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may 2014

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From the editor: Smaller patients, bigger challenges

Children are not simply smaller versions of adults, and therefore their healthcare shouldn't be a scaled-down version of adult management. We know this. But every once in a while we come across a poignant reminder of just how important that maxim is.

Some of you may remember the popular feature we published in *LER* on the challenges faced by wearers of ankle foot orthoses with regard to clothing styles (see "Finding fashion options that accommodate AFOs," August 2013, page 25). This isn't something you'll read about in the medical literature, but it can make a big difference to a patient's quality of life.

The same writer, Shalmali Pal, explored the same topic for this issue of *LER: Pediatrics* and found that while AFOs certainly can pose a stylistic challenge for many adults, having to make clothing choices work with AFOs can be an even bigger deal for kids.

For children, clothing choices are about independence. Picking out an outfit is one of the first memories most of us have of doing something for ourselves that a parent had typically always done for us. Yes, the stylishness of our efforts might have been questionable, but at least most of us didn't have leg braces to complicate the process.

For children, clothing choices are also about identity, about standing out from the crowd or fitting in. Sometimes it's great to make a statement with colorful AFOs, but other times a kid just wants to be able to wear the same skinny jeans as everyone else.

Children are not simply smaller versions of adults. Sometimes they're much more complicated. And that's what *LER: Pediatrics* is all about.

Jordana Bieze Foster, *Editor*

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Plaster outranks other pediatric casting materials for moldability

Second study assesses 'creep' risk

By Larry Hand

Sometimes, even when new treatment materials are available, it may be better to rely on traditional options. Such may be the case when it comes to choosing a molding material to form casts for children with clubfoot or fractures.

Researchers from the University of Vermont College of Medicine (UVM) in Burlington reached that conclusion after comparing three cast-molding materials.

"Molding plays a pivotal role in the nonoperative treatment of many conditions like clubfoot casting and children's fractures," said first author Steven B. Daines, MD, clinical instructor in the departments of orthopedics and rehabilitation at UVM. "A material's failure to hold a mold could mean a poor correction of a deformity or a loss of reduction. This could result in the prolongation of treatment, the failure of treatment causing a need for surgical intervention, or a poor outcome."

The researchers compared 12.7 cm-wide casts of plaster, fiberglass, and soft cast. They prepared the casts in 40° C water, five layers thick, and placed over them two layers of cotton padding on 5.1 cm- and 15.2 cm-diameter foam cylinders. They used loading devices to simulate the thumb loads physicians apply when molding casts for clubfoot and other conditions that included developmental dysplasia of the hip (DDH) and femoral fracture.

For clubfoot, the loading device applied a thumb-shaped 50-N load on the 5.1-cm model for seven minutes. For DDH, the device applied a 100-N load on the 15.2-cm model, as did the device for femur fracture.

The researchers made five casts of each material and, when the molded casts were removed, they photographed them and compared maximal deformation areas of molded and unmolded casts. A large maximal deformation area meant the molding was less precise.

They found plaster was more precise than fiberglass and soft cast for clubfoot, DDH, and femur fracture because it had the best moldability, or ability to retain the desired shape.

"Our study has further emphasized the importance of considering the benefits of various materials when using them in the clinical setting," Daines said. "At UVM, we have utilized various casting materials based on the advantages of their material properties. For example, many of our clubfoot casts are made of plaster, which helps us carefully mold casts to correct the clubfoot deformity. Some of our children's fractures, like buckle fractures of the distal radius, do not require precise molding. We have used removable soft casts with waterproof liners to treat these fractures, maximizing patient comfort and minimizing follow-up appointments as parents can remove the casts at home."

> Plaster was more precise than fiberglass and soft cast for DDH and femoral fracture because of its moldability, or ability to retain its shape.

The UVM study, published online in February by the *Journal of Pediatric Orthopedics*, comes on the heels of an August 2013 study looking into the mechanical performance and displacement (or "creep") of three materials used for casting clubfoot patients. Using a cast-testing device built to model clubfoot correction, including the internal force on the cast coming from the foot, researchers analyzed the rotational displacement and linearity of the limb-cast composite during three 10-minute intervals after the cast had set.

The results suggested that at least 65% of cast creep occurs during the first 10 minutes after setting, according to study coauthor Tamara Cohen, a PhD candidate in biomedical engineering at Marquette University in Milwaukee, WI. The amounts of displacement were small for all of the materials, indicating that any could be used with the Ponseti method of clubfoot treatment. However, displacement occurred to the greatest extent with plaster (2°), followed by semirigid fiberglass (1°) and rigid fiberglass (.4°), and those differences were statistically significant.

Photo courtesy of the University of Iowa.

The two studies don't conflict with each other, they just look at mechanical properties in different ways, according to Cohen and coauthor Peter Smith, MD, a pediatric orthopedic surgeon at Shriners Hospital for Children in Chicago.

The earlier study addresses changes over time, while the new study addresses how perfectly a cast conforms to initial molding. Both studies, Cohen and Smith said, add information on a topic that, previously, was basically ignored in the literature.

"We've changed over the years to using more of the soft casts for clubfoot, because it can be removed more easily. But, for the ones that are difficult to mold, the ones where we think that it would change the outcome, then we definitely use plaster. It's what works," Smith said.

Larry Hand is a writer in Massachusetts.

