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LOWER EXTREMITY REVIEW
March 15 / volume 7 / number 3

Down Syndrome & Hip Arthroplasty

Opportunities to Optimize Outcomes

+

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SPORTS MEDICINE
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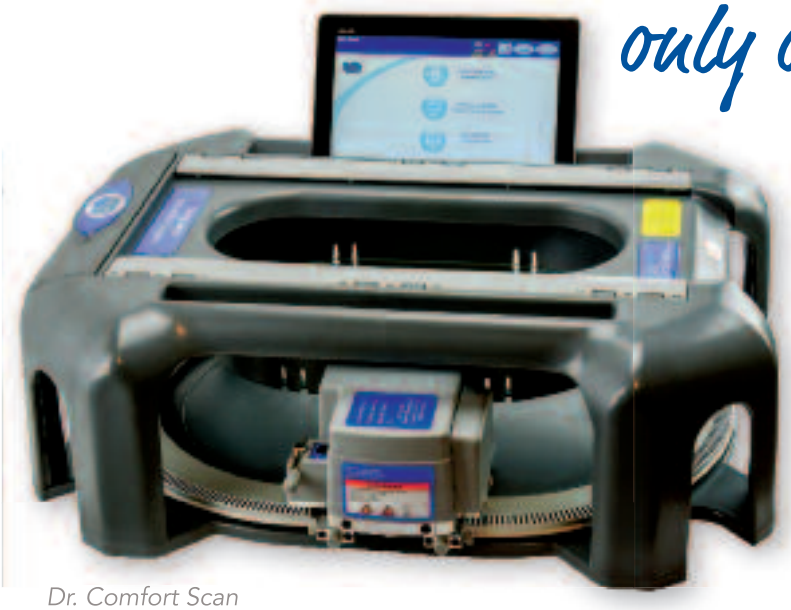

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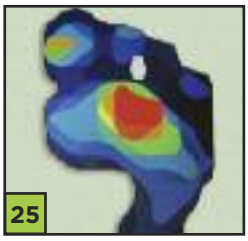

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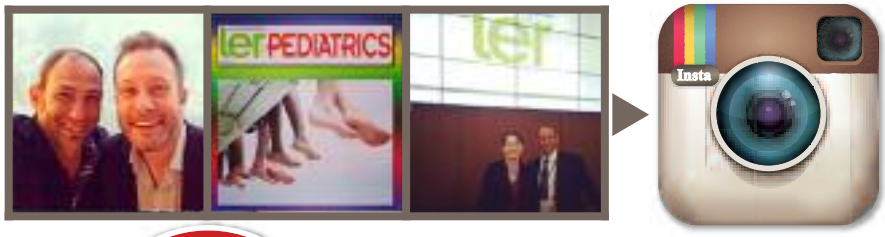

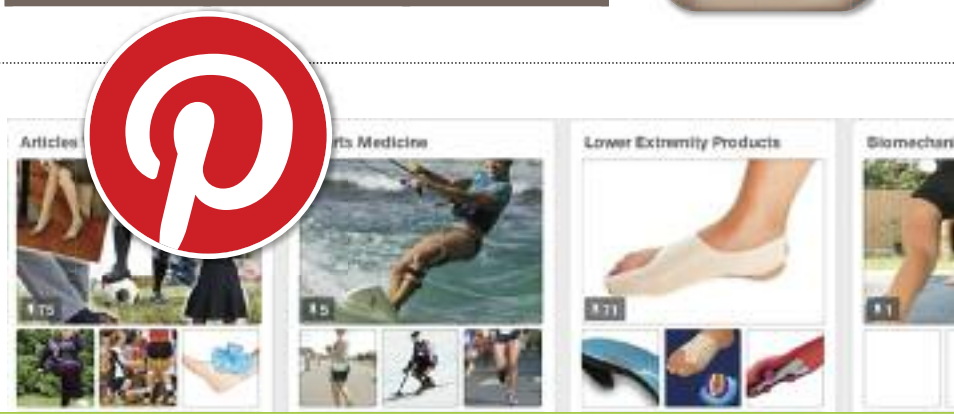

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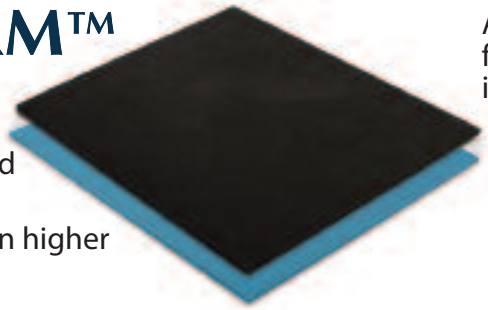

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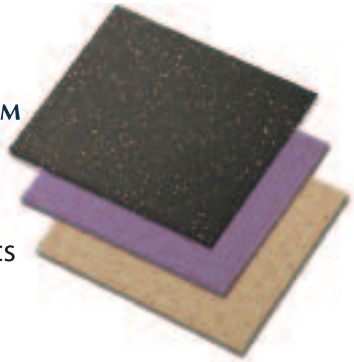

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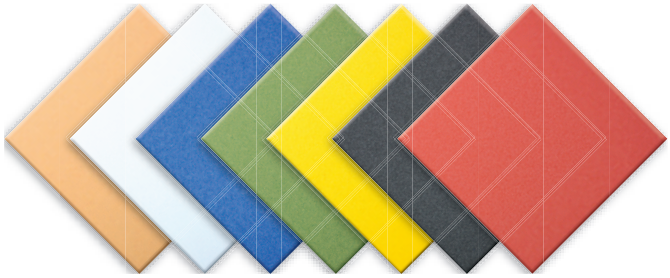

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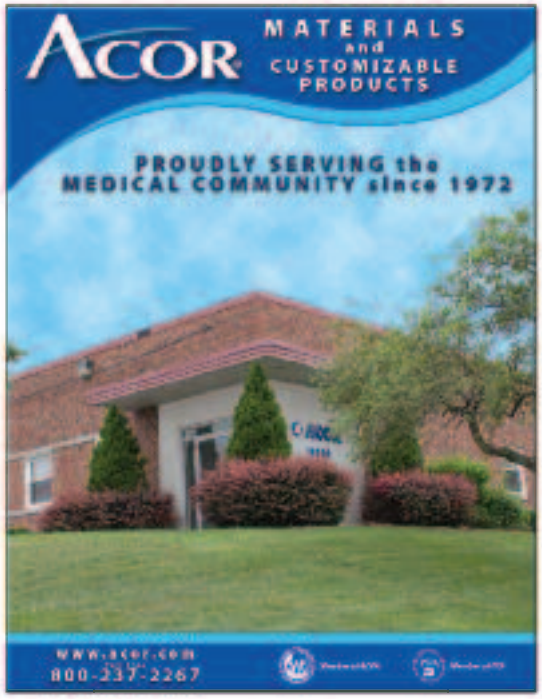

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out on a limb: Rethinking pain

Pain doesn't always behave the way we think it will. An intervention that relieves pain in the majority of patients might not provide relief for a significant minority. But that might mean we need to change the way we think about pain.

Many patients with knee osteoarthritis (OA) choose to undergo total knee arthroplasty (TKA) because they believe it will succeed where more conservative methods of pain management have failed. But the medical literature suggests that up to 25% of patients end up dissatisfied with the results of their TKA procedure. And multiple recent studies suggest that patients whose knee degeneration on x-rays (Kellgren-Lawrence, or KL score) is mild to moderate are up to three times as likely to be dissatisfied as those with greater radiographic severity—even when preoperative pain levels are similar.

That means something unrelated to the knee joint itself must be influencing pain in patients with less-severe KL scores before and after TKA. A new study, epublished in February by the *Journal of Arthroplasty*, suggests the prevalence of chronic nonorthopedic conditions might play a significant role. In that study, less severe KL scores were associated with higher levels of dissatisfaction than severe KL scores, and chronic nonorthopedic conditions—including depression and anxiety, fibromyalgia, low back pain, and traumatic brain injury and stroke—were more prevalent in the less severe group.

These findings are consistent with the concept of central sensitization, in which a patient's sensitivity to pain is elevated even when there is no local explanation for it. Patellofemoral pain (PFP) researchers have been starting to explore this concept, which generated a great deal of discussion at their last research retreat (see "Conference coverage: 3rd PFP research retreat," November 2013, page 19). More recently, investigators from the University of Kentucky in Lexington reported at the American Physical Therapy Association Combined Sections Meeting in February that individuals with PFP demonstrate lower pressure-pain thresholds than controls—not just at the knee, but also at the elbow.

What all of this means is that, if a patient's lower extremity pain is not responding as expected to local interventions, it's worth asking whether his or her local lower extremity pain might also have a central component, possibly related to one of the nonorthopedic conditions listed earlier. If so, the most effective intervention for that patient's lower extremity pain might turn out to involve multiple clinical disciplines, and it might not involve the lower extremity at all. Better management of fibromyalgia symptoms, for example, might have a positive effect on knee OA symptoms in a patient who is struggling with both conditions.

> The most effective intervention for a patient's lower extremity pain might not involve the lower extremity at all.

There are still a lot of unknowns regarding the most effective methods of treating patients with central sensitization. But correctly identifying the problem brings practitioners one step closer to finding a solution. And finding a solution to the central sensitization aspects of a patient's pain, particularly patients whose KL scores don't match their knee OA symptoms, will go a long way toward improving clinical outcomes and patient satisfaction.

Jordana Bieze Foster, *Editor*

By P.K. Daniel

Retraining gains

In-field cadence cues reduce impacts

In-field gait retraining, which cues a modest increase in step rate, can help address biomechanical risk factors associated with tibial stress fracture in runners, according to research from East Carolina University in Greenville, NC.


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Richard W. Willy, PhD, PT, OCS, an assistant professor in the Physical Therapy Department at East Carolina University and colleagues assessed the effects of step-rate retraining in 30 runners with high impact forces.

"If they didn't have high loading, we didn't necessarily want to change their running mechanics," Willy said.

The study group included 30 runners with a range of experience and skill levels, including a couple of elite runners, but all were injury-free. They were randomized to retraining (age, 21.1 ± 1.9 years; average distance, 22.1 ±10.8 km/wk) or control groups (age, 21 ± 1.3 years; average distance, 23.2 ± 8.7 km/wk).

All participants wore a commercial running computer system featuring a wrist watch (feedback monitor) and foot pod (a wireless accelerometer that collects and sends speed, distance, and step-rate data) positioned on the runner's right shoe. The system cued the runners in the retraining group to increase their preferred step rate by 7.5% during eight unsupervised training sessions. After a lab

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Study finds triceps surae injury rate associated with age in soccer players

Older elite male soccer players sustain significantly more triceps surae injuries than do their younger counterparts, and could benefit from targeted training to prevent such injuries, according to a study epublished in February by *Knee Surgery, Sports Traumatology, Arthroscopy*.

Researchers from the Stockholm Sports Trauma Research Center in Sweden analyzed 145 muscle injuries sustained by members of a Swedish soccer team between 2007 and 2012. Injury localization to the tendon or muscle, hematoma size, and the affected muscle group were assessed using ultrasound.

When players aged 23 years or younger were compared with those older than 23 years, there was no difference between the two age groups in injury distribution to muscles or tendons or hematoma size. However, the older players experienced significantly more injuries to the triceps surae than the younger players.

The findings suggest clinicians who work with elite soccer players should pay attention to triceps surae muscle function in older players and identify players who may benefit from a targeted injury prevention program, the authors wrote. ler

Source:

Svensson K, Alricsson M, Karnebäck G, et al. Muscle injuries of the lower extremity: a comparison between young and old male elite soccer players. Knee Surg Sports Traumatol Arthrosc 2015 Feb 11. [Epub ahead of print]

Most baseball players return from ACL reconstruction, but play in fewer games

Nearly all Major League Baseball position players who undergo anterior cruciate ligament (ACL) reconstruction return to play at least 30 games, but those who do return play in fewer games in the season after surgery, according to a study whose authors include the head athletic trainer for the Los Angeles Dodgers.

ACL injury data from 1999 to 2012 were collected and 26 position players identified who had participated in at least 30 games before their ACL injury. Twenty-three players (88%) were able to play in at least 30 games after surgery, but played 21.2% fewer games on average in the season after surgery than in the season before surgery. In a separate analysis, four of seven pitchers (57%) made a similar comeback after ACL injury. The findings were epublished in February by *Arthroscopy*.

In the position players, injury to the rear batting leg resulted in a 12.3% decline in batting average. But those who had reconstruction for a lead leg injury had a 6.4% increase in batting average. Side of injury was not associated with number of stolen bases or the number of times a player was caught stealing. ler

Source:

Fabricant PD, Chin CS, Conte S, et al. Return to play after anterior cruciate ligament reconstruction in Major League Baseball athletes. Arthroscopy 2015 Feb 3. [Epub ahead of print]

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testing session, the runners wore the system for an additional 30 days unsupervised, during which time researchers continued to collect step-rate data but the runners' watch displays no longer provided step-rate feedback. Runners in the control group also wore the watches and foot pods for the entire study period but were not given any step-rate feedback.

"We wanted to test out the real-world application of this technique. They weren't coming into a clinic or to a laboratory to do the study," Willy said. "The participants weren't asked to change their normal running routine, only their step rate."

The majority of runners in the retraining group achieved the prescribed step rate during in-field runs and retained those changes through 30 days. The in-field gait retraining was also associated with reduced impact forces, peak hip adduction, and eccentric knee joint work compared with baseline; impact forces were also significantly lower than in the control group. The findings were epublished in February by the *Scandinavian Journal of Medicine & Science in Sports*.

"It was certainly effective in increasing their step rate," Willy said. "We saw some really nice reductions in impact forces, as well as knee joint loads."

Stacey Meardon, PhD, PT, ATC, CSCS, assistant professor in the Physical Therapy Department at East Carolina University, has also studied the effects of gait modification on tibial stress during running. In a lab-based study, published in the August 2014 issue of the *Journal of Biomechanics*, Meardon and colleagues found that tibia stresses were influenced by step width.

"We found that tibia stresses were influenced by step width, which to me means when you run narrower, your tibia undergoes greater stress than when you run wider," Meardon said. "Part of the driving factor for me doing my study was to evaluate whether a change in technique can actually influence the loading environment of the bone. And basically what I found was that, yes, we can change the way we run, and we can alter the load that the bone experiences."

When performing gait modification in a clinical setting, it's important to match the retraining program to the runner's specific mechanics, Willy said.

"If you have a runner whom you suspect has much more of a sagittal plane contribution to their excess of loading on the tibia, then maybe the step-rate modification is the way to go," he said. "But if you feel like it's more of a frontal plane issue—they're crossing over a lot—then the step width [modification] is the way to go."

There would be no added benefit to changing both variables, Willy said.

"You basically need to pick your poison and stick with that," he said. ler

Sources:

Willy RW, Buchenic L, Rogacki K, et al. In-field gait retraining and mobile monitoring to address running biomechanics associated with tibial stress fracture. Scand J Med Sci Sports 2015 Feb 4. [Epub ahead of print]

Meardon SA, Derrick TR. Effect of step width manipulation on tibial stress during running. J Biomech 2014;47(11): 2738-2744.

By Jordana Bieze Foster

Double bonus

AFOs improves dual-task gait in two ways

Wearing ankle foot orthoses (AFOs) is associated with both physical and cognitive performance during dual-task gait in children with myelomeningocele, according to research presented in February at the annual meeting of the American Academy of Orthotists and Prosthetists (AAOP) in New Orleans.


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The findings suggest that the benefits of AFOs in this patient population extend beyond gait itself, and may have positive effects on the more complicated aspects of daily life—such as playing with others—in children with myelomeningocele.

"If we fail to consider the demands on these patients outside the clinic, we may not be fully addressing the patients' needs," said Nikta Pirouz, CPO, an orthotist at the Ann & Robert Lurie Children's Hospital of Chicago, who presented the study findings at the AAOP meeting as part of the Thranhardt Lecture Series. "Ankle foot orthoses intervene at the level of the body and at the level of activity. But they might also have effects at the level of participation."

Pirouz and colleagues analyzed 16 children aged between 7 and 13 years with varying levels of myelomeningocele (low lumbar, lumbosacral, and sacral), all of whom were regular users of solid AFOs. The children were assessed at two visits, two weeks apart. Each visit included three trials: one involving a counting task only,

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Plantar flexion resistance alters knee flexion, foot strike in stroke patients

Increasing the plantar flexion resistance of an ankle foot orthosis (AFO) reduces knee hyperextension and changes foot strike pattern during gait in chronic stroke patients, according to research presented in February at the AAOP meeting in New Orleans.

A multicenter team of investigators assessed 10 patients (two women), who were an average of six years post-stroke, as they walked while wearing an experimental AFO with a steel-spring design that adjusts for different degrees of plantar flexion resistance.

Increasing the resistance of the AFO was associated with a systematic response involving increased knee flexion during gait and a shift from a forefoot strike pattern to a rearfoot strike pattern.

"This indicates the importance of tuning the plantar flexion resistance of the AFO," said Toshiki Kobayashi, PhD, a research scientist with Orthocare Innovations in Oklahoma City, OK, who presented the findings at the AAOP meeting. "In the future we should be able to tune the resistance of an AFO the way we tune the alignment of a prosthesis."

Source:
Kobayashi T. Effect of ankle foot orthosis plantar flexion resistance on lower-limb kinematics and kinetics in patients with stroke. Presented at the American Academy of Orthotists and Prosthetists Annual Meeting and Scientific Symposium, New Orleans, February 2015.

More restrictive orthotic devices boost balance over time in children with CP

Balance improves over time in children with cerebral palsy (CP) who switch from a dorsiflexion-free orthotic device to a more restrictive one, according to research from Northwestern University's Feinberg School of Medicine in Chicago.

Investigators analyzed five children with CP who regularly wore either supramalleolar orthoses or articulated ankle foot orthoses (AFOs) as they walked in each of two more-restrictive AFOs. The children had four weeks to accommodate to each new AFO.

The researchers found that switching devices had mixed effects with regard to step activity, walking endurance, patient satisfaction, and lifestyle participation—which may indicate that a longer transition time is warranted, according to Stefania Fatone, PhD, BPO (Hons), an associate professor of physical medicine and rehabilitation at the university, who presented the findings at the AAOP meeting in New Orleans.

But restricted motion was associated with improved balance over time in all patients, regardless of the specific device worn. This may mean that the improved stability provided by the orthotic devices facilitated strengthening of the more proximal muscles, although the study did not measure strength, Fatone said.

Source:
Fatone S. Effect of two orthotic approaches on activity level, balance, and satisfaction in children with cerebral palsy. Presented at the American Academy of Orthotists and Prosthetists Annual Meeting and Scientific Symposium, New Orleans, February 2015.

Continued from page 13

one involving walking at a self-selected speed only, and one involving both counting and walking. On the first visit, the children were tested while wearing shoes only; on the second visit, they were tested while wearing shoes and AFOs. Because there was a range of cognitive development levels within the study population, the difficulty of the counting task was matched to the developmental level of each child.

Gait variables measured included velocity, cadence, and stride length. Counting-related variables included rate of response, rate of correct response, and percent of correct responses.

As expected, during the walking-only task, AFO use was associated with significantly faster velocity and a longer stride than the shoes-only condition. Velocity was also faster with AFOs than without during the dual-task tests, primarily as a function of increased cadence. But, even with AFOs, velocity remained below the single-task level.

Counting performance during the dual-task condition was also better with AFOs than without. Rate of response and rate of correct response were both significantly better, and there was a trend toward significance for improvement in percent of correct responses. Interestingly, dual-task counting performance while wearing AFOs approached single-task levels, Pirouz said.

"Counting was the primary task, as its performance was preserved while velocity was not," she said. "It's possible that this pediatric population is more willing to sacrifice gait to maintain performance of an additional task."

This finding appears to be consistent with a study from Uppsala University Hospital in Sweden, in which children with myelomeningocele performed an executive task and a visual-spatial task separately and in combination while sitting. In a group of matched controls, postural sway was affected when the visual-spatial task was added to the executive task, but in the children with myelomeningocele, postural sway was affected when the executive task was the one added. That study was published in the November 2009 issue of *Gait & Posture*.

Pirouz noted that counting is just one subset of cognitive performance, and that cognitively different tasks—particularly less rhythmic tasks that might be less influenced by walking cadence—might lead to different results. But she also hypothesized that targeted adjustment of AFOs to alter specific aspects of gait may lead to even more improvement in both the physical and cognitive aspects of dual-task performance.

"There may be key gait parameters that can be unlocked to improve these dual-task challenges," Pirouz said. "It might be that we need to optimize knee alignment, or ankle alignment, or something like that."

Sources:

Pirouz N. Ankle foot orthoses for children with myelomeningocele: Functional effects under a dual-task paradigm. Presented at the American Academy of Orthotists and Prosthetists Annual Meeting and Scientific Symposium, New Orleans, February 2015.

Hoglund A, Norrlin S. Influence of dual tasks on sitting postural sway in children and adolescents with myelomeningocele. Gait Posture 2009;30(4):424-430.

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Managing Finger and Toe Wounds

The closing and healing of all wounds involves establishing and maintaining optimal wound healing conditions. Managing wounds on fingers and toes can be difficult due to the need to reduce edema without a good way to accomplish the goal. Additionally, a caregiver is often required to apply dressings in a way that limits the digit's range of motion, further interfering with the healing process. Dressings applied to the finger or toe often need to be changed frequently because they slip off due to movement. In patients with vascular or diabetic co-morbidities, digit wounds can be especially slow to heal and often require multiple medical interventions.

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Patient 1 was a 78-year-old diabetic male with a below-the-knee right leg amputation. He bumped his left foot during a transfer from his wheelchair to the toilet. The trauma resulted in three blood-filled blisters on the second toe of the left foot and swelling of his left lower extremity became a healing obstacle. Due to increased susceptibility to infection, the silver version of the PolyMem Finger/Toe dressing was applied to the blisters. His wife performed the dressing changes and his blisters dried under the dressings in less than two weeks, using only two dressings.

The Silver Finger/Toe dressing was easily applied.

Patient 2 was a 71-year-old diabetic male with a history of poor vascular perfusion, below-the-knee amputation of the right leg, and venous stasis ulcers. The hook-and-loop fastener of a post-operative shoe created a friction wound on the top of the toe on his remaining foot. The periwound skin became edematous and macerated. Using the PolyMem Finger/Toe dressing, he was able to do his own dressing changes and the periwound maceration, swelling and weeping decreased. The wound, which originally measured 0.5 cm x 0.7 cm x 0.1 cm, was closed in 14 days. Only two PolyMem dressings were used to close this wound.

Patient 3 was a 56-year-old paraplegic female whose shoe came off when her foot fell from the wheelchair footrest, resulting in an avulsion of the second toenail of the left foot. The periwound skin became slightly erythemic and edematous. Her dressing changes were performed by home health and the wound closed in only three days.

Patient 4 was a 56-year-old male who suffered an amputation at the proximal joint of the first finger of his right hand while operating a hydraulic log-splitter. A surgical flap was attempted, but it was unsuccessful. The periwound skin was swollen, macerated and warm to the touch. He received whirlpool baths to the wound twice weekly by physical therapy. He changed his own dressings when required and when no whirlpool treatments were scheduled. The macerated periwound skin resulting from the whirlpools was managed with a barrier cream. The pain during the whirlpool treatments was managed with oral analgesia. All these wounds healed rapidly using PolyMem Finger/Toe dressings.

PolyMem is a multifunctional polymeric membrane dressing and contains components that draw and concentrate the body's natural healing substances into the wound bed to promote rapid healing. PolyMem Silver has all the unique properties of the standard pink PolyMem dressings with the additional antimicrobial properties provided by elemental silver.

The Finger/Toe dressings, like all PolyMem products, help to reduce edema, bruising, pain and inflammation when applied to either open or closed injuries. The dressings help relieve both persistent and procedural pain that is associated with injury and are effective throughout all stages of the healing process. The dressings fit securely over the finger or toe while allowing freedom of movement; encouraging range of motion; helping reduce pain, swelling, bruising and inflammation; and providing cushioning protection.

After application of PolyMem dressings, all these patients experienced significant swelling reduction in the affected digits and saw rapid resolution of any previously present periwound skin complications. Nurses, patients and caregivers found the dressings easy and convenient to use. Finger/Toe dressings were shown to be cost effective when compared to other approaches as the number of dressings used was significantly decreased, the time needed for dressing changes was minimal and the home health nurses made fewer visits. PolyMem dressings provided optimal healing environments, which resulted in rapid wound resolutions.

The entire dressing was applied to cover the the knuckle as well as the wound in order to help reduce the swelling faster.

Reference:

1. Harrison J. Successful Healing of Digit Wounds with One Dressing. Poster 6130. Wound Ostomy and Continence Nurses Association (WOCN). June 9-13, 2012. Charlotte, NC, USA.

Down syndrome and total hip arthroplasty:

Opportunities to optimize outcomes

Total hip arthroplasty can markedly improve quality of life in patients with Down syndrome, but the comorbidities and developmental disability associated with the chromosomal abnormality need to be taken into consideration when planning surgery and rehabilitation.

By Shalmali Pal

The life expectancy for people with Down syndrome (DS) has increased dramatically, from 25 years in 1983 to 60 years in 2014.[1] Many patients with DS, the most commonly occurring chromosomal abnormality, are graduating from high school, going to college, building careers or holding jobs, marrying, and becoming active members of society.

But, as with the general population, these 400,000 adults in the US also have to contend with the aging process and its related health issues, including musculoskeletal disorders that require surgical intervention. More than 285,000 total hip arthroplasty (THA) procedures are performed annually in the US,[2] and patients with Down syndrome account for more of those procedures each year, although exact numbers are hard to come by.

The developmental disability associated with Down syndrome, as well as musculoskeletal issues that can make THA more technically challenging, have led to concerns among some practitioners as to whether the surgery is appropriate in patients with the condi-

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tion. But Down syndrome itself is no reason to rule out a patient as a viable surgical candidate, according to experts who spoke with *LER*. In fact, THA can be valuable in this population, experts say, but certain factors do need to be taken into consideration to ensure optimal outcomes.

Reliable surgical intervention

The majority of adult patients with DS are eligible for THA, according to Allan Gross, MD, a professor of orthopedic surgery at the University of Toronto in Canada and lead investigator for the Replacement Arthroplasty in Down Syndrome (RADS) Study Group.

"I can't remember the last time I turned down a patient with Down's for joint replacement," Gross said. "They come to us with pretty good function, and after the surgery, they continue to function well. The most important aspects are to give top-of-the-line implants and aftercare, the same as you would with any patient."

Published studies on THA in patients with Down syndrome report a high degree of success. In 2011, the RADS group reported THA results in seven patients (nine hips) with an average age of 34.8 years.[3] At six weeks postsurgery, the average Harris Hip Score (HHS) improved from 41.1 preoperatively to 59.1 (out of 100 points). The HHS improvements held at one year (79.8) and two years (85.2), as well as eight years (70.9) postprocedure.

"We contend that THA is a reliable surgical intervention in patients with DS and may be performed in symptomatic patients," the group concluded.

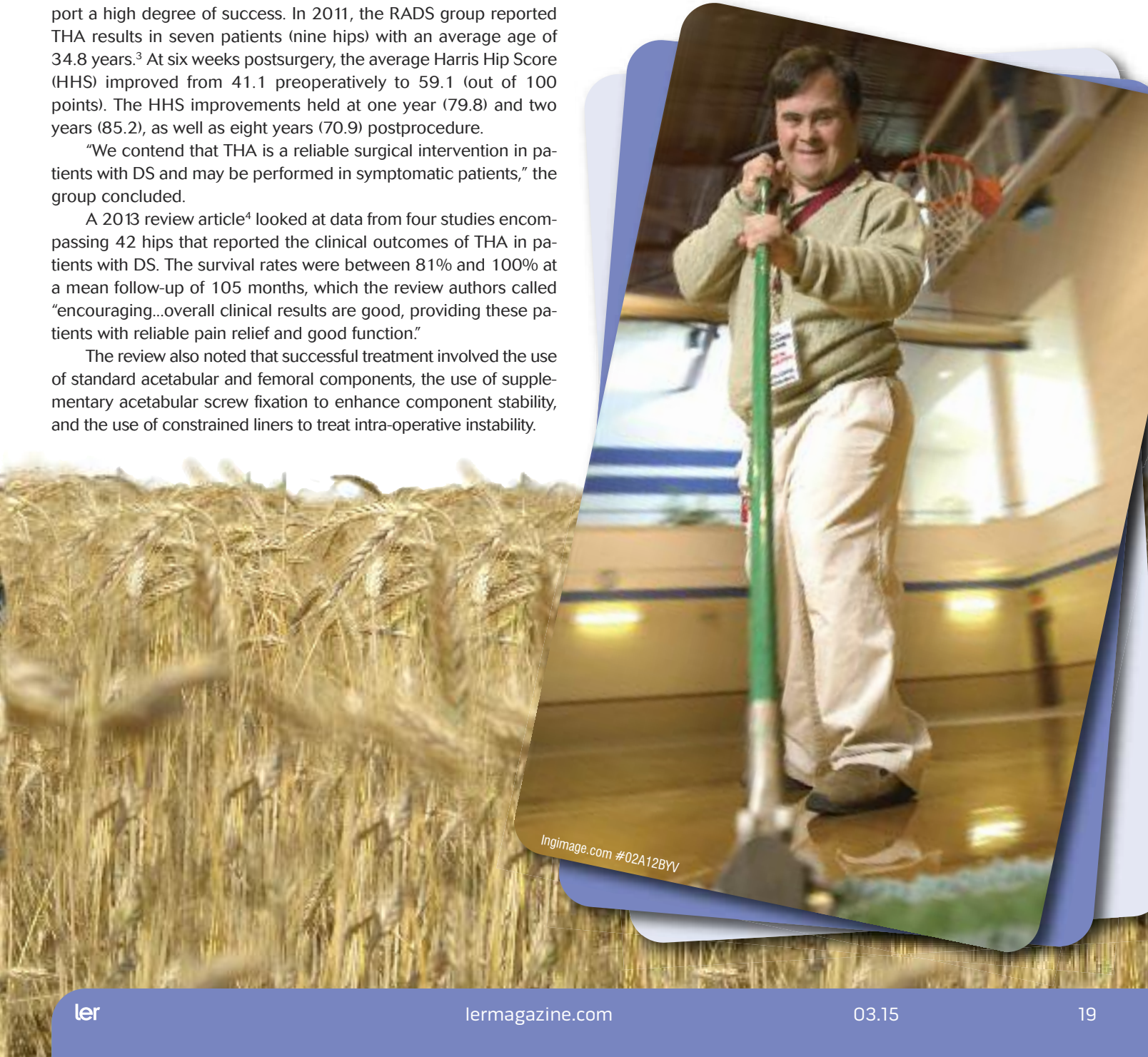
A 2013 review article[4] looked at data from four studies encompassing 42 hips that reported the clinical outcomes of THA in patients with DS. The survival rates were between 81% and 100% at a mean follow-up of 105 months, which the review authors called "encouraging...overall clinical results are good, providing these patients with reliable pain relief and good function."

The review also noted that successful treatment involved the use of standard acetabular and femoral components, the use of supplementary acetabular screw fixation to enhance component stability, and the use of constrained liners to treat intra-operative instability.

For Gross, constrained liners represent an advance in THA hardware that is tailor-made to address one of the main barriers to this procedure in patients with DS: They are prone to ligamentous hyperlaxity and muscle hypotonia that can cause instability, subluxation, and potentially an increased risk of THA dislocation.

"One of the reasons that surgeons have been hesitant to do THA in these patients has been the higher chance of dislocation," Gross acknowledged. "But with the constrained liners, the head is constrained into the cup so it's much more difficult to dislocate. Another option in Down's patients is to use a large femoral head because it takes a lot more force to dislocate. Both of these technologies have improved in the last ten years, which makes dislocation less of an issue with normal usage, assuming there's no trauma."

Additionally, his group wrote, constrained liners "provide more reliable pain relief as there is no motion between the [head] and the acetabular bone."[3]



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Another surgical boon has been the movement away from performing THA with a posterior-lateral approach and toward an anterior-medial approach, which also reduces the risk for hip dislocation, explained Eric Robertson, PT, DPT, who is the director of Kaiser Permanente's Hayward Fellowship in Advanced Orthopaedic Manual Therapy in Hayward, CA, a clinical assistant professor at the University of Texas at El Paso, and a spokesperson for the American Physical Therapy Association.

Of course, some patients will require surgical revision. In the study by Gross's group, two patients met that criteria: One experienced stem loosening at year five while the other had loosening of the femoral stem 16 years postsurgery as a result of proximal femoral osteolysis.[3]

But instances of failure are probably not any more common in patients with DS than in the general population, suggested orthopedic surgeon Michael Marks, MD, a spokesperson for the American Academy of Orthopaedic Surgeons.

He cautioned against assuming that the THA in these patients failed because of the DS.

"I think it's important to do a root-cause analysis: Did it fail because of technical errors? If there was no trauma, like a fall, is there an issue with the hardware? Did it happen because the patient or the caregiver didn't follow postop instructions? There are lots of different reasons for failure that apply to THA patients whether they have Down's or not," Marks said.

In the absence of a fall or a serious infection, THA in these patients should last at least a couple of decades, especially if they have the surgery earlier rather than later, Marks pointed out.

"If the average age of a THA patient in the general population is about sixty, then maybe we'll consider the surgery in Down's patients in their forties if it's going to help them maintain their quality of life," he said.

Photo courtesy of Peter and Jonathan Henry.

Preoperative care

From a surgical perspective, THA in patients with DS is not that different from the general population, Gross and Marks agreed. The difference between the two populations is "all the support staff that you need to have in place, before and after surgery" for patients with DS, Marks said.

How to determine if a patient with DS is a candidate for THA? First, practitioners need to ascertain if patients are experiencing potentially debilitating hip pain. That's where communication becomes key. Obviously, patients who are highly functional and have advanced verbal skills may have no qualms about voicing complaints about hip pain, but that's not always the case.

"We need to keep in mind that this is a population with a whole different variety of ability levels—their cognitive function, their ability to follow instructions, their ability to follow through—all of those are constant issues in this population," stressed Debbie Caprielian, MPT, PT, president of Northstar Physical and Occupational Therapy Consulting Services in Norwalk, CA.

Healthcare professionals may have to rely on caregivers or family members to convey information about hip pain. A patient may call the caregiver's attention to the hip by pointing at it, for example, or caregivers may notice more gradual changes, such as a decrease in mobility or the development of a limp.

"You have to spend time with the caregivers and make sure that the pain is actually coming from the hip," Gross emphasized. "In that respect, the preop assessment in these patients will require more time because you need to establish those lines of communication from the start."

A determination that hip pain can be resolved with THA is not the end of the story. As with any surgery, the risks and benefits must be weighed, Robertson and Caprielian agreed.

Robertson said he'd prefer to see a course of conservative rehabilitation with physical therapy (PT) before surgery is agreed upon, but once it is, education will be paramount, focusing specifically on the type of postoperative PT that will be provided, how much of it will be necessary, and any postop precautions.

"I wouldn't approach this population and say, 'Here are your home exercises and your precautions,' because you can't assume the same level of compliance as in the general population," Robertson said. "The patient's entire support network is going to have to be extensively educated on what they can expect after the operation."

Caprielian advised looking for red flags during the presurgical education process. For instance, if a discussion about postoperative issues, such as exercises, pain levels, and weight-bearing status, proves too overwhelming for the patient or caregiver beforehand, then it may not be the right time for surgery, she pointed out.

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"The bottom line is that a high-functioning Down's client is probably the most pleasant person to work with. They want to please you; they want to do what's right," Caprielian said. "But if you sense any hesitation on the part of the patient or the caregivers, then who is the surgery really benefiting?"

Postoperative care

Most standard PT protocols can be utilized in patients with DS, Robertson said, adding that "the great thing about this rehab is that it can be quite simple: Something like sitting down and standing up again can be an effective exercise in a post-THA population."

A published post-THA protocol from Poland could apply to a patient with DS, Robertson said. The rehab algorithm calls for exercises done in supine positions, such as dorsiflexion of the foot and lower limb abduction, and standing positions, such as extending the operated hip joint against resistance.[5]

What the practitioner will need to ascertain is the level of assistance the patient will need to perform these exercises, and that will most likely mean more hands-on care and involvement, Robertson said.

"With the general THA population, they get PT initially in the hospital to improve mobilization, and then they are given a course of home exercises," Robertson stated. "Again, that's not something I would recommend for Down's patients because you can't count on their ability to perform exercises independently. They will need more guidance during exercise and rehab, and I think it's best if the PT can provide as much of that as possible."

If compliance is an issue, Robertson suggested taking the same approach as with a less compliant typical patient—adapt the PT routine to reflect abilities and interests.

"I think it's a matter of getting to know the person; you don't need a detailed psychological profile," he said. "Let's say the patient seems to get frustrated quickly; maybe you have more sessions that aren't as long in duration. Maybe the patient is interested in a particular sport; can you incorporate some of that into the PT? It's similar to adapting a PT protocol to keep kids interested—games or puzzles—whatever is going to engage them."

Caprielian suggested that physical therapists be prepared to do a lot of demonstration of exercises, possibly several times. If the patient or the caregiver still seems uncertain, she will do a hand-over-hand demo, physically guiding them through the exercise.

Marks recommends that a PT protocol take into consideration where the patient was in terms of mobility prior to the onset of pain.

"Many of these patients use assistive devices—a walker, a crutch, a cane—so you want to make sure that they can use them again. I'd recommend incorporating those devices into postoperative care," he said.

For Gross, the immediate goal of PT should be to prevent post-THA complications to which patients with DS are particularly prone, such as dangerous blood clots and muscle atrophy.[3,4] Over the long term, he likes to see patients who were mobile before THA continue on that track.

The quality-of-life question

Perhaps the least straightforward aspect of working with this population is determining if THA will lead to a better quality of life (QOL).

Of course, if the patient is complaining of pain in the affected area, and the surgery relieves that pain, that's a win. And an ambulatory patient who is able to maintain an active lifestyle after THA also benefits.

But patients with DS do contend with other comorbidities, especially as they age, and these may impact THA outcomes. These include other musculoskeletal disorders, such as midcervical arthritis, and higher rates of obesity, hypothyroidism, visual impairment, and depression.[6]

Perhaps the most detrimental change in these patients is Alzheimer disease (AD). By age 40 years, almost all individuals with trisomy 21 will have the characteristic amyloid plaques and neurofibrillary tangles of AD, though not all develop symptoms.[7]

If a patient shows signs of dementia during the preoperative phase, what does that mean for THA? The experts offered mixed opinions.

In a 2013 study,[8] Gross's group assessed post-THA QOL more than eight years after surgery in patients with DS and reported that the mean HHS improved to 84 points. They emphasized in the paper that early development of AD should be taken into account during the preoperative evaluation, and Gross told *LER* that the interaction between the early stages of cognitive decline and THA outcomes will depend on the patient and his or her support system.

"Making that determination will mean taking time to talk to the caregivers, because they'll have the best perspective on what the patient needs," he said. "But, in terms of longevity of the THA and QOL, these patients are much less likely to be engaged in high-impact activities than the general population, so the beneficial results should be viable for a longer time."

Caprielian is a bit more cautious. The onset of early AD doesn't make a patient ineligible for THA, she said. But the healthcare team does need to figure out how cognitive decline may complicate postoperative care.

"The surgery may take care of any short-term problems such as pain management. But if the client isn't able to respond to the postop PT, what are we accomplishing?" she said. "Once the dementia starts, many Down's patients become nonambulatory. If they are going to spend a lot of their time sitting, then what are they going to achieve after surgery?"

Caprielian emphasized the importance of discussing potential signs of AD preoperatively. These can include a reduction in interest in being social or conveying thoughts, lack of enthusiasm for usual activities, anxiety, uncooperativeness, and changes in coordination or walking.

It's the latter that Caprielian suggested the healthcare team look closely at before considering THA.

"We have some clients with DS who've gone from being independent ambulators to completely wheelchair-bound; it can be a very fast decline. Others progress more slowly over many years. It's difficult to predict that, but if you see a client is headed in that direction, that person may not be a candidate for joint replacement if they aren't in pain or complaining of pain," she said.

Evolution

It seems likely that attitudes about THA in patients with DS will change over time, as has happened with other patient populations. Marks pointed out that, during the early days of THA, many patient subgroups were not considered good prospects, but those opinions evolved. For example, once upon a time, 50 years was considered the minimum age for a joint replacement, he said.

"Another example is patients with parkinsonism who, unlike in Down's, have marked spasm, so we were reticent to do joint replacement, but we do them fairly routinely now," he said. "There have always been patients who are initially put into the category of 'We should never do that.' Over the years, we've changed our attitude about quality of life and what we can do to help patients continue to participate in society." ler

Shalmali Pal is a freelance writer based in Tucson, AZ.

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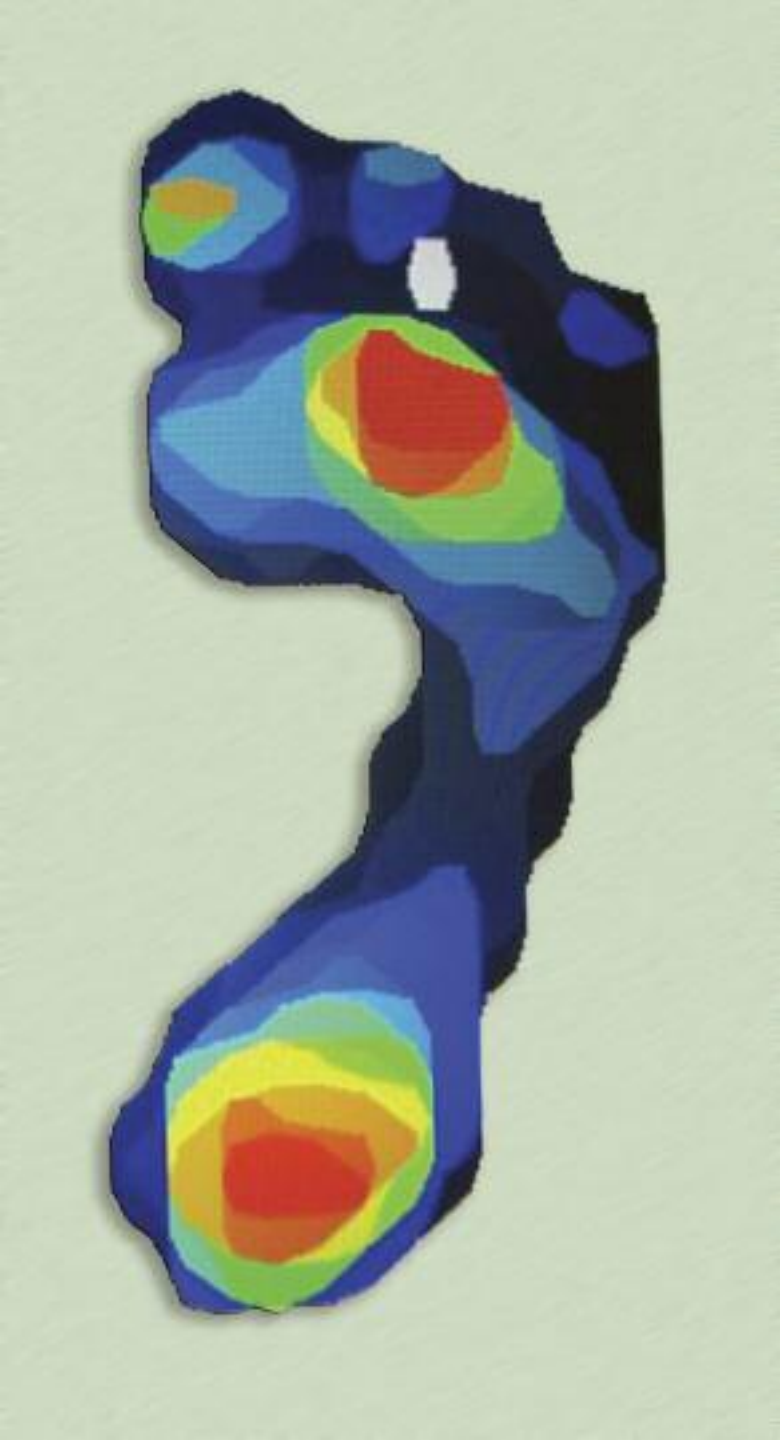

Hallux valgus and plantar pressure measurement

Researchers and clinicians have found that plantar pressure assessment can help document the dynamic effects of hallux valgus surgery, postoperative physical therapy, and footwear or orthotic interventions, particularly in cases involving less than optimal results after surgery.

By Hank Black

From aboriginal trackers to Robinson Crusoe and on to modern clinicians, humans have found plenty of uses for the study of pressure patterns of the plantar surface of the foot. Once skilled observation of footprints could have been a matter of life and death for the hunter and the hunted; today it tells us about foot pathology. Perhaps this started when Boy Scout founder Lord Baden-Powell suggested that scoutmasters fill an evening in camp by having their troops provide an ink footprint in part to identify those boys whose feet may have been warped by ill-fitting shoes.[1]

Today the ill-fitting shoes are more likely to be a woman's narrow-toed high heels,[2] and in place of the footprint in ink, modern pedobarometrists are more likely using electronic plantar pressure measurements from sensor-embedded mats and in-shoe devices.

One common current use by researchers and clinicians is in the assessment of people with hallux valgus (HV), the structural deformity of the first ray that is often associated with the development of a reactive soft tissue bunion. The incidence of HV is more than 35% of adults older than 65 years, and women are twice as likely as men to be diagnosed with the disorder. Footwear, especially high-heeled or improperly fitting shoes, is implicated in HV development.

Some 25 years ago,[3] pressure distribution instruments were used to describe lateral forefoot load shifts in feet with hallux valgus (HV). Five years later, a study found high-heeled shoes were associated with lower loads under the heel and increased loads under the forefoot, with the higher medial forefoot loads potentially aggravating pain in patients with HV.[4]

"Pressure mapping is affordable, easy to use, and fast, depending on the format you choose to use," according to Bruce E. Williams, DPM, a past president of the American Academy of Podiatric Sports Medicine who recently became director of gait analysis studies at Weil Foot & Ankle Institute in Chicago. "The smaller pressure mats are obviously less expensive than in-shoe systems, and for hallux valgus are adequate for pre- and postsurgical evaluation. In most instances, referral to a full-option gait lab would not be necessary."

Researchers have used pedobarometric analysis to confirm the effectiveness of a surgical intervention for hallux valgus or to compare two different interventions.

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Comparing surgical outcomes

Researchers commonly employ pedobarometric analysis to compare outcomes of different surgical interventions. Christy King, DPM, who practices at Kaiser Permanente in Oakland, CA, collected pre- and postoperative pressure measurements for a study comparing Lapidus arthrodesis and chevron osteotomy in people undergoing hallux valgus surgery.[5]

"The decision for bunion correction surgery is multifactorial, including both clinical and radiographic evaluation," she said. "Typically, a Lapidus bunionectomy is indicated in a patient with a larger intermetarsal [IM] angle, first ray instability, hypermobility, or all three of these. Chevron osteotomy is used in those with a lesser IM angle. In our study, while both sets of patients improved clinically after surgery, we found that the plantar pressures in those who underwent Lapidus bunionectomy were distributed more evenly across the five metatarsal heads and represented more of a tripod-like stability underneath the first and fifth metatarsal heads and the heel."

Other researchers may gather plantar pressure measures before and after a single intervention to help determine effectiveness, as Kernozek et al did in analyses of characteristics before and after various chevron-type osteotomy procedures to correct for HV.[6,7]

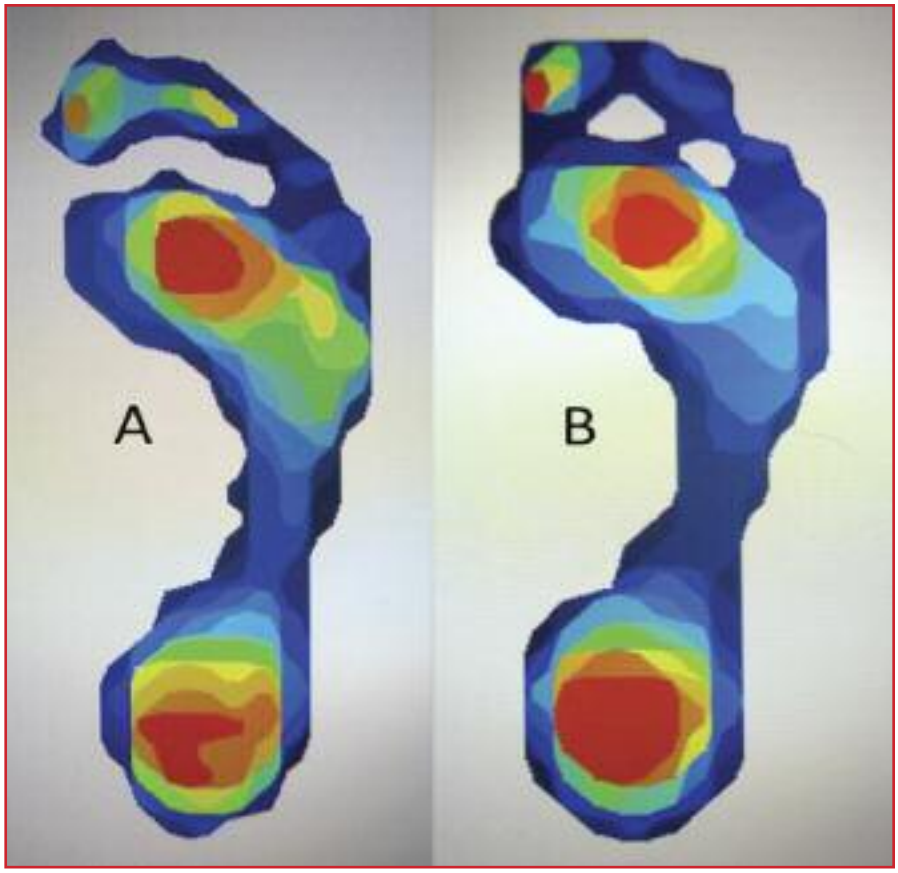

Figure 1. Plantar pressures of a chevron bunionectomy patient show a similar pattern before (A) and after (B) surgery. (Images courtesy of Christy King, DPM.)

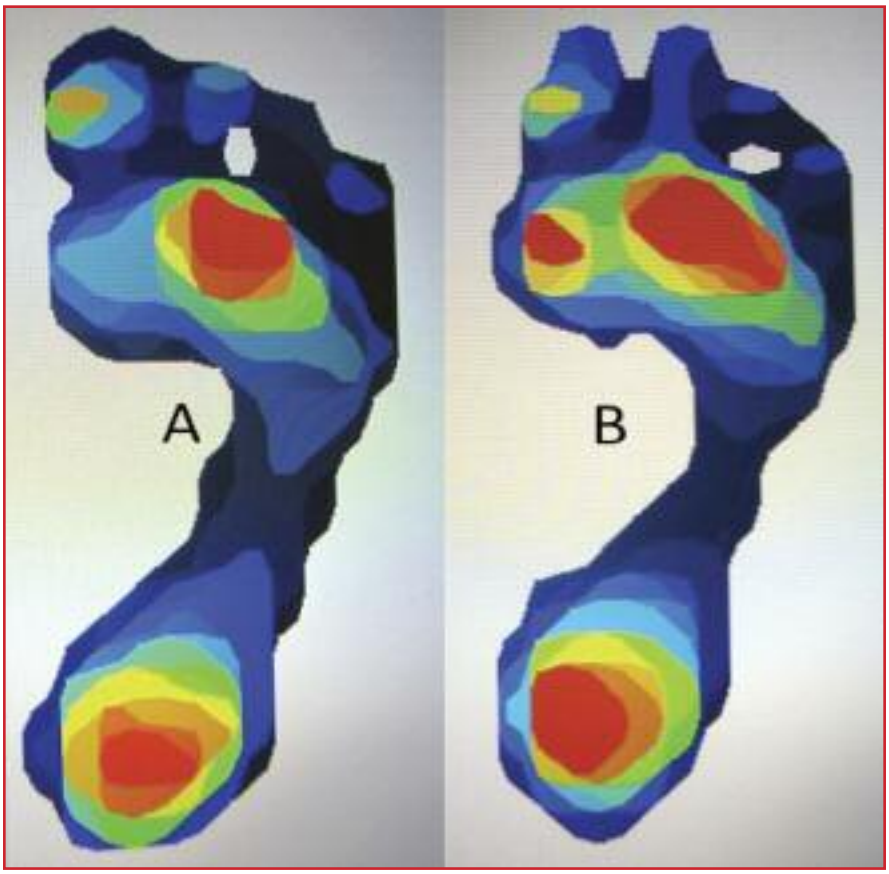

Figure 2. Preoperative (A) and postoperative (B) images of a Lapidus bunionectomy patient show increased load sharing of the lesser metatarsals after surgery. (Images courtesy of Christy King, DPM.)

And, while there are now a large variety of bunion surgeries, clinicians are always looking for different ways of helping patients with the HV conundrum. Wong et al recently described a successful HV surgery that used soft tissues and a cerclage wire around the necks of the first and second metatarsals to realign the first metatarsal. The force data suggested that the function of the hallux was restored by the procedure.[8]

Clinical utility

Researchers appreciate the data-gathering capabilities of modern plantar pressure measurements, but practitioners may vary in how clinically useful they consider the metrics to be for hallux valgus. King, for one, does not typically collect pressure measurements for assessment of hallux valgus prior to surgery, but views it as a valuable research tool.

"While the pedographic measurement device is easy to use, the pressure measurement collection is not typically part of our preoperative protocol, primarily due to staffing and time constraints," she said.

Erin Klein, DPM, who, like Williams, is associated with the Weil Foot & Ankle Institute, collects plantar pressure data preoperatively on all patients with hallux valgus but does not make use of it unless a postoperative complication develops.

"Plantar pressures measurements do provide a more dynamic look at how the foot functions, but I

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tend to focus on the common radiographic variables when I'm fixing a bunion," she said. "Nevertheless, if the patient has postoperative pain under the metatarsal heads, particularly the second metatarsal head, we can go back to the pressure data for guidance on developing an appropriate orthosis prescription for offloading that area."

Williams said that correction of abnormal pressure distribution is vitally important in restoring overall foot and lower extremity function and symmetry. However, surgical intervention alone does not always result in a change in pressure pattern, particularly in cases involving unstable medial columns that rarely are associated with high pressures either pre- or postsurgery.[9]

"Simply reducing the angle of the hallux valgus deformity, although greatly beneficial to the patient, will not necessarily change the overall sagittal plane structure of the first ray or the stiffness of the first ray enough to change the pressure patterns," Williams said. "However, most patients with bunions obtain pain relief and reduction of their angular deformity with bunion surgery regardless of the overall pressure pattern and whether or not the pattern has changed."

Plantar pressure assessment can be useful in patients who do not experience optimal results after surgery, Williams said, particularly in determining the effect of an orthotic or footwear intervention.

"When I have tested patients who have complaints after bunion surgery, I can usually benefit them by modifying a custom foot orthotic for them that will improve their overall pressure profile and the timing of their force versus time curve," he said.

Similarly, researchers have used pressure measurements to help assess whether foot orthoses can decrease pain associated with hallux valgus by offloading elevated medial forefoot pressures. In a 2014 Iranian publication, Farzadi et al used an in-shoe system to evaluate a medial arch support orthosis worn by female patients with mild-to-moderate hallux valgus. They found that the orthosis could reduce pressure under the hallux and first metatarsal head by transferring the load to the medial midfoot region.[10]

Klein, a clinical instructor of podiatric surgery at the William M. Scholl College of Podiatric Medicine in Chicago, collects mat-based plantar pressure measurements as part of her normal preoperative hallux valgus protocol, primarily with an eye toward using the data in retrospective outcomes studies.

"I don't necessarily analyze the measurements before surgery, but they can be helpful if there is a complication postoperatively, such as when over-shortening of the metatarsal occurs following the Scarf osteotomy,"[11] she said. "In that case, the plantar pressure measurements taken before surgery can augment x-rays in determining how to alter our prescription of orthoses."

Differing results

Reports of subhallux pressure in people with HV have been inconsistent, with studies variously reporting reduced loading, increased loading, or no change in pressure at that site.[12-14] Some of this inconsistency may be related to the different technologies used to assess plantar pressures in different studies, Williams said.

"Most studies [before and after] bunion surgery use pressure mats to evaluate the pressures. If an in-shoe pressure system were used instead of or in combination with a mat, a demonstrated change in pressure would be more likely, depending on the shoe worn and whether a custom foot orthotic was used during the testing as well," he said.

Some of the discrepancies in study outcomes may be explained by the progressive nature of the disease. In an analysis of how the magnitude and distribution of forefoot plantar pressures correspond with clinical and anthropometric determinants in mild disease, Martinez-Nova et al found significantly increased pressures under the hallux due to deviation of the first ray.[12] Hurn et al, in a study published this year and also utilizing an in-shoe device, found no significant differences in plantar pressures between individuals with mild HV and controls, but did find that greater HV severity was associated with reduced loading under the hallux.[14]

Klein said she believes plantar pressure measurements to evaluate HV might be utilized more if the literature showed a more consistent correlation between plantar pressures and dysfunction.

"Many studies lack a description of the postoperative surgical and rehabilitation protocol, which plays an important role in outcomes. I'd like to see more single-surgeon, single-procedure studies with described and more standardized postoperative rehabilitation protocols, since there are many ways to fix hallux valgus and many variations in the postoperative protocols," she said. "There's also a need for a better way to standardize masks for plantar pressure zones to assure consistency within different sized feet."

Marian Hannan, DSc, MPH, associate professor of medicine at Harvard Medical School in Boston, said inconsistent findings may result from small sample sizes in many studies along with failure to take into consideration coexisting foot disorders, degree of HV severity, and the age of participants.

"All of the studies are informative, but usually are looking at different parts of the elephant," Hannan said.

> Published studies of subhallux pressure in people with hallux valgus have been inconsistent, variously reporting reduced loading, increased loading, or no change in pressure at that site.

Framingham Foot Study

Hannan, who is also editor of *Arthritis Care and Research*, led a vast, population-based study of hallux valgus that was published in 2013.[15] Her research group recruited 3205 participants from the Framingham Foot Study and collected biomechanical data on both feet for almost every participant. Those with HV (defined as a 15° or greater abduction of the hallux) were assigned to one of two groups, one with HV only and one with HV plus at least one additional foot disorder. A third group had no HV but at least one other foot disorder, and a reference group had no foot pathology. Using a pressure mat, the researchers found that, compared with the reference group, participants with HV had lower hallucal loading and higher forces at the lesser toes, and those with HV and another foot disorder also had abnormal rearfoot forces and pressures.

"It is a cross-sectional study, but it's my suggestion that HV can change how a person walks, putting them at greater risk for other foot disorders," Hannan said. "Our participants with HV, whether they had concurrent foot disorders or not, had a lower center of pressure excursion index, which we expect to see clinically in peo-

ple with HV. However, they also had a higher arch as measured by the modified arch index [MAI]. That was contrary to what we were expecting, as typically HV is associated with a lower MAI."[16]

The Framingham cohort is largely urban or suburban, white, and older. Hannan's group is completing data collection on a similar study of HV and plantar pressure loading that involves about 2000 people in North Carolina, of whom one-third are African American.

"We will be interested to see how this rural, younger, and more racially diverse group differs from the Framingham group in regard to hallux valgus. We know, for example, that African Americans typically have lower arches than Caucasians,[17] so that aspect will be especially interesting to follow," she said.

Hannan hopes to secure funding to undertake a longitudinal study of both the Framingham and North Carolina cohorts.

"We want to look at them over three to five years and be able to describe any functional and structural changes that may be due to hallux valgus," she said.

Therapy after intervention

Postoperative rehabilitation after hallux valgus surgery is increasingly being viewed as important for recovering physiological gait and foot function,[18] and plantar pressure measurement can confirm improved weightbearing after corrective bunion surgery.[19] Schuh et al evaluated plantar pressure in 29 patients with mild to moderate HV who had undergone chevron osteotomy, with half of them receiving physical therapy after surgery. They determined that physical therapy was able to increase the hallux plantar pressure to more normal values when compared with baseline levels, supporting the use of early first metatarsophalangeal joint range of motion exercises.[19]

"Many patients start asking when they can play sports and run. If patients don't have sufficient motion in the big toe, their gait is altered. This can lead to changes in the pressure mapping of their feet," Klein said.

Klein sees a possible role for the use of plantar pressure monitoring in physical therapy following HV surgery, particularly in the area of gait analysis.

"Pressure measurements could provide a new way of monitoring improvement if the therapist uses it periodically," she said. "Initially, postoperative patients may walk with more lateral pressure because they are afraid to put their big toe on the floor or move their big toe. Pain may be a component of this as well. Over time the function of the hallux will normalize and strengthen, providing propulsion. This should normalize over the course of physical therapy."

Pedobarometric analysis may also provide a way to influence patient satisfaction. The National Institutes of Health and specialty societies are placing a greater emphasis on collection of patient-based outcome measures in addition to clinical outcomes.

"We could show patients how pressure measures change pre- to postintervention. We show them x-rays before and after, so it would be an interesting concept to add the pressure data, too," Klein said. "I am not quite sure if there is any connection, but patient perception of outcome is a complex and multifaceted issue. Pedobarometric measurements may be a part of this."

Hank Black is a medical writer in Birmingham, AL.

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The role of hip strength in ACL rehabilitation

A protocol that includes isolated hip strengthening exercises during the early stages of postoperative rehabilitation after anterior cruciate ligament reconstruction may provide a platform on which to build in the later stages of rehab and may predict future performance.

By J. Craig Garrison, PhD, PT, ATC, SCS

Injuries to the anterior cruciate ligament (ACL) are common across a variety of sports and are often noncontact in nature. Noncontact ACL injuries typically are associated with sports that involve activities such as cutting, landing, and deceleration.[1-4] The mechanism of injury often involves abnormal movement in the frontal and transverse planes of motion, which puts the knee in a position of relative valgus and internal rotation and, in turn, increases strain on the ACL.[5-7] Valgus loading of the ACL occurs rapidly following ground contact, and researchers have suggested that weakness[8] and poor neuromuscular control[1] of the hip musculature contribute to increased loading.

Several other studies have expanded our understanding of the relationship between hip strength and lower extremity mechanics. A study of 30 healthy individuals established a relationship between hip strength and valgus movement during a single-leg squat.[9] Those with less hip abduction strength demonstrated greater knee movement in a valgus direction during the single-leg squat than individuals with greater hip strength. Similarly, Willson et al found hip external rotation strength was associated with frontal plane knee motion during a single-leg squat in a population of college athletes.[10] And Jacobs et al reported that, during a single limb landing maneuver, women (who have a higher risk of ACL injury than their male counterparts[11]) demonstrated decreased peak hip abductor torque and increased knee valgus compared with men.[12]

Homan et al found that, when a double-limb landing task was performed, healthy active individuals contacted the ground with slight knee valgus that increased during the loading phase of the landing.[13] When the researchers examined these landing kinematics for isometric hip abductor and external rotation strength, they found no differences between the high- and low-strength groups. However, those with lower hip strength values demonstrated greater muscle activity in the gluteus medius and maximus during the landing, indicating a possible increase in neural drive.[13]

These results suggest that hip strength and neuromuscular

Preoperative risk factors involving hip strength, biomechanics, and neuromuscular control may still persist following primary anterior cruciate ligament reconstruction.

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Table 1. Gluteus activity during selected exercises

Hip Strengthening Exercise	Range of % MVIC	
	Gluteus Medius	Gluteus Maximus
Sidelying hip abduction[30-32]	42-81	39-51
Sidelying clam shell[30,32]	38-67	34-53
Bridge – double limb[31]	28	25
Bridge – single limb[31,32]	47-55	40-54
Prone hip extension[32]	46	59
Quadruped arm/lower extremity lift[31]	42	56
Side bridge[31,32]	74-103	21-71
Standing hip abduction[30]	33	Not tested
Lateral step-up[28,31,32]	43-59	29-63

% MVIC = Percent of maximum voluntary contraction

control are related to altered positioning of the knee and may play a role in the risk of ACL injury. This is consistent with the findings of Leetun et al, who tracked lower extremity injuries in college athletes and found that those who did not sustain a lower extremity injury during a season had greater hip abduction and external rotator strength than those who were injured.[14]

Hip strength and prevention

Although the literature suggests that decreased hip strength can lead to biomechanical alterations that are associated with ACL injury risk, there is limited evidence to support hip strengthening either for prevention of primary ACL injury or following ACL reconstruction (ACLR) to prevent reinjury. In a hip-focused training program of healthy women aged between 18 and 25 years, investigators saw significant improvements in landing kinematics after the training, signifying a potential model for ACL prevention.[15] Following four weeks of plyometric and balance exercises with an emphasis on the hip, maximal isometric strength of the hip abductors and hip extensors increased, and the participants utilized greater hip and knee flexion and lower knee abduction (valgus) angles during landing. Although this study was performed in a healthy population, and the effects of the program were not tracked for future ACL tears,[15] the results do suggest the potential for effectively reducing ACL injury risk.

The majority of evidence linking hip strength and knee pain has previously been established in the patellofemoral pain (PFP) literature.[16-18] However, increasing numbers of studies have suggested that multiple biomechanical variables, including knee valgus angle and hip muscle weakness, appear to be risk factors for both ACL injury and PFP.[1,19-24] Because of these apparent mechanistic similarities between ACL injury and PFP, studies that have reported improvements in pain, knee kinematics, and outcome scores in patients with PFP following a course of hip abductor, extensor, and external rotator strengthening exercises[16,17,25,26] may suggest that this treatment also would be beneficial in those who have undergone ACLR.

Our research

A recent study by this author and colleagues compared the effects of hip strengthening versus no hip strengthening on early outcomes following ACLR.[27] Forty-three participants (21 women) volunteered for a study to assess the effect of adding hip strengthening to standard rehabilitation for 12 weeks after ACLR. Patients were randomly enrolled into either a group that performed traditional ACL rehabilitation plus the addition of isolated hip strengthening exercises (Hip group) or traditional ACL rehabilitation alone (NoHip group). The Hip group performed hip strengthening exercises two times per week during the first eight weeks of rehabilitation following ACLR, while those in the NoHip group were not allowed to perform any hip strengthening exercises during the first eight weeks. The hip strengthening exercises (Table 1) performed during this study have been shown to elicit a strength training stimulus in the gluteus medius and gluteus maximus muscles of a healthy population.[28-32]

Knee extension range of motion (ROM), pain, and Y Balance Test-Lower Quarter (YBT-LQ) performance were assessed at eight and 12 weeks postoperatively. While no significant differences were seen between groups at eight weeks for ROM, pain, or YBT-LQ, significant ($p = .008$) side-to-side limb differences (involved to uninvolved) in the YBT-LQ anterior reach were found between groups at 12 weeks.[27] Hip group participants demonstrated significantly smaller side-to-side limb differences in the YBT-LQ anterior reach (2.7 ± 2.9 cm) than those in the NoHip group (6.1 ± 4.6 cm). We attributed these between-group differences for single-limb activities to possible improvements in hip strength,[27] improvements in proximal neuromuscular control at the hip and trunk, or both.[31] (The study did not measure hip strength.)

Previously, the anterior reach of the YBT-LQ has demonstrated a higher normalized electromyography (EMG) signal in the gluteus medius than the posteromedial reach.[32] Likewise, the anterior reach is essentially a single-leg squat and therefore produces high EMG activation of the gluteus medius and maximus,[29,32] as well as earlier gluteus medius activity in those who produce a "good" squat.[34] This increase in gluteal activation during the single-leg squat is believed to minimize trunk collapse and valgus movement at the knee.[34]

Because knee valgus loading and compensations at the contralateral hip/trunk have been implicated in contributing to a second ACL injury,[35] a rehabilitation program that addresses altered hip and knee kinematics through the use of hip strengthening exercises appears to be important.[27] Additionally, our findings[27] suggest that hip strengthening exercises performed in the early stages of rehabilitation following ACLR may provide a platform on which to build in the later stages of the rehabilitation and return-to-sport processes.

Neuromuscular control

The data to support hip strengthening to improve patient outcomes following ACLR are unfortunately sparse. However, new evidence suggests that preoperative risk factors of decreased neuromuscular control and altered biomechanics in the lower extremity may still persist following primary ACLR.[35,36] Of 56 athletes who completed a biomechanical screening following primary ACLR, 13 suffered a subsequent ACL tear. Predictors of ACL injury in this group of individuals included altered neuromuscular control at the hip and knee during landing, as well as decreased single-limb postural stability.[35]

In another study, a group of 78 patients (mean age, 17.1 ± 3.1 years) who had undergone primary ACLR and had returned to sports were prospectively followed and compared with 47 controls with no history of ACL injury (mean age, 17.2 ± 2.6 years) for up to two years after returning to their respective sports. The overall incidence of a second ACL injury was approximately six times higher in the group with a previous ACLR than in the healthy group.[36] Some of the factors that could have potentially persisted in the group with

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Figure 1. If the goal is to minimize valgus movement of the knee during a squat, a resistance band can be placed around the knees and the patient can be instructed to maintain tension of the band during the squat.

a history of ACLR included increased knee valgus and altered hip kinematics during dynamic athletic activities,[1,3,37] which may be related to deficits in strength and neuromuscular control at the hip.[35] Similarly, a deficit in uninvolved net hip external rotation torque during the initial portion of landing has been shown to predict a second ACL injury with high specificity.[35]

These results suggest that interventions that focus on impairments in both strength and neuromuscular control at the hip could potentially decrease the risk of second ACL injury after ACLR. Therefore, treatment and rehabilitation programs following ACLR should involve exercises that incorporate the hip extensor and external rotator muscles to minimize knee loading in the frontal plane.[35]

In addition to implementing hip strengthening exercises as part of the post-ACLR rehabilitation program, it may also be beneficial to use neuromuscular training and feedback techniques. Even if patients have undergone a hip strengthening program and developed increased strength, they don't necessarily improve the functional use of that new strength. Gokeler et al have proposed incorporating feedback training that utilizes an external focus for optimization of training adaptations following ACLR.[38] Using an external focus training technique directs the patient's attention to the effects of the movement being performed or to the overall outcome of the movement rather than to the movement itself. For example, if the goal is to minimize valgus movement of the knee during a squat, a resistance band can be placed around the knees and the patient can be instructed to maintain tension of the band during the squat (Figure 1).

In a study of 28 healthy recreational athletes performing a landing task, a resistance band placed around the ankles effectively increased the internal hip abductor moment (hip abductor muscle

Figure 2. If frontal plane knee alignment during jump landing is the goal of training, pieces of