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August 2015

Growing pains: Adapting O&P devices to maturing patients

Childhood obesity and OA: Can early care reduce risk?

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news

features

From the editor:
A matter of perspective

Often, especially when talking about family or intimate relationships, people qualify the meaning of normal—adding "whatever that means." In pediatric gait training, though, normative values do exist, and parents and practitioners commonly strive to help children achieve these benchmarks.

A number of studies show that parents of children with cerebral palsy (CP) prioritize walking as a primary goal for their child, often focusing on these normal gait patterns as well as the child being able to walk independently. Research on the children's perceptions and values, however, shows their views on the definition of normal walking—as well as their desire to achieve it—aren't as clear-cut.

In a study of robotic gait training detailed in this issue (see "Robotic gait training doesn't wow young patients with CP: Kids, parents differ on 'normal' gait," page 7), young participants sometimes saw their current, though technically impaired, gait as normal. In addition, unlike their parents, the children didn't explicitly express a desire to walk using nondisabled gait patterns.

Similarly, in research reported previously in *LER* on children's and parents' beliefs about the value of walking, the investigator-author noted that, by internalizing ideas about what parents and society see as "normal" gait—as well as the value of reaching that standard—children may struggle with self-image and self-esteem if they can't achieve these goals or need to use assistive devices (see "The value of walking in children with CP: A matter of perception," *LER*, January 2013, page 14).

By reflecting critically on how perspectives on gait may diverge among young patients and those most involved in their care, and by focusing on outcomes and attitudes that support the child's needs, desires, and self-confidence, practitioners can help patients and their parents achieve feasible goals that are meaningful to the child.

Emily Delzell, *Senior Editor*

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Taller, heavier children have heightened Sever disease risk

Long-term pain warrants early ID

By Katie Bell

Children presenting with calcaneal apophysitis (Sever disease) are anthropometrically different from their peers and experience a lengthy period of pain, according to Australian study findings that underscore the importance of early intervention and a holistic management approach in this patient population.

"I think this study highlights the importance of looking at the entire child, not just their foot," said study author Alicia James, BPod, MHealth Sci, director of the Kingston Foot Clinic in Cheltenham, Australia.

The researchers set out to identify any association between the pain experienced from Sever disease, anthropometric data, and lower limb measurements. The cross-sectional study, which was part of a wider randomized comparative efficacy trial, enrolled 124 children (72 boys) with Sever disease aged between 8 and 14 years. Measures of height, weight, waist circumference, body mass index (BMI), foot posture, and ankle joint range of motion were recorded and compared with normative values. Pain was assessed using a visual analog scale.

Compared with normative values, children with Sever disease were taller, heavier, and had a higher mean BMI. Sever disease was also associated with a higher foot posture index, indicative of greater pronation, and greater ankle joint range of motion compared with normative values.

The foot and ankle findings are more likely to be contributing factors than compensatory factors, James said. The finding of increased ankle range of motion contrasts with a 2011 study and contradicts the theory that passive tension in the gastrocnemius-soleus complex contributes to Sever disease in taller children. Instead, James and colleagues hypothesized, it may be that the physiology of the apophysis in taller children may increase its vulnerability to the stresses involved in physical activity.

"I believe this finding has the greatest influence on our treatment regimes when considering previous literature," James said.

Joanna Conway, BSc Podiatry, SRCh, MChs, Senior Podiatrist at the Royal Orthopaedic Hospital in Birmingham, UK, noted though foot and ankle variables can contribute to Sever disease, the possibility of compensatory foot and ankle issues should not be overlooked.

"The pain of calcaneal apophysitis can cause further problems, such as a limp on the affected side. This will further alter the child's gait as they try to avoid the pain, and this can cause further musculoskeletal and biomechanical issues," Conway said.

> "While the growth plate remains open, monitoring and treatment will assist in pain relief."
>
> — Alicia James, BPod, MHealth Sci

The study, which was epublished in May by the *Journal of Pediatrics*, also found older participants and those who had experienced longer durations of pain reported higher levels of pain severity.

"This study for me has highlighted the duration of pain these children can endure. The mean length of time the children experienced pain before they contacted us for the study was ten months, and we found pain increased as the child increased in age. I believe this encourages intervention at presentation," James said. "We must explain to parents that, while the growth plate remains open, monitoring and treatment will assist in pain relief. Once the growth plate has closed, and only then, complete pain resolution will be achieved."

Conway agreed that early intervention is essential.

"In children where it is undiagnosed

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over a long period of time, I have seen the condition worsen, and often activity levels decrease, which can be difficult for a child who is involved in team sports," she said. "Early intervention is key to treating these patients due to their high activity levels. Also, multidisciplinary treatment is advantageous."

Although the authors were not able to determine if BMI was a causative factor for Sever disease or a result of pain-related inactivity, the anthropometric findings suggest early management of the condition with weight loss through diet and cushioned shoes for better shock absorption can help decrease the intensity and duration of pain, James said.

Interventions involving stretching, heel raises, and foot orthoses may also be warranted, she said, but should be considered in the context of the child as a whole.

"Such interventions are reported to assist in the pain relief and clinically likely do, but I believe this [study] supports a thorough assessment prior to prescribing your intervention," James said. "[The results] encourage the clinician to treat the entire child and to assess each child individually rather than following a previous script we may have developed due to university training or opinion pieces."

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

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Gait analysis for clubfoot may reveal long-term issues

Surgery more likely to alter gait

By Larry Hand

Children treated for idiopathic clubfoot by age 2 years may experience subtle changes in gait by the time they are aged 5 years, and nonoperative treatment may confer more normal movement than surgery, according to a recent study.

After treatment for idiopathic clubfoot at the Texas Scottish Rite Hospital for Children in Dallas, investigators analyzed data from 181 children seen for gait analysis when aged 2 and 5 years. Among 276 feet, 132 underwent Ponseti treatment, and 144 received French physical therapy (PT). By the time children were aged 5 years, 30 Ponseti and 61 PT feet had required surgery (47 feet before age 2 years, 44 between ages 2 and 5 years).

Among the surgically treated children, data collected at their second gait analysis showed only 17% of the Ponseti and 21% of the PT feet had normal ankle motion. The surgical PT feet had persistent in-toeing at both gait analyses; additionally, ankle power in these feet was significantly lower than in feet treated with the Ponseti method and surgery.

In addition, feet treated with posteromedial (PMR) tendon releases had significantly less ankle power compared with nonoperative feet and those treated with limited posterior release (PR).

"By age five, we are starting to see limited ankle motion in both the PR and PMR feet. The PMR feet are starting to show compromised ankle power compared to the nonoperative feet," said Kelly Jeans, MS, laboratory manager and senior biomechanist at the Movement Science Lab at the Texas Scottish Rite Hospital.

She noted following up takes a team approach.

"Adherence to treatment protocols has been shown to be variable, especially in the use of the abduction brace following Ponseti casting. However, the physician or therapist's ability to correct the deformity is another factor, as is the family's ability to follow through with the treatment protocol once the foot has been corrected," she said. "In certain cases where a child is unable to tolerate the abduction brace, and starts to lose correction, the foot might be recasted, or [the child] referred to the physical therapist to see if the foot can be corrected [without surgery]."

Jeans also noted plantar pressure measurement can provide useful information. "Plantar pressure measures can be very insightful as to the foot's ability to contact the ground and how the pressure is being distributed through the foot," she said.

Adam Graf, MS, senior motion analysis laboratory engineer at the Shriners Hospital for Children in Chicago, noted, "Gait analysis is important to fully evaluate the long-term results of clubfoot treatment. That has been its biggest contribution to date—determining that Ponseti management in general has yielded better results and is preferable to comprehensive surgical release at an early age," he said.

> "Gait studies are especially helpful in identifying specific issues that need to be addressed."
>
> — Rachel Goldstein, MD, MPH

The study, epublished in May in the *Journal of Pediatric Orthopedics*, "provides additional information to us on exactly what type of gait patterns return after nonoperative treatment for clubfoot," said Rachel Y. Goldstein, MD, MPH, assistant professor of pediatric orthopedics at Children's Hospital of Los Angeles. "The issue with clubfoot is really understanding the deformity and that this is almost a lifelong commitment. You can avoid complications by having a close relationship with your families and having a better understanding of the types of issues they pointed out in the study."

Photo courtesy of MD Orthopaedics.

For example, Jeans and colleagues noted, "residual in-toeing is easily identified by the patient, the family, and the clinician. Following these patients long term provides better understanding of interventions and the natural course after nonoperative treatment."

Goldstein noted, "Gait studies are especially helpful in identifying specific issues that need to be addressed, so that you're not overtreating or undertreating or treating the wrong component of gait." However, "there are some deformities that come after clubfoot treatment that are identifiable without a gait study, such as the recurrence of the equinus," she said.

Jeans agreed on the commitment issue. "In studying these children longitudinally, our clinicians have a better understanding of their treatments and what can be expected with growth and time. They can better address these issues and counsel new families that are presenting to the hospital for the first time with their newborn babies and continue to counsel as the child grows," she said.

Larry Hand is a freelance writer in Massachusetts.

Sources:

Jeans KA, Erdman AL, Chan-Hee J, Karol LA. A longitudinal review of gait following treatment for idiopathic clubfoot: gait analysis at 2 and 5 years. J Pediatr Orthop 2015 May 12 [Epub ahead of print]

Robotic gait training doesn't wow young patients with CP

Kids, parents differ on 'normal' gait

By Brigid Galloway

Although physical therapists and parents often strive for attaining "normal" gait in children with neuromotor disorders, a new study from researchers at the University of Alberta in Edmonton, Canada, indicates that children undergoing robotic gait training therapy may not share the same enthusiasm for this goal.

The qualitative study assessed the expectations and experiences of five children aged 8 to 11 years with cerebral palsy (CP, gross motor function classification system levels II or III), who underwent robotic gait training with a treadmill-based gait trainer, and their parents. The trainer provides upright support while using robotic orthoses to move the patient's legs. Its adjustable body-weight support allows children to use a more vertical, physiologically typical gait pattern.

Over about 10 weeks, the children underwent 16 sessions of robotic gait training, which involved stepping over blocks, active hip extension against resistance, and playing with a ball while walking. The sessions also included video games in which children had to do specific movements to advance in play.

Researchers interviewed children and parents after the child's last robotic training session. They asked parents about their expectations, experiences, and perceived outcomes with regard to the robotic trainer and walking goals for their child. Questions for children were designed to get their perspective on walking, as well as how they felt about using the trainer.

Parents generally expressed interest in continuing robotic gait training, felt it made their children more confident, and assumed their children found the games engaging and that they valued being able to walk like a typically developing child.

The children had more mixed impressions of the robotic trainer, finding it alternately "fun," "boring," and even "uncomfortable/painful." Young respondents also did not echo their parents' point of view on "normal" gait, said lead author Shanon Phelan, PhD, assistant professor of occupational therapy at the University of Alberta. "They often equated normal walking with their typical gait, weren't always sure whether the robot was helping them, and didn't universally find it fun or engaging."

Parents thought robotic training, which took place at Holland Bloorview Kids Rehabilitation Hospital in Toronto, boosted children's confidence, but the children didn't express this, and some felt anxiety about engaging the technology. Also a prominent problem for children was skin irritation caused by the trainer's straps.

> The study underscores the need for research that focuses on the opinion and voices of young patients, who often get mixed messages.

Both children and parents, however, said they valued the interactions with their therapists regardless of the technology.

"This study calls for critical reflection on why and how one might engage children in gait-related rehabilitation in ways that bring children's desires and expectations to the forefront," said Phelan. "This challenges clinicians to rethink how gait-related interventions are presented to children and families and how goals and outcomes are framed. For example, if a child is ambivalent about the quality of his or her gait, or [already] sees his or her gait pattern as 'normal,' one might consider presenting the benefits of an intervention in ways that highlight what is meaningful to the child and reinforce their abilities and positive self-identity."

The study underscores the need for research that focuses on the opinion and voices of young patients, who often get mixed messages, she said.

"People in their lives often reinforce the idea of social acceptance. They hear, 'there is nothing wrong with the way you walk,' yet they participate in therapy to work on walking more like their same-aged, nondisabled peers," she said. "When we focus solely on the physical aspects of walking/gait training, we can forget about the social and emotional implications for children."

Photo courtesy of William Suarez/Holland Bloorview Kids Rehabilitation Hospital.

Disability and Rehabilitation epublished the study on April 9.

Theresa Sukal Moulton, PT, DPT, assistant research professor at Northwestern University in Evanston, IL, has worked extensively with children with CP using therapeutic robotic devices. Despite the inability to generalize the feelings, perceptions, and goals of this small cohort of patients onto all children with gait disorders, the study brings significant considerations to light, she said.

"The mismatch between a parent's and child's goals and perceptions about the effectiveness of therapeutic modalities is not uncommon in my clinical experience," said Moulton. "Pediatric clinicians have the unique challenge of treating the whole family, so the perspective of both parents and patients must be considered and balanced, in an age-appropriate way." ler

Brigid Galloway is a freelance journalist in Birmingham, AL.

Source:
Phelan SK, Gibson BE, Wright FV. What is it like to walk with the help of a robot? Children's perspectives on robotic gait training technology. Disabil Rehabil 2015 Apr 9:1-10. [Epub ahead of print]

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Growing pains: Adapting O&P devices to maturing patients

Accommodating growth without compromising fit and function is a challenge for practitioners who prescribe orthotic devices for young patients. Adjustments and add-ons—as well as educating parents about expected changes—can make for smoother transitions.

By Shalmali Pal

YouTube is a treasure trove of feel-good videos featuring children walking for the first time with the help of O&P devices. There's 2-year-old Kayden, 1-year-old Samantha, and 14-year-old Zoe, who lost her left leg below the knee in a jet skiing accident.

But these inspiring images capture only one moment in each child's journey. What happens down the road as Kayden, Samantha, and Zoe mature and outgrow their devices?

The need to replace an O&P device on a regular basis has its challenges for practitioners, patients, and parents. The patient who has just become accustomed to a device has to start all over. Parents want the best for their children but know these replacements can come with a hefty price tag. And that means the practitioner must attempt to optimize fit and function for the moment, make adjustments over time if possible, and, ultimately, determine when a completely new device is necessary.

LER: Pediatrics spoke with O&P experts on how to handle these issues, including how to accommodate growth without compromising fit and function.

"We are always considering growth: How long can they wear it? What can we do to try to make it last longer?" said Leigh Davis, CPO, LPO, of Children's Healthcare of Atlanta, and a board member of the American Academy of Orthotists and Prosthetists. "At the same time, since growth is so variable, you want to plan for what you see now rather than what might happen. You want to plan for care today versus planning for something that might happen in the future."

Growth spurts

Of course, all children grow, but as Davis pointed out, not all kids grow at the same rate, even during infant, toddler, and adolescent years, which are known for growth. And children who require O&P devices often have compromised skeletal systems and musculature because of their underlying diagnosis, and that may affect their growth schedule.

While not a technical issue, patient and parent education is key to ensuring that everyone understands the purpose of a device and its projected longevity.

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Photo courtesy of Allard USA.

Tony Wickman, CTPO, chief executive officer of Freedom Fabrication in Havana, FL, noted that bones tend to grow faster linearly than they do circumferentially. Unlike in adults, in whom changes tend to be more global, changes in kids may happen in a piecemeal fashion. For instance, a child may experience linear growth of the feet rather than medial-lateral growth, but without any major growth in the rest of the lower limbs.

Davis agreed that linear growth is more of a concern in kids who may not build muscle mass as quickly as typically developing children.

"So you don't often see a really large increase in calf circumference in kids with certain disabilities," she explained. "But let's say their ankle-malleolar width increases so much that it's painful to put the brace on or they can't even put it on at all. They'd have to come in so that we could make adjustments to the device."

At the O&P service at Ann & Robert H. Lurie Children's Hospital of Chicago, Nikta Pirouz, CPO, and colleagues make ankle foot orthoses (AFOs) for children as young as a day old.

"Any presentation that requires an orthosis at that young an age requires a good fit even though these children aren't ambulatory," she said.

Many children who require O&P devices have underlying neurological conditions that can impact their ability to understand the purpose of the devices, use them properly, and express when the device is causing discomfort, possibly because of a change in body habitus.

Pirouz noted that standard clinical growth charts don't really apply to kids who require devices, even if they don't have underlying conditions.

"Even for typical kids, those charts are an aggregate. The chart will tell me where the child will be in a year, but it's not going to tell me exactly when that will happen for each individual child. A week from now? Over the summer? That's why follow-up is so important," she said.

Finally, just as in the general population, childhood obesity is a problem in O&P patients. Pirouz pointed out that weight gain will most likely necessitate adjustments so that a device doesn't pinch or dig into "redundant soft tissue." But those adjustments don't have to be complex.

"Whether it's weight gain, or volume change that is part of the disease presentation, you can address that," she said. "You can add a tongue to contain tissue. You can flare. You can pad. You can try interfaces to contain the tissue better."

Don't fit for the future

It's not worth trying to fit a device for potential growth because it will compromise fit in the here and now, experts agreed.

"I want the device as fitted as much as possible to the child's current shape and size," Wickman emphasized. "What I don't like to see is a big, sloppy fit in hopes that the child will grow into it. Then you lose control of the fit and possibly compromise the device's efficacy."

Davis concurred. For example, she said she wouldn't typically build extra padding into an AFO that could be removed at a later time, because that can add bulk and compromise fit. She would leave the footplate a centimeter longer than the toes to accommodate for growth—but no longer, as that can cause problems with tripping or may require a shoe that's a size too big. Footplate size can be misleading to parents as well, she said.

"A lot of parents will rely on the footplate as a measure of growth. So if they wait [to replace the device] until the toes are hanging all the way over the footplate, then the height of the AFO becomes a concern," she said.

Pirouz agreed that achieving maximum fit and function in the present is paramount. Adjustments for growth can be made, but in the right context.

"For instance, with a night AFO, the patient is not ambulating, so you can make that footplate as long as you want in order to accommodate for growth," she said. "But if you think about the height of the device, that can only be so tall, otherwise it may make the brace uncomfortable."

Adjustments, add-ons, education

Adding that extra centimeter to a footplate is just one of many tactics practitioners use to maintain a quality fit while also accommodating for growth. But no single approach will work well for all children.

"You really have to look at the individual child and their diagnosis, their size, and their level of tolerance," Davis said. "Is the weight of the device an issue for them? Is cosmesis an issue? Those sorts of things have to be taken into consideration."

Wickman also cited diagnosis as a driving factor.

"With a diagnosis that's relatively easy to manage, like genu valgum at the knee, that takes relatively gross pressures to manage and can be done with a minimum of contact," he explained. "So in circumstances like that, it's quite easy to manage for growth. The less surface that you have touching the patient, the more room you have for growth."

But treating a condition like clubfoot is another matter, because the volume and circumference of the orthoses have to be managed in addition to the length, he added.

LER asked the O&P specialists specifically about a number of common techniques.

Leaving room to grow. Again, no one advocated a compromised fit for future growth. As Davis mentioned, she may leave a bit of room on an AFO footplate, but not at the top of the brace as it would hinder the child's ability to bend their legs. Building extra width or circumference into a device also may compromise that device's ability to control movement.

"Most of the kids are going to have pretty serious frontal plane involvement, so you need to be able to control supramalleolarly," Davis said.

Infants grow very quickly so leaving room to grow can be tricky, Wickman said.

"There's an old adage in O&P about growth adjustment: 'The more you need, the less you can have.' Very small children are going to need a lot of growth adjustment, but if they are smaller, then we can't build in a lot for growth because achieving the best fit doesn't give us a lot of room to work with," he said.

Pirouz noted that pediatric devices generally don't encapsulate the entire limb so allowances for growth can be made. This may mean using different interfaces to gain the best fit or using different tensions on the straps.

Adding toe pads or removable liners. Davis and Pirouz said they did not use removable liners because of the bulk they add, but have used toe pads to increase the length of a device.

Wickman acknowledged that removable liners can allow for extended device use in a growing child, but agreed that the added bulk and weight may not be desirable. Instead, he recommended using spot pads to cushion the bony prominences without adding bulk.

Heating/flaring to increase volume. Increasing volume by heating is a go-to protocol for making adjustments, Wickman said, and today's thermoplastic materials can withstand heating if the circumference of the device needs to be increased. Another benefit of using spot pads rather than full liners is that the latter can get in the way of heating the device, he said.

Davis also supports heating to increase or decrease the circumference of a device, but she cautioned that doing so will also change the depth of the device in ways that could compromise its effectiveness.

"If I heat it out and it makes [the device] wider, it's not as deep as it used to be," she said.

Pirouz pointed out that it's easier to maintain depth when decreasing the volume of a device than when increasing it.

"You can just cut the plastic away and maintain the depth," she said. "If you are trying to increase the volume, then you will get a shallower device. As the calf portion of the AFO gets shallower from widening it [with heating], you can add a foam tongue to address

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Photo courtesy of Allard USA.

that problem to match the volume of the device to the patient."

Screwed-on joints vs internal or riveted joints. In general, Davis advised positioning screwed-on joints on the outside of the device so the practitioner has the option to move the proximal section superiorly.

With knee AFOs (KAFOs), she said she aims to build in the capability to bring the knee joint up for growth, whether that's with Chicago screws or an attach plate.

"In either case, you can do growth adjustments, although the attach plate will add a lot of thickness," Davis said. "We don't do attach plates very often. More often, we move the holes and re-rivet or re-Chicago screw it."

The use of growth adjustment bars will depend on the size of the child and how much weight he or she can tolerate, she added.

"If it's a very small child, that may be more than they can handle," Davis said. "Now, if it's an adolescent, then a growth adjustment bar is probably a good idea. They have a lot of growth at that age, plus they are a bit bigger so that extra weight isn't going to be that big a deal."

In terms of adjustment bars, Wickman recommended stainless steel over aluminum as the former offers lighter weight but better durability, especially because active kids can be particularly rough on their devices. Stainless steel also will handle the stresses from repeated bending forces, for example in devices for genu varum or genu valgum, he said.

Pirouz said her group has not had any problems with internal joints, though she conceded that "you do have to extend your build-

up to accommodate for that growth where the malleolae are going to move proximally."

Prefab vs custom. The use of off-the-shelf (OTS), or prefabricated, devices may seem like an attractive option for growing children simply because they are less expensive than custom devices. But other factors also come into play.

Davis said her group does not use OTS devices very often in their pediatric population, in part because, in their experience, OTS devices aren't always effective in kids who have triplanar deformities.

For Pirouz, whether a device is OTS or custom is less of an issue than its material construction.

"I think being able to make adjustments is the key, and some prefab devices allow you to do that while others don't. It's the same with some custom devices," she explained. "Let's say you have a custom carbon AFO that is laminated. Unless you build in padding that you can grind out, you really don't have a lot of room to adjust that device."

On the other hand, an OTS carbon AFO may have such a low profile, and such limited contact with the anatomy, that it can accommodate circumferential or linear growth, Pirouz said.

"Sometimes the referring specialist will just assume that a prefab device won't work, and that's not necessarily true," she said.

Education. While it's not a technical issue, patient and parent education is key to ensuring that everyone understands the purpose of a device and its projected longevity.

"A huge component of accommodating for growth is education—making sure the patient and the parents know what the device should look like when it's properly fitted and when it may be time to come in for adjustments," Pirouz stressed.

Pirouz said she and her colleagues start with very short follow-up periods of one to two weeks to establish compliance and a schedule for wearing the device. After that, follow-up appointments are scheduled every one to three months, depending on the child's age.

"We always explain that we are shooting for the brace to last a year, but the priority is fit and function, so there is a chance that a new brace might be needed sooner," she cautioned.

Davis makes sure to take measurements every time the patient comes for a follow-up visit so, should a new brace be necessary, she'll have the data to back up that request.

"A lot of insurance companies will replace the device if there's documented physiologic change," she said. "So, let's say the patient has gained ten pounds; that can be a valid justification to get a new brace."

It also can be reassuring to parents who are concerned about the cost of replacing a device sooner rather than later.

On the other hand, practitioners may also find themselves contending with parents who will insist on a new device on a regular basis, especially if they believe that a newer device will work better and faster. Pirouz said that scenario is one she encounters more often than parents who are reluctant to get a new device. But if the desired clinical results are seen during regular follow-up, she said, then there may not be a need to jump immediately to a new brace.

Shalmali Pal is a freelance writer in Tucson, AZ.

Recent study shows children prefer to wear DAFOs.

Research article *"Comparison of 2 Orthotic Approaches in Children With Cerebral Palsy"* published online in the APTA journal *Pediatric Physical Therapy, May 2015*

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Childhood obesity and OA: Can early care reduce risk?

Osteoarthritis (OA) risk factors and symptoms seen in adults have been found in obese kids, who often have musculoskeletal pain. Weight loss may help, but preventing OA may also require gait and exercise interventions, particularly those that reduce pain that leads to inactivity.

By Erin Boutwell

Osteoarthritis is an extremely common musculoskeletal disorder. In 2008, an estimated 27 million US adults had clinical OA in one or more joints.[1] OA may be caused by mechanical, systemic, and genetic factors.[2] It represents the failure of a joint caused by abnormal mechanical loads, and the ability to comprehend this disorder requires a biomechanical perspective.[3]

No cure exists for OA,[4] though clinicians often emphasize weight loss and exercise because of the clear association between musculoskeletal issues and obesity in adults.[5-7] However, the applicability of adult-centered research findings to the treatment of obese children—who do not yet have OA but appear to be at increased risk—is problematic.

Simone Gill, PhD, OTR/L, assistant professor in the Department of Occupational Therapy and director of the Motor Development Laboratory at Boston University, outlined a major issue in extending adult OA research findings to a pediatric population. "Children are still growing and developing, and we know very little about how obesity impacts changes in their development," she said.

Because the rising worldwide population of persons classified as "overweight" (body mass index [BMI] $\geq$ 25 kg/m^2 and $<$ 30 kg/m^2) or "obese" (BMI $\geq$ 30 kg/m^2) is expected to contribute to increased OA incidence,[4] it's important to consider early intervention in heavy children and adolescents. Assessment of body fat in children is not calculated using an absolute BMI, as in adults, but rather using age- and gender-specific percentiles; in children aged 5 to 19 years, "overweight" typically corresponds to a BMI between the 85th and 94th percentile, and "obese" is typically associated with a BMI greater than the 95th percentile.[8]

No data have established a direct link between OA and obesity in children, but researchers are beginning to uncover evidence of musculoskeletal complaints and injuries that are precursors to adult OA in the younger obese population.

It may be possible to reverse some musculoskeletal symptoms seen in obese children, particularly those associated with OA in adults: pain, cartilage damage, and gait deviations

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Obesity in children

Currently, the connection between OA later in life and childhood obesity is primarily hypothetical. Marienke van Middelkoop, PhD, assistant professor at the Erasmus MC Medical University Department of General Practice in Rotterdam in the Netherlands, offered an explanation of the mechanism by which obesity could be a risk factor for development of musculoskeletal issues in children.

"Obesity could indeed be a cause of increased strain on joints during weight bearing," she said. "The [same] mechanism has also been suggested for the association between obesity and osteoarthritis of weight-bearing joints such as the hip and the knee."

Research has linked knee OA to excessive forces transmitted across a joint because of high body weight, potentially leading to cartilage breakdown and progressing to OA.[9] Loading alone, however, doesn't explain why hand OA is also more prevalent in obese individuals.[9]

"There are also other potential disease pathways suggested [for obesity-related osteoarthritis], including inflammation and hormone secretion," van Middelkoop said.

Musculoskeletal pain

Children are in general at a high risk for musculoskeletal pain; studies have reported that between 18% and 32% of children experience pain at least once a week.[10-12] The exact mechanism behind this pain is unknown, but it may be related to overuse.[13] A systematic review coauthored by van Middelkoop suggests the occurrence of musculoskeletal pain may be even higher in heavier children than in the general population.[5] In the review, van Middelkoop found the overall prevalence of musculoskeletal pain was 26% higher in overweight children than in normal-weight children, and that low back pain in particular was 42% more common in overweight children.

Cartilage lesions

Perhaps the strongest link between obesity and musculoskeletal degeneration comes from a series of studies using magnetic resonance imaging (MRI) to examine the knee joints of morbidly obese children and adolescents.[14,15] (Morbid obesity was defined as BMIs exceeding the 99.5th percentile for participants' age and gender.) These studies, coauthored by Harald Widhalm, MD, of the Department of Trauma Surgery at the Medical University of Vienna in Austria, demonstrate the possibility that children aged as young as 9 years may show symptoms of joint degeneration. In a 2012 study, Widhalm and colleagues found that 100% of 20 morbidly obese children aged 9 to 19 years had cartilage lesions in at least one knee compartment.

"These [morbidly obese] patients often present with severe deviations of the leg, showing cartilage pathologies…in the medial joint," said Widhalm, who went on to warn, "The fact that these patients are often developing cartilage lesions even at that young age is a big problem. We also do not know…if cartilage lesions in these patient types are reversible."

Articular cartilage lesions have been related to long-term joint issues such as adult OA.[16] While a direct causative link between these lesions and obesity has not been established, Widhalm et al reported their prevalence seems to correlate with musculoskeletal pain symptoms commonly found in obese children.[17]

Knee malalignment

Poor frontal-plane knee alignment can play a large role in joint loading. In a 2014 *Rheumatology* study van Middelkoop and others noted a significant increase in the risk of developing radiographic knee OA in middle-aged overweight women with knees in varus alignment (odds ratio of 3.3), finding a more modest association in women with valgus knee alignment (odds ratio of 2.8).[18]

Sarah Shultz, PhD, ATC, a lecturer in exercise and sport science at Massey University in Wellington, New Zealand, noted, "If the child is choosing to be in genu valgum in order to relieve some pressure medially…then they are inadvertently placing themselves at greater risk for osteoarthritis to the lateral aspect of the knee."

Nor is the knee the only critical joint to consider in obese children. "The foot and ankle [complex] is the first line of defense against the extra ground reaction forces; combined with the architecture of the foot [small bones, ligaments, arches], it makes the foot highly susceptible to changes due to mass," she said.

Another potential issue in obese children is that their increased body mass may result in gait compensations that exacerbate these lower limb malalignments and may increase the risk of OA.[19] Gill elaborated, "Obese children tend to walk more slowly, and then try to stabilize their bodies…by keeping their feet on the ground for longer periods of time during the gait cycle." Previous work documents that obese children may walk at slower speeds,[20] increase their step widths,[20] and experience higher joint powers at the hip and knee during loading response.[21]

Treatment

Weight loss. Weight loss is commonly recommended in adults as a method of reducing abnormal loading on lower limb joints,[9] and many doctors and scientists advocate multidisciplinary weight-loss approaches. Widhalm coordinates such weight reduction programs. "It is very important to have a multiprofessional team; otherwise, there is no chance to help these patients," he said.

However, is weight loss alone enough?

Sharon Bout-Tabaku, MD, assistant professor of pediatrics at Nationwide Children's Hospital in Columbus, OH, said, "The question is: Can you can make people's outcomes even better in regards to pain and risk of developing osteoarthritis, if—along with weight loss—you can strengthen their muscles or if you can help train them to walk better?"

Exercise & physical therapy. Bout-Tabaku gave an example of a weight-loss concurrent therapy, suggesting, "Obese kids have a lot of truncal mass, and it's possible that truncal mass, even though it improves with weight loss, still causes some instability. Thus, strengthening of the core and lower extremity muscle groups may help the downstream effects of injury to the knee."

Gill also suggested that gait pattern deviations could be addressed through exercise interventions. "Changes in muscle quality can happen with strength training," she said, then highlighted the importance of cardiovascular fitness. "Another possible benefit in terms of aerobic activity in particular is that it not only helps burn fat, but also contributes to increased blood flow in the brain, which might be related to some of the issues of motor planning in that population."

Shultz observed, "I think it's important to include physical activity in any weight-management program, but physical limitations should be considered. I am a big believer in resistance training for

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obese youth and think that activities like boxing or aquatics are great alternatives to the more conventional activities [such as running]." Alternative activities are important to consider in obese children because the higher mechanical joint powers [the rate of mechanical work performed at the joint] they experience during exercises such as running may reduce their motivation for regular participation.[21]

Orthotic devices. Studies have evaluated various orthotic interventions for reducing pain and redistributing load within the knee joint in adults with OA, but the efficacy of such devices in adult knees is inconclusive at best. Several studies have investigated the effects of lateral wedges on peak knee external adduction moment, a measure often used to approximate knee loading,[22] and have reported peak moment reductions of 5.8%[23] and 8.7%[24] with a laterally wedged insole compared with a neutral insole during walking in subjects with medial knee OA. The effects of lateral wedges on pain, however, have been inconsistent.[25,26] Also, there are few high-quality studies that have evaluated the use of knee bracing in patients with knee OA;[27] however, some investigations have reported improved walking distance[28,29] and pain relief[28-30] with a knee brace compared with no brace.

The potential influence of orthotic devices is an as-yet unexplored avenue of research in correcting joint malalignment or preventing OA risk factors in children in adolescents. "Both knee braces and wedged insoles reduce the medial knee joint load [in adults], but the preventive effects have never been studied," noted van Middelkoop. "It is so far unknown if you can prevent osteoarthritis with these interventions in high-risk groups."

Reversibility. The ability to reverse obesity-related disease states that occur in children and adolescents is an important topic to explore. Bout-Tabaku said drawing a distinction between musculoskeletal complaints and OA in children is key. She queried, "What does 'disease' mean? Does 'disease' mean just having pain? Or does 'disease' mean having osteoarthritis?"

She added, "We don't have any data saying that kids already have osteoarthritis." All that has been reported, she said, is the existence of "some lesions in obese children that may be similar to what people see in adults who have very early stage osteoarthritis," a reference to Widhalm's previously cited detection of articular cartilage lesions in morbidly obese children.[14,15]

Therefore, "reversing" OA in children may not be a meaningful goal. It may be possible, however, to reverse some of the musculoskeletal symptoms demonstrated by obese children, particularly those that have been associated with OA in adults: pain, cartilage damage, and gait deviations. But how reversible are these symptoms?

Investigators like Gill are optimistic about the ability of weight loss and exercise regimens to reverse some of the musculoskeletal disease and damage reported in obese children and adolescents, including poor muscle quality and gait abnormalities. Improvements in gait (eg, increased step lengths, increased walking speeds, and reduced step width) have been reported in adults who have undergone bariatric surgery in as little as three months postsurgery.[31]

Regarding the reversal of cartilage damage, though, Gill was not as optimistic. "If you decrease the load that is being applied to those joints, then you might be able to minimize the wear and tear that we all experience in terms of lost cartilage over time. Because obesity exacerbates that," she said. "That [cartilage loss] might not

be reversible, per se, but you can slow how much that is happening."

Gill's thoughts build on the findings of a seminal 2005 *Arthritis & Rheumatism* study in which the authors found that in adults, for each pound of weight loss, four fewer pounds of force are applied to the knee joint.[32] However, a direct causative link between reduction in knee load and slowed disease progression has yet to be established.

Nor is it clear exactly where the threshold between reversible and permanent joint damage lies. Bout-Tabaku asked, "When you're done growing, does obesity confer greater or less of a risk than when you're still growing?"

The idea that a child's stage of development could affect obesity-related risk factors is a finding of Bout-Tabaku's 2015 *Journal of Rheumatology* paper, in which she reported that pubertal stage (measured by Tanner stage) influenced knee alignment in obese children.[33] In particular, knee alignment was comparable between obese and normal-weight children at Tanner stages 2 and 3, but, at Tanner stages 4 and 5, she found a greater valgus alignment in obese compared with normal-weight children (See "Obese children develop knee malalignment as they mature," *LER: Pediatrics*, May 2015, page 5).

Bout-Tabaku emphasized the importance of pain reduction in obese kids, saying, "Pain itself is a disease state. We know that obese kids have more prevalent pain than nonobese kids." She found that 76% of obese adolescents participating in the Teen–Longitudinal Assessment of Bariatric Surgery (Teen-LABS) study had pain at baseline.[34]

The next, ongoing phase of the Teen-LABS study involves investigating whether weight loss can reduce the pain incidence in these children. Bout-Tabaku said, "If kids are having pain, they then go into this vicious cycle of being more sedentary and deconditioned, putting them at risk for falls, abnormal joint mechanics, and injury to their joints." In adults, weight loss has been associated with a reduction in joint loading,[35] inflammation,[35,36] and pain.[31,35,36]

The big picture

A common theme among all researchers and clinicians in this area was the information gap with regard to OA risks in this young population. Even more mysterious is how to identify root causes versus downstream effects.

Gill is convinced longitudinal studies are needed to parse some of the cause-and-effect relationships proposed between obesity and poor motor function over time. Bout-Tabaku added that a longitudinal study tracking obese and nonobese individuals over time who start with a normal knee alignment could be extremely informative.

These numerous unknowns, combined with the detrimental effects of OA, make it clear that intervening early, before musculoskeletal problems develop, is key. As Widhalm puts it, "For sure, prevention of morbid obesity is the best strategy." ler

Erin Boutwell is a freelance writer based in Chapel Hill, NC.

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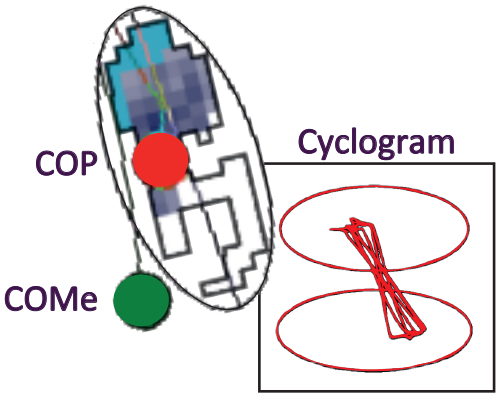

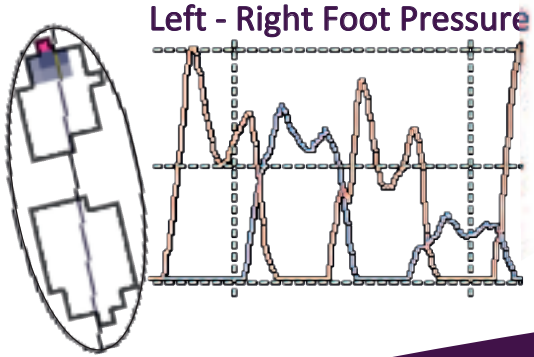

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