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Risks of overuse, burnout extend to youth athletes

Position statement cites warning signs

By P.K. Daniel

Despite the slim odds of securing an athletic scholarship and the even slimmer prospect of playing professional sports, there's an overemphasis today on success in competitive youth sports, including specialization and elite-level training. As such, and with the proliferation of travel teams and club sports, practitioners have seen an increase in overuse injuries and burnout.

Starting a child in sports before he or she is developmentally ready, committing early to one sport, and overtraining are cited by practitioners as risk factors for overuse injuries and burnout in a recent position statement by the American Medical Society for Sports Medicine (AMSSM).

The current literature reports that overuse injuries comprise half of all sports injuries. Lower extremity overuse injuries include medial tibial stress syndrome, osteochondritis dissecans, Osgood Schlatter disease, and Sinding-Larsen-Johansson disease (SLJD). The prevalence varies by sport, ranging from 37% (skiing and handball) to 68% (running). The AMSSM, however, suggests overuse injuries are underestimated since many of these injuries don't result in loss of participation time.

But the lack of time loss is not because the injuries don't warrant rest.

"If they have an overuse injury and they're not losing time, it's more because people are not recognizing them or ignoring them, and that can then lead to the injury becoming worse," said Joel Brenner, MD, MPH, FAAP, a coauthor of the AMSSM position statement, which was published in the *Clinical Journal of Sport Medicine* and the *British Journal of Sports Medicine*.

"The main thing for parents and coaches to understand is that since most kids are not going to become professional athletes and most are not going to get the college scholarship, we want them to have fun and learn lifelong physical activity skills," said Brenner, chair of the American Academy of Pediatrics Council on Sports Medicine and Fitness. "The big thing is making sure that young athletes are not participating in one sport year-round, and also that they're having some time off throughout the year from a particular sport to prevent these overuse injuries and burnout."

Practitioners need to address sports readiness in terms of cognitive, social, and motor skill development, as age is not an indicator of whether a child is physically and developmentally prepared. This can also help to prevent overuse injuries and burnout.

"One of the problems we have is parents who expect their children to do certain sporting activities before they're ready," said Greg Landry, MD, a report coauthor and faculty member in the departments of pediatrics and orthopedics at the University of Wisconsin School of Medicine and Public Health in Madison. "A lot of times [children] get involved in team sports before they have the skills or the cognition to really do it."

> Participating on multiple sports teams during a single season leads to overtraining and increases the risk of overuse injury.

An excessive focus on early intensive training and competition—rather than skill development—can lead to overuse injury and burnout. These injuries can require extended recovery, and sometimes can lead to long-term complications. Ultimately, they can endanger future participation.

"[Youth athletes] often play with pain when they should be resting," Landry said. "That potentially can result in long-term problems."

Participating on multiple sports teams (in the same or different sports, particularly if the sports have similar components, eg, soccer and track) during a single season leads to overtraining and an increased risk of overuse injury. A 2008 study of 2721 high school athletes showed a relationship between hours of sport participation and risk of injury. Training more than 16 hours per week was associated with a significantly increased risk of injury requiring medical care.

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Robbie Bowers, ATC, head athletic trainer at Rancho Bernardo High School in San Diego, likened the AMSSM position paper to one the National Athletic Trainers Association published on pediatric overuse injuries in 2011 that recommended no more than 16 to 20 hours per week of vigorous physical activity by pediatric athletes.

"With overtraining you break your body down before it has time to respond and restore itself to a stronger level before it gets broken down yet again," Bowers said. "It's going to find the weak spots and a lot of times it's those apophyses [cartilaginous growth centers]."

Repeated injuries, coupled with extended recoveries and long-term effects, can affect an athlete's quality of life.

"One of the things we see in the office is that they often have one overuse injury after another," Landry said. "I think over time they begin to enjoy their sport less and less because of all the injuries. It does impact the fun of participating."

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

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Early outcomes support internal technique for limb lengthening

Intramedullary nail is 'a step forward'

By Samantha Rosenblum

Preliminary evidence supports the use of a new internal technique for limb lengthening, according to data from the International Center for Limb Lengthening (ICLL) at the Rubin Institute for Advanced Orthopedics of Sinai Hospital in Baltimore.

The ICLL has used an internal lengthening nail in 82 patients, 48 of whom were younger than 18 years, in the past two years and reports that patients experience less pain, less joint stiffness, and fewer general complications compared with lengthening using external fixation.

The nail, an extendible intramedullary rod for lengthening the femur and tibia, utilizes a magnetic-powered external remote controller that lengthens it noninvasively. Use of the nail addresses many problems associated with external fixation, such as pin-site infections, muscle tethering, and pain, according to the ICLL.

In a paper presented at the American Academy of Orthopaedic Surgeons 2014 meeting in New Orleans, researchers at the ICLL asked 15 patients (or parents of young patients, if appropriate) who had undergone limb lengthening with both external and internal techniques to compare the experiences. The average age at external fixation was 9 years; for internal lengthening, 14 years.

On a 10-point scale, patients on average ranked visual analog pain associated with external fixation at a 7, while the average pain associated with internal fixation was a 3. Use of pain medication averaged 11 weeks with external fixation and five weeks for internal fixation; time to full weight bearing averaged 21 weeks for both techniques. The internal device was associated with higher levels of patient satisfaction regarding ease of physical therapy, cosmetic results, complication rate, day-to-day function, and return to activity. Earlier results from the same study were presented in July 2013 at the annual meeting of the Limb Lengthening and Reconstruction Society.

Joshua Hyman, MD, associate professor of orthopedic surgery at Columbia University College of Physicians and Surgeons in New York City and director of the pediatric orthopedic fellowship at Morgan Stanley Children's Hospital of New York, has yet to use the nail but noted that external fixation is associated with a number of potential risks.

"I always have a discussion with patients and their parents about the risk of superficial infection, which I describe as about one hundred percent," Hyman said. Other risks include injury to nerves and blood vessels at pin sites or when the bone is cut.

The benefits of internal lengthening are not limited to physical advantages, according to John Herzenberg, MD, FRSCS, director of Pediatric Orthopedics at Sinai Hospital and of the ICLL, who presented the study findings.

"It's certainly psychologically better for the patient because they don't have a huge external scaffolding contraption outside their leg attached to them for months at a time," Herzenberg said. "If someone has [internal lengthening], you wouldn't know if they were sitting next to you. It takes the whole process and makes it more comfortable."

> Smaller versions of the intramedullary nail are becoming available, which will increase its potential for use in young children.

Smaller versions of the original nail are becoming available, which will increase its potential for use in young children. The latest generation of the internal system is also four times stronger than the original, Herzenberg said.

Hyman says he sees a future for internal lengthening.

"It gives us another tool for treating deformity. And, when we speak about deformity, most of us think about a wavy or a curvy bone. But it also means a short bone, and it gives us another way to address this," he said.

X-rays show femur with nail inserted before lengthening (left), after lengthening (center), and after the lengthened bone has healed (right). (Images courtesy of John Herzenberg, MD, FRSCS.)

There have been about 700 nails implanted worldwide. But the new technique has not solved all the problems associated with limb lengthening, Herzenberg said.

"We're still stretching muscles, we're still stretching bone, and the bone still has to heal," he said. "It's a step forward, but not a panacea. It doesn't cure all the problems of making limb lengthening a simple process. It's still a very serious procedure."

The new nail is also a straight nail, which limits its ability to lengthen crooked bones.

"If this is the case, you could use an external fixator with hinges that allows straightening of the fixator as well as lengthening," Herzenberg said. Another alternative might be to perform an osteotomy to straighten the bone and then use the nail once the bone has healed.

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

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In the February issue of *LER: Pediatrics*, the article "Ponseti method surpasses surgery for long-term clubfoot outcomes" incorrectly quoted John Herzenberg, MD, FRSCS, with regard to the duration of casting involved in the Ponseti approach. The correct casting duration is three months. *LER* apologizes for the error.

Photo courtesy of Allard USA.

Kids, clothes, and AFOs: Finding just the right fit

When a child is required to wear ankle foot orthoses (AFOs), his or her clothes have to be more than just cute. Trying to match the logistical requirements of AFOs with fashion concerns and psychosocial development can be a challenge for patients and parents alike.

By Shalmali Pal

In the anthology of cute kid stories, there's at least one chapter about children and their clothes. There's the one about the toddler who insists on choosing her outfit, proudly exiting the house in a riot of colors and patterns. Or the kindergartener who refuses to attend school unless he wears his superhero costume. Or the tween who must have the same pair of jeans as her friends, no substitutions allowed.

But when the child is required to wear ankle foot orthoses (AFOs), cute can quickly morph into challenging for patients and parents alike as they try to match the logistical requirements of the AFOs with fashion concerns and psychosocial development. *LER* checked in with some experts for advice on how to make that match happen and what clinicians can do to help.

Infants, crawlers, and toddlers

For small children (aged 5 years and younger), clothes need to be easy-on, easy-off, whether it's to facilitate a diaper change or make it more efficient to help the child don and doff the AFOs.

Kathy Martin, PT, DHS, said she's yet to encounter problems with AFOs related to the type of clothing that is typical for infants, such as baby sacks and onesies.

"It's not been my experience that parents have to choose different types of clothes based on the braces except that, as with all babies, you want to be able to get them off and on easily," said Martin, professor and Doctor of Physical Therapy program director at the Krannert School of Physical Therapy at University of Indianapolis. "At that age, kids don't usually have the manual dexterity or strength to get their braces off, so I don't think you need special clothing to try to stop them from doing that."

Lara Hartung, CO, of O&P Labs in St. Louis, MO, agreed.

"I tell the parents of these kiddos that anything that snaps open and closed along the bottom is usually the way to go," Hartung said, adding that this holds true even if the child requires a brace with an abduction bar to treat clubfoot.

> As children mature and develop personalities and personal tastes, the issue of making clothing work with AFOs is no longer just about comfort.

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Yaron "Ron" Raducanu, DPM, president of the American College of Foot and Ankle Pediatrics, added the reminder that climate will impact clothing choices. An infant living in a warmer region may be able to get away with short onesies that leave the AFOs uncovered. Climates that call for more coverage may require some experimentation to determine what accommodates the AFOs best.

Regardless of the clothing, "one key with AFOs, especially if they are custom made, is that they should not cause any irritation to the wearer," said Raducanu, who is in private practice in Philadelphia. "It's up to the practitioner to make the brace as comfortable as possible. I think it's more important to get that right than to be too concerned with anything that goes over the brace."

But what happens when children become mobile? How should parents dress a crawler or toddler who requires AFOs?

In young children, experts say, often the AFO itself is more restrictive than the child's clothing. But Raducanu reiterated that streamlining the AFOs as much as possible curtails problems with children's clothing.

"The Velcro can sometimes be troublesome and catch on the AFOs, so that's something that I check for and try to minimize," he said. "Also, you have to look at the placement of the buckles and latches, so that they don't interfere with clothing and cause discomfort."

Photo courtesy of Cascade Dafo.

As for clothing materials, there are no hard and fast rules. The experts agreed that socks made with moisture-wicking materials are best for regulating sweat. Otherwise, it's mostly a matter of trial and error, and communicating with the child to see if the items are suitable for the AFOs, comfortable, and appealing.

Of course, if the child is preverbal, traditional communication may be difficult, but family therapist Jillian Pizzi, MA, has ways to manage that. First, she suggested, healthcare practitioners can use dolls or stuffed animals to show the child where the AFOs will be placed and how their clothing will accommodate the braces. Then, once the child has donned the AFOs, the outfit, or both, use the same dolls to ask the child to point out areas where the braces or the clothes are uncomfortable.

Pretending to put the AFOs on the doll first allows the child to "buy in" to the braces, explained Pizzi, who is with South Bay Mental Health in Lowell, MA.

"They will feel more comfortable seeing it done [on the doll] first, and this may enable them to relax a bit," she said.

Pizzi has a unique perspective on pediatric AFOs—she was diagnosed with distal arthrogryposis and underwent multiple surgeries, starting when she was 10 months old and ending at age 4. She wore AFOs off and on until she was 7 years old. She now works with disabled children at her counseling practice.

Even when children are very young, Pizzi advised building trust by taking the time to explain the devices, and then giving them some say in the clothes they need to adapt to those devices.

"Taking the time to explain, show, demonstrate, and check in with kids helps to strengthen their trust of who is in their environment and what is going on," Pizzi said.

Growing up with AFOs

As children develop personalities and personal tastes, the issue of making clothing work with AFOs is no longer just about comfort; the focus can shift to what's socially acceptable to children and their peers.

"I think it was around age six that I started to become aware of clothes and how things matched or how they looked," Pizzi recalled. "I remember that I had a terrible time with jeans. I wore a lot of stretchy pants or sweatpants."

Parents and practitioners need to be aware of the balance between doing what is best for the child's health and allowing the child to have some say in his or her life, Pizzi said.

"Telling a child, 'I'm going to give you your own voice' can be very helpful. Kids respond better if they feel they have some sense of control," she said.

The first place to start that process is with the AFOs themselves. The ability to dress up AFOs with colors, decals, or stickers has been a tremendous boon.

Photo courtesy of Cascade Dafo.

First, it's an opportunity for the child to be involved in the decision-making process and gain a sense of control by choosing a design or color. It also "makes the brace less medical," Hartung pointed out. "It allows them to make it more about something fun for a toddler, or something fashionable for an older child."

Martin said that being able to bring that sense of fun or fashion can even tip the balance in favor of the AFOs in terms of patient compliance.

"I've had parents tell me that their child goes to school with the AFOs featuring a cartoon character and other kids say, 'I want those!' It almost becomes a personal fashion statement. And if it's more appealing to the kids, then they are more likely to wear the braces," Martin said.

For specific clothing choices, trial and error is what the experts advised, and easy-on, easy-off shouldn't be completely discounted. Annette is the mother of an 8-year-old girl with Charcot-Marie-Tooth disease. Her daughter has worn AFOs for two years, and she's finding the balance between being independent and learning to work within some of the limits presented by the AFOs.

"She generally wears sweats [or] elastic waistband pants to

make it easier for her to use the restroom," explained Annette, who lives in California. "She does want to assert her independence as she's growing up; she gets herself dressed. She is learning to adapt and do things differently than everyone else."

The experts emphasized two points: making the AFOs part of the child's routine and letting them make decisions—within limits.

"As soon as you can, have them learn that the AFO is part of their daily lives," is a recommendation that Hartung makes to parents. "If they are involved from the very beginning, it's not something that is so torturous. It becomes part of their everyday activities."

An example would be for the parent or caregiver to give a daily review of the process of putting on and taking off the AFOs, even if the child may be too young to fully comprehend what's happening. And older children can be allowed to put on their AFOs and shoes and socks themselves, rather than making it something mom or dad does to them.

Pizzi suggested starting this process in children as young as 4 or 5 years, and framing the importance of the AFOs within a story.

"In the story, the adult could describe the activities that they are going to be able to do today because the child is wearing the brace," she said. "Or maybe there's a special occasion coming up like a birthday or a family event. The parent could talk about how the child will be able to participate in that more easily with their braces on."

One of the major rules of parenting also applies to kids and their AFOs—children like making decisions, but they also need boundaries, and that includes their clothing options.

"I think it's important to structure the choices in a specific way," Martin said. "A parent can say, 'Do you want to wear the blue socks or the red socks with the braces?' You didn't give them a choice regarding the braces at all; it's understood that the braces will be worn. It's up to [the adults] to structure the choices so we get the outcomes we want."

Raducanu suggested that parents avoid the trauma of trips to the mall with younger kids to try on clothes and shoes. Instead, parents should go out and do the shopping themselves, choosing items that they believe will work with the AFOs, and then let the child try on and choose from that selection at home.

Having to return the unwanted items will require an additional trip to the store, but he pointed out that it's a small price to pay to avoid "a huge battle that's only going to leave everyone upset and feeling resentful. That can impact the child's attitude towards the braces."

OMG: Teens and AFOs

There's another chapter in that anthology about the rebellious teen. It's a time when the desire to fit in is paramount, and having to wear AFOs may not fit the bill at all.

"One of the biggest problems with teenagers is compliance," Hartung said. "They don't want to wear something that makes them different."

Once again, the experts agreed that helping teens fit their fashion needs around their AFOs starts with the devices themselves. The use of light, thin materials, for example, can help AFOs fit under trendy skinny jeans or leggings, Hartung said.

"Our goal is to make sure the brace functions properly and that the patient will wear it," Hartung said.

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Photo courtesy of SureStep.

If a teenage girl is keen on wearing below-the-knee skirts, but the extra material gets stuck on the Velcro closures, Hartung said she would make it a priority to adjust the closure rather than ruling out the clothing item. Another option for some AFO-wearing teens is to switch from a taller brace to one with a lower profile.

Pizzi pointed out that a militant attitude about AFO compliance can be especially hurtful to an adolescent who is already struggling with the usual teen issues beyond the AFOs. In an essay she wrote as an undergraduate at Rivier University in Nashua, NH, Pizzi recounted a day of shopping for clothes with her mother as "somewhat torturous. If the pants are good, the shoes are not, and if the shoes are good, the pants are not. It is a vicious cycle. I cannot win. So, after...the tenth pair of pants that I had tried that day...I had had enough and stormed out of the store."

So what's the best way to manage that kind of frustration, anger, and resentment? Pizzi advised that the teen years would be a good time to introduce psychosocial therapy, which can benefit both the patient and the parents.

Parental protectiveness can be heightened when a child requires AFOs. But teenagers are more likely to misinterpret that caring and become less compliant.

"Who wants their parents nagging them constantly, and what parent really wants to be the nonstop nag? I think it's important to start empowering teens to more fully understand what they could or should do to help themselves live comfortably with their disability," Pizzi said. "The idea is that the teen can be a bit more proactive or responsible for his own body and the parent can still [offer] support...and step back or out of the protective role."

Professional counseling is one option, as are support groups and workshops. Pizzi said she found it very cathartic to pen her college essay.

As for those potentially perilous shopping trips, Pizzi summed up her advice in one word: patience.

"When my mom and I would go to the mall, it could take us five hours to find the right shoes or clothes. We just had to accept that it was going to be a slow, steady process. Eventually, we'd find clothes that were cute and functional, but we both had to be willing to put in the time," she said.

Ultimately, practitioners and parents alike may have to accept that a teen's AFOs may spend more time in a closet or school locker than they will on the patients.

"At some point, they may stop wearing the AFOs, or wear them out of the house and then take them off the minute they get to school. And you may just have to let that go. The patient needs to make that decision to wear their AFOs," Raducanu said.

Adaptive apparel

Parents searching online for clothing options for their AFO-wearing children are likely to come across adaptive apparel. These are clothes and shoes that have been specially designed to work with AFOs. Examples include "hatchback shoes," that allow the back of the shoe to open up so the foot can slide in; longer, seamless socks that are long enough to cover AFOs of varying heights; and pants that snap closed on the sides so that the front "breaks away" rather than having to be pulled down.

Photo courtesy of Allard USA.

Most of these items are not cheap. Socks can cost as much as $10 a pair, while shoe prices generally run between $80 and $100. Our experts were divided on whether adaptive apparel is worth that kind of money.

Hartung expressed reservations, especially given that kids grow out of shoes and clothes so quickly. She also pointed out that AFOs—and the children who wear them—can take their toll on shoes.

"An older child who is on the go may not take the time to put the shoes on and take them off properly. He might try to jam his foot into the shoe, brace and all, and then collapse the back of the shoe," she said. "If a parent has spent a lot on a specialty shoe, that's a problem. I'd rather get them into a regular shoe."

On the other hand, Annette has opted for adaptive shoes for her daughter and, on the whole, considers them a good fit.

"They are expensive—it cost me about eighty dollars-plus to order her a pair of shoes...and it'll take two to three weeks before we'll get them. They can be a good investment since they easily fit her braces," she said. However, Annette warned that shoes styles are limited. "They only have one pink color for girls and a Mary Jane-type shoe."

Pizzi remembers her mother investing a few hundred dollars in a couple pairs of adaptive shoes.

"They were very expensive, and she knew I'd outgrow them pretty fast," Pizzi said. "But they were beautiful shoes, and I did wear them without any complaint." ler

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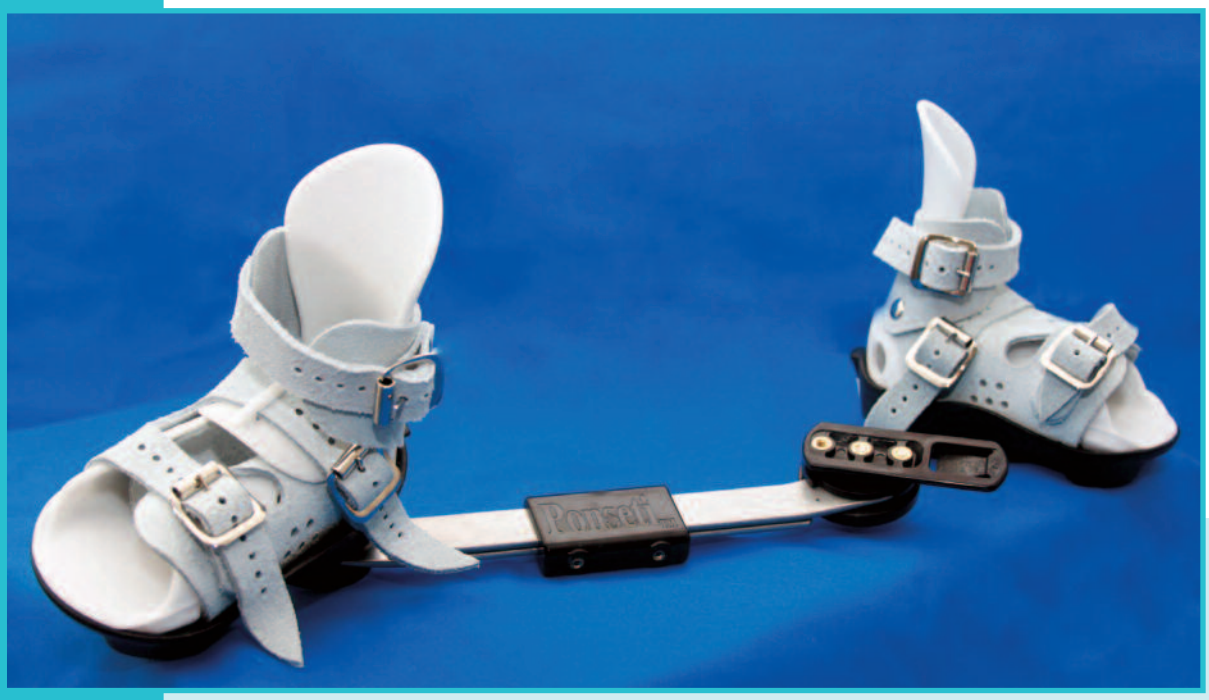

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Juvenile hallux valgus: Shoe fit and other considerations

Austrian research suggests too-short shoes may contribute to the development of bunions in children, and genetics also appear to play a role. Most clinicians try to avoid surgery in young patients, instead turning to conservative strategies such as foot orthoses and night splints.

By Christina Hall Nettles

Two Austrian studies suggest that juvenile hallux valgus (JHV) is far more prevalent in young children than previously recognized and that the culprit is too-short shoes. But will this relationship apply to children in other countries?

Christian Klein, MD, Elisabeth Groll-Knapp, PhD, Michael Kundi, PhD, and Wieland Kinz, PhD, of the Institute for Environmental Health, Center for Public Health, at the Medical University of Vienna, recorded the hallux angle and length of 1579 individual feet among preschool children aged 3 to 6.5 years.[1] Fewer than 25% of the children's feet exhibited a straight position of the great toe, with the majority displaying lateral deviations at different degrees. The "great toe varied between a straight position and a hallux angle of up to 19°,"[1] according to the researchers, who stated there were no known evidence-based normal values and ranges of hallux angle for "children of such a young age, either based on radiographic measurements" or on data using their external method.

Investigators stratified the study sample's 858 participants by gender, geographic location (urban vs rural), and Austrian province and performed upright 3D measurement of the children's feet using an external method based on footprints (to avoid exposing healthy children to x-rays). They then randomly selected days to measure the inside length of the children's indoor and outdoor shoes and compared those measurements with the length of the feet. Nearly 90% of the participants' indoor shoe sizes were too short, and nearly 70% of the children wore outdoor shoes of insufficient length.[1]

"We showed that there is a significant relationship between too-short shoes and the hallux angle; the shorter the shoe, the higher the value of the hallux angle. Although currently we are not able to tell which dosage is harmful, for example, four hours per day during two months leading to an angle of fifteen degrees," Kinz said.

The Austrian Federal Ministry of Health commissioned the same group of researchers to analyze children's perceptions and parents' awareness of properly fitted shoes compared with investigators' measurements.[2] They recorded data from more than 496

Conservative management of hallux valgus is recommended in skeletally immature patients, who have an increased risk of recurrence after surgery.

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children aged 6 to 10 years and looked at approximately 1000 pairs of outdoor shoes, slippers, and house shoes. Children were asked to wear one shoe that was several sizes too small, and one shoe that was fitted correctly. Interviewers asked test subjects to walk in both shoes and then questioned them about the experience. They found the participants could not feel a clear difference in fit, and many children described the shoe that was markedly shorter than the foot itself as a good fit.[2]

"During our research projects and numerous 'Measuring Days for Kids' Feet' held in Germany, Switzerland, and Liechtenstein, we were surprised to see how many children were wearing shoes that were much too short; up to five sizes too small. Oddly, all of these children were entirely convinced that their shoes fit perfectly," Kinz said.

Shoe sizes increase about a half size every four months in children aged 3 to 5 years, with boys' feet typically presenting one size longer and one size wider than girls' feet at the same age.[3]

"We advise children's feet need twelve to seventeen millimeters [about one half to three quarters of an inch] of extra space in their shoes. One should measure the length of the feet and also the inner length of the shoes using a homemade cardboard template or a tool such as the plus12,[4] a measuring tool we developed for parents," he added.

The team acknowledged the validity of studies that show heredity, pes planus, metatarsus primus varus, first metatarsal length, and hypermobility of the metatarsocuneiform joint are significant factors in understanding the etiology of JHV. However, they believed no studies of extrinsic factors had investigated a significant relationship between wearing shoes of insufficient length and lateral deviation of the great toe.

Intrinsic vs extrinsic factors

Hallux valgus is the most commonly reported forefoot deformity in adults, yet a 2010 systematic review of papers reporting results of nearly 497,000 participants found its actual prevalence difficult to estimate consistently, and concluded only that the condition is common and is diagnosed more often in women and with increasing age.[5]

In juvenile imaging studies, normal hallux valgus angles range below 16°, and a normal intrametatarsal angle must not exceed 9°,[6] but singular measurements may not be enough to make an accurate diagnosis. Juvenile hallux valgus is often bilateral, and an "increased distal metatarsal articular angle may be the defining characteristic of JHV," according to a 1995 study[7] of 60 feet that were treated with a variety of surgical corrections individualized to their specific deformities. Michael J. Coughlin, MD, current clinical professor of orthopedic surgery at the University of California San Francisco and past president of both the American Orthopaedic Foot and Ankle Society and the International Federation of Foot and Ankle Societies, led the investigation.

Coughlin acknowledged the importance of properly fitting shoes, but questioned if studies based in central Europe would apply with equal measure to children in other countries.

"Insufficient length is an interesting factor, but I think it plays a minor role in America, where children have multiple shoes and purchase shoe wear frequently," Coughlin said. "In adolescent hallux valgus, I believe shoe wear plays a minor role in development and progression of deformity. We specifically asked our patients about shoe wear, and a small percentage felt this was a factor."

Coughlin's 1995 study was an 11-year retrospective review of 45 children (60 feet) with JHV. It found that constricting footwear was noted in only 24% of patients, but that nearly 75% of the study

cohort inherited the deformity from their mothers.[7] The latter finding was supported by a 2010 study of bilateral scarf osteotomy performed in adolescents with JHV, which found 100% maternal inheritance of hallux valgus deformity.[8]

Coughlin suggested that medical providers evaluating suspected JHV take a family history to determine the incidence of bunion deformities in parents, siblings, and close relatives, and take a closer look at patients with a hallux valgus angle greater than 25° aged between 12 and 14 years.

"Most children with JHV experience onset at ages seven to ten years or earlier. The age of onset is associated with increased severity of deformity. Family history and early onset make a difference in the severity—and often the progression—of deformity," he told *LER*.

Coughlin's research found no increase of pes planus in patients with JHV. Foot pronation may predispose hallux valgus in certain patients, such as those with ligamentous laxity, but research has not quantitatively demonstrated this predisposition.[9]

In 1993, a critical literature review noted JHV is often inherited and is more common in girls and in shoe-wearing populations, yet studies searching for the etiology of JHV had failed to prove the deformity was a product of the shape and length of the first metatarsal.[10] More recent studies have continued exploring the associative or causative relationship of the first metatarsal in JHV.[11]

Management strategies

Norman Otsuka, MD, Joseph Milgram professor of orthopedic surgery at NYU Langone Medical Center in New York City, and orthopedic surgery resident Rachel J. Shakked, MD, typically see adolescent hallux valgus in female patients with a positive family history.

"Standing radiographs can calculate the intrametatarsal angle to confirm diagnosis, but the main factors in deciding whether to refer a patient for surgical consultation are the presence of pain and the need to significantly modify activities," Shakked said.

"Diagnosing JHV in younger patients, male and female, is approached similarly—determining whether the foot deformity is painful and affecting activities," she continued. "Conservative management may be advised unless pain, functional deficit, rapid progression, or other concerning signs are present. In younger patients, we advise nonoperative management when possible, as there is a high recurrence rate of hallux valgus after surgery if a patient is skeletally immature.[12] Conservative treatment can include shoe modification to a wide toe box and night splints to abduct the great toe."

In a 1992 study of 56 children with hallux valgus (aged one month to 16 years), night use of a thermoplastic splint along with exercises were associated with improved metatarsophalangeal joint angle, intermetatarsal angle, or both in about half the feet treated.[13] Researchers reported no recurrences among those successful outcomes at follow-up, which ranged from two to six years.

Conservative interventions for hallux valgus may provide relief from symptoms, but may not reverse the deformity, which in some cases may be severe enough to dislocate the first metatarsophalangeal joint, according to Ward M. Glasoe, PhD, PT, ATC, assistant professor in the Physical Therapy Program at the University of Minnesota Medical School in Minneapolis.

Researchers have not been able to determine consistently which conservative interventions are appropriate in children who have not reached skeletal maturity. Glasoe cited a landmark study

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by Kilmartin et al[14] indicating foot orthoses worsened the existing JHV angle in children aged 9 to 10 years, but he noted the study was limited by its use of rigid partial-contact foot orthoses designed to limit hindfoot pronation and by an unverifiable measure of patient compliance.

"More current evidence recognizes the benefits of treating hallux valgus with foot orthoses," Glasoe wrote in *Physical Therapy*.[15] "Orthoses that bolster the arch and orient the first metatarsal horizontally may work to contain the kinetics and kinematics of the first metatarsal to the sagittal plane."

"Orthoses posted medially combined with strengthening exercise of the tibialis posterior, in my clinical experience, offer a chance to correct flattening of the arch and excess eversion of the hindfoot and possibly counteract the progression of hallux valgus," Glasoe said.

Seattle podiatrist Lawrence Z. Huppin, DPM, of The Foot and Ankle Center of Washington, fits custom and customized foot orthoses for children and adolescents with JHV. He, too, looks closely at family history when determining how aggressively to treat young patients with hallux valgus.

"In adolescent patients, our primary goal is to allow the first ray to plantar flex. When we cast for orthoses, we plantar flex the first ray so that the resultant orthosis is more effective at preventing jamming of the first midtarsophalangeal joint. When writing the orthotic prescription, we use a minimum cast fill and several degrees of inversion in the positive cast, so the orthosis conforms closely to the arch in order to allow that first ray to plantar flex. If the rearfoot is everted, we prescribe a device with a deeper heel cup and a medial heel skive to prevent further eversion," he told *LER*.

"In younger children, I am more likely to prescribe a prefabricated orthosis that offers these features [deep heel cup, medial skive, forefoot valgus correction, and a fairly high arch], because children grow out of them quickly and they can become prohibitively expensive. Adolescents' custom orthotics are likely to last for several years."

Pain is the most common reason for surgical intervention in JHV, with progression of deformity another major factor to consider, Coughlin reported.

"On the other hand, we sometimes wait until a patient is a bit older to perform surgery," he said. "It is not imperative that growth lines be closed, but surgery must be carefully performed to avoid injury to the growth plate."

Several surgical procedures have been shown to successfully correct JHV, but as Coughlin and Shakked noted, concerns remain about performing orthopedic surgery in skeletally immature patients.

Shakked clarified that postsurgical therapy depends on the type of surgery performed.

"Aggressive range-of-motion activities should be minimized if an osteotomy is done to allow the osteotomy site to heal, which usually takes about six to eight weeks," she said. "The surgeon may apply a bandage with a toe spica tape splint to keep the soft tissues stretched on the lateral side of the first MTP joint. Stretching activities of these ligaments and strengthening the abductor hallucis can be helpful postoperatively. After the bone has healed, surgeons may recommend range-of-motion activities of the hallux to prevent stiff-

ness and regain preoperative range of motion."

Physical therapy after any mode of JHV surgery may require extra measures to protect the surgical site and the rehabilitation of posture and gait.

In an earlier *LER* article exploring physical therapy after bunionectomy in adults, Clarke D. Brown, PT, DPT, OCS, ATC, who is in private practice in Macedon, NY, and is president of the American Physical Therapy Association's foot and ankle special interest group, noted that postsurgical physical therapy should extend well above the ankle, and protocols must be adapted for individual patients (see "Beyond bunionectomy: The role of physical therapy," August 2010, page 18). He further advised unique factors to consider when evaluating children who have undergone osteotomy for JHV.

"Young adults can be impetuous and impatient. If their surgery restores weight-bearing activity or relieves pain, these patients may push weight bearing by standing or walking on the surgical side earlier than is appropriate," Brown said.

"Great attention should be paid to making sure surgical sites are well protected, proximally and distally. Younger children will often retain gait and movement deviations learned during painful periods. Many will continue to needlessly limp or substitute during gait, because their motor patterns were chronically changed. It is often difficult to restore normal movement even when pain and mobility are corrected," he cautioned.

Next steps

Further studies by Kinz's team in Austria will explore the effects of intervention programs that seek to ensure correctly fitting shoes and assess whether hallux valgus is reversible after changing footwear habits.

Coughlin led a preoperative study of demographics, etiology, and radiographic findings in adults with moderate to severe hallux valgus deformities and found that 34% of patients implicated constricting shoes or occupation as causes of their bunions.[16] However, nearly a quarter of participants had developed the deformity at age 20 years or younger. Family history, female gender, a long first metatarsal, and an oval or curved metatarsophalangeal joint articular surface were common findings.

Clearly, more research is needed to identify the role of poorly fitting footwear and its causative or associative function in the early development of JHV, but the persistent inability of children to distinguish poorly fitting from properly fitting shoes reported in the Austrian studies is a critical observation.

"These studies are a reminder that any of us who treat children's feet should take the opportunity to educate parents about proper fit," Huppin said. "Children's feet are more pliable than adults'. While shoe length certainly is important, we also need to make sure children's shoes are wide enough for their toes and are not applying external medial or lateral force." ler

Christina Hall Nettles is a freelance writer based in Monroeville, AL.

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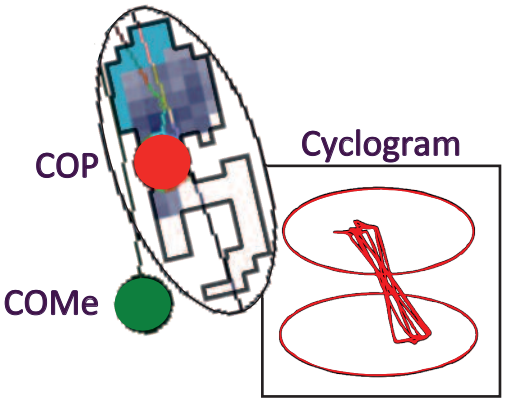

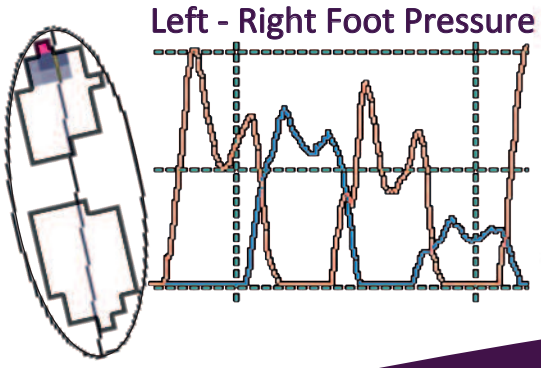

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