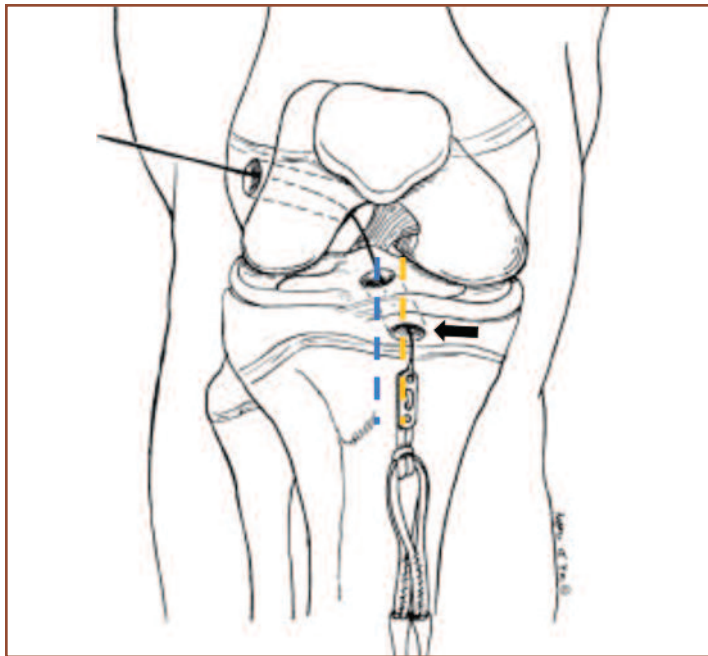


Figure 1. Illustration of the knee depicting an all-epiphyseal ACLR. The arrow indicates the location of the entrance of the tibial tunnel at the anteromedial margin of the tibial epiphysis. (Reprinted with permission from reference 6.)

actively. Ten of the 15 knees demonstrated violation of the tibial physis, typically at the anteromedial region where tunnel drilling occurred. The group's mean volume of physeal damage was 2.1%, but two knees had a physeal injury greater than 6%.⁷ A 2017 meta-analysis of outcomes and complications of different ACLR techniques found the overall rate of growth disturbance after ACLR was 2.6%, with no significant difference between transphyseal and physeal-sparing techniques, though the latter had a lower rate of post-operative complications compared with transphyseal techniques.⁸

Paterno noted that while this research shows ACLR poses some risk to the physis, that risk is relatively low.

"Physeal-sparing ACL reconstruction may be a good option to restore stability at reduced risk to an open physis," he said. "Although no procedure can eliminate risk, the physeal-sparing procedures may reduce risk of altered growth secondary to potential physeal injury while providing necessary stability in some patients."

Nonsurgical treatment options are suitable for nondisplaced ACL injuries, such as Type 1 tibial eminence fractures, per the Modified Meyers and McKeever Classification.⁹ Treatment generally consists of three to four weeks of immobilization, either with long leg casting or splinting in extension.

Bracing after ACLR, preventive use

As for the role of bracing in ACL injuries, it's often recommended after reconstruction with an eye toward controlling range of motion and protecting the graft as it heals.¹⁰ But there's a fair amount of uncertainty about the value of knee bracing in this setting, such as whether it can mechanically protect a reconstructed ACL, and if long-term bracing will impact joint laxity and functional outcomes (see "Postop bracing after ACL reconstruction," *LER*, January 2011, page 43).

"Bracing has not consistently been shown to reduce noncontact ACL injury rates. Braces are used inconsistently after ACLR, but, again, there is little evidence to confirm a reduced second injury

rate in this population," said Paterno. "Bracing may help improve proprioceptive awareness and protect against a contact injury in this population, which may be sufficient justification to support its use, as it may help increase patient comfort when they return to sports."

Then there is the issue of using braces prophylactically to prevent injuries. Brian G. Pietrosimone, PhD, ATC, and colleagues conducted a systematic review of prophylactic braces for the prevention of knee ligament injuries in collegiate football players.¹¹

Some studies showed a relative risk reduction, while others actually indicated an increased risk of injury. But overall, the flawed methodology of the studies reviewed was enough for Pietrosimone's group to conclude that "due to the inconsistent findings within the literature, we deem the current evidence regarding the efficacy of prophylactic knee bracing in reducing knee injuries inconclusive."

The participants in the studies reviewed were young adults, but the efficacy of prophylactic bracing in children who are still growing is just as uncertain, said Pietrosimone.

"We wrote that [review] almost ten years ago, and the data that was part of that study was older than that; from the nineties," said Pietrosimone, an assistant professor in the Department of Exercise and Sports Science at the University of North Carolina at Chapel Hill. "The braces that were studied in that paper are probably obsolete. Nobody has done what's really needed—a randomized controlled trial to see if [prophylactic] braces are effective. But people are using them for their theoretical benefits."

In 2001, however, the American Academy of Pediatrics (AAP) issued a technical report on the use of knee braces in young athletes, which was updated in 2015.^{12,13} The report acknowledged: "There is a lack of scientific evidence that these braces are helpful at the level required for athletic participation. However, patients report a positive subjective response, claiming an increase in knee stability, pain attenuation, performance enhancement, and confidence during athletics with brace use. ... Brace wearers have higher energy expenditures than do nonwearers. Current experimental evidence suggests that [prophylactic] knee braces do not significantly affect performance."

For Pietrosimone, the take-home message for practitioners about prophylactic bracing in this patient population is to proceed with caution. "I think it really comes down to the previous medical history of that athlete," he said. "If you are talking about using bracing to prevent an injury in a person who has never had one, there's not enough evidence to suggest this is a worthwhile use of your resources."

He pointed out the AAP technical report covers a wide variety of knee braces—neoprene sleeves, padded knees braces, rigid braces—and that "these are all very different, and aren't necessarily suitable across the board."

For instance, a padded knee brace might make sense for a volleyball player, whereas a rigid collateral or rotational brace may not, given the player's movement patterns.

"In the AAP technical report, some of the indications are for chronic knee issues ... like trying to align the patella," he noted. "A neoprene sleeve, in general, may be helpful for someone that has some sort of stiffness or chronic swelling; a sleeve may be useful to keep blood flow to the area. It could also provide some compression to the joint. But it may not necessarily improve stability."

Knees, feet, and ankles

Physical knee, foot, and ankle injuries can be put into three general categories: growth-related, overuse injuries, and acute injuries.

Growth-related injuries. The most common growth-related injury seen in young athletes is Sever disease, or an apophysitis of the os calcis. In young athletes, heel pain can be a tell-tale sign of an unfused apophysis. Sever disease is bilateral in the majority of cases, and affects male athletes more often.¹⁴ (See “Sever disease: Intervene early to relieve symptoms,” May 2015, page 15.)

Issues to look for during the physical exam are “posterior calcaneal tenderness with mediolateral compression anterior to the Achilles tendon insertion. Ankle dorsiflexion may aggravate the pain due to tight heel cords,” according to a *Sports Health* review article. Sever disease is often tied to forefoot pronation.¹⁴

“The differential diagnosis for calcaneal apophysitis includes tarsal coalition, osteomyelitis, retrocalcaneal bursitis, and neurologic disorders,” wrote the review authors.

Two good examples of coalition injuries in the foot are a talar calcaneal bar or a calcaneal navicular bar, according to Robert M. Conenello, DPM, a podiatrist with Orangetown Podiatry in Orangeburg, NY, and a past president of the American Academy of Podiatric Sports Medicine.

In young athletes, excessive pronation while running may increase the chances that they are setting themselves up for these types of injuries.¹⁵ He noted a young athlete may sustain these physical injuries before they experience obvious symptoms. “When these areas start to ossify, they become more painful under stress ... the patient may not notice there’s a problem until their midteens, when they start to add more bulk, strength, and weight,” said Conenello, who is also a clinical adviser for Special Olympics Fit Feet program. (See “Taller, heavier children have heightened Sever disease risk,” August 2015, page 5.)

He also described treating accessory ossicles in young athletes. Accessory ossicles are separate ossification centers located extrachondrally, and they are different from coalitions because they do not form a connection between two bones but exist at the end of certain bones.¹⁶

Accessory ossicles generally appear when children are aged 8 to 10 years, and fuse about a year after their formation. According to a review article, “When they do not fuse, they become symptomatic. The most common sites for accessory ossification center formation are at the posterior talus, known as os trigonum, the medial malleolus, and the navicular. The navicular ossification center sometimes can form an entirely new bone known as an accessory navicular.”¹⁶

As with other physical injuries, accessory ossicles can be misdiagnosed in the urgent care or emergency department (ED) setting. “I had this happen ... with one of the kids on my son’s baseball team,” Conenello explained. “He said they’d gone to the [ED] and they told him he had a fracture. I asked to see the x-ray and said, ‘That’s not a fracture; that’s an accessory bone.’ I asked if they took an x-ray of the other foot because sometimes you’ll see the same problem on the other side.”

Overuse injuries. Then there are the overuse injuries, such as tibial tubercle apophysitis (Osgood-Schlatter disease) and osteochondroses. Osgood-Schlatter disease is often seen with activities that call for repeated forced knee extension. This extensor mechanism causes repetitive tensile microtrauma at the tibial tubercle apophysis.¹⁴

Continued on page 18

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"The patellar tendon inserts at the unossified distal portion of the tibial tubercle apophysis via fibrocartilage. When this weak secondary ossification center is unable to withstand the repetitive tensile forces, bony or cartilaginous separation occurs, usually during the preossification or ossification phase; bone formation between the fragments follows," the review authors wrote.

It's more common among boys and can be bilateral in more than half of the cases. The symptoms—gradual onset of pain, swelling, tenderness, and/or a prominent at the tibial tuberosity region—can worsen with jumping or running.¹⁶

Osteochondroses refer to lesions of the ossification centers that eventually undergo recalcification. The two most common lesions are osteochondrosis of the tarsal navicular (Kohler disease) and osteochondrosis of the second or third metatarsal heads (Freiberg infarction). These injuries can occur with up to 6.5% of ankle sprains and present as a chronic condition associated with an acute injury.¹⁶

The last of the overuse injuries are stress fractures, described as a process that leads to fatigue or insufficiency or failure of bone that occurs when the bone's reparative abilities have been surpassed and the bone is unable to withstand chronic repetitive submaximal loads. These injuries account for up to 15% of all athletic injuries in young athletes, and are commonly seen in adolescent runners, but can occur during any sport that requires repetitive running or cutting actions.¹⁵

Acute injuries. Finally, there are acute physal acute fractures, which are covered more extensively in part one of this series. Generally classified with the Salter-Harris system, acute fractures of the foot and ankle are most commonly seen in the distal tibia, distal fibula, and the phalanges.

While the experts in part one discussed problems with misdiagnosis of these fractures, Conenello brought up another concern, that of overtreatment.

"I think misdiagnosis can go both ways," he said. "Physal frac-

tures may be missed in EDs and trauma centers. But, sometimes, they'll call it correctly as a growth plate fracture, and [subsequent physicians] will overtreat it. So, a patient will be in a CAM boot walker for six weeks. Then they get out of the boot and someone says to the kid, 'Now get back on that soccer field.' Now the athlete is deconditioned, and is set up for another potential injury down the line."

And that dovetails with Conenello's general philosophy when it comes to treating physal injuries of the foot and ankle—he encourages his patients to work on their strength and balance.

"The more important thing to teach is strength because a strong athlete is one who is less likely to sustain injuries," he noted. "As parents ... we drive them from practice to practice [where] they work super hard. But in between practices, we don't necessarily work on things like balance, strength, figuring out their weaknesses and what they could work on."

For example, Conenello said he has treated gymnasts with Sever disease. During the exam, he said he'll ask them to stand and balance on one foot. "And they fall—they're gymnasts! Sure, they can do back walkovers and jump up in the air and twist around, but they aren't strong enough yet. I'll tell them to brush their teeth while standing on one foot, and they struggle with it. It's overuse coupled with a certain lack of strength, especially in their feet and ankles."


While he may use an over-the-counter (OTC) insole to address the heel pain in the acute phase, he is not apt to use devices long term. Instead, he will send patients for preferred body-weight training or plyometrics as ways to gain strength and mobility. "I think balance and proprioception are important in terms of being able to feel where their bodies are in space," he explained.

Another issue Conenello will address in patients with physal injuries is footwear, both on and off the playing field, court, or pitch. He noted kids will often gravitate toward athletic shoes because of the style, or because they are endorsed or designed by their favorite sports star. But that particular shoe may be inappropriate in terms how much flexibility it provides, how rigid it is, or the amount of room in the toe box.

"You have to really look at how the shoe fits on that kid," he said. "I like shoes with wide toe boxes and some flexibility in the outsole. You also have to ensure that the kid is wearing the shoes properly."

For instance, a child in basketball shoes who complains of heel pain may be tying the laces loosely, which is fashionable but not supportive of their feet and ankles (See "Basketball shoes trends favor fashion over feet, *LER*, February 2017, page 43, and "Seeking shoe closure: Laces versus alternatives," *LER Foot Health*, October 2015, page 15).

Finally, Conenello said he always asks about shoe choices when the young athlete is not at play. He shared the story of a 13-year-old gymnast who complained of foot pain from a physal injury, and when he asked her about her everyday footwear, she replied that she wore either flip flops, sheepskin-lined boots, or lace-up sneakers with a very flat, rigid insole.

"I told her: 'That's the problem. You spend the majority of your day in shoes that aren't giving you the right support.' I prescribed an OTC insole to educate her about what a supportive shoe should feel like. It's important to teach good foot health outside of the sport." 

Shalmali Pal is a freelance writer in Tucson, AZ.

References are available at lerpediatrics.com.



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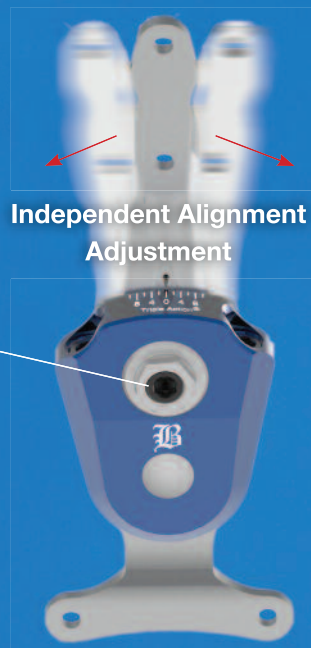
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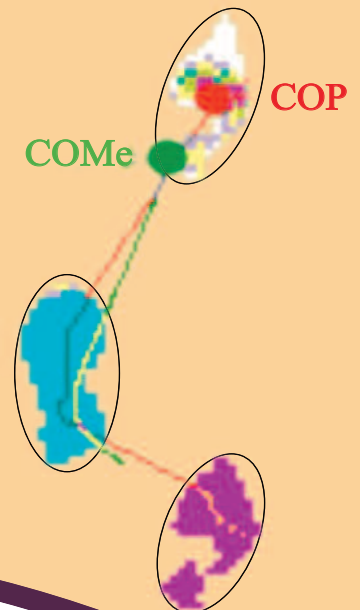
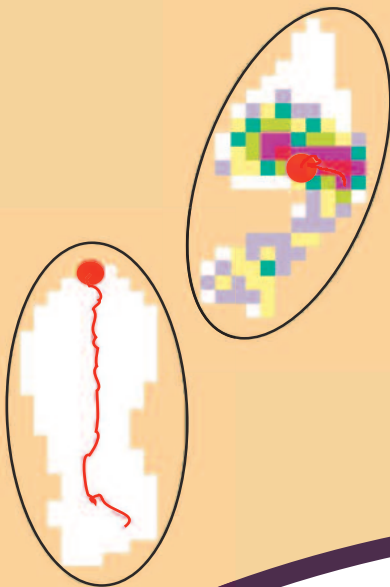
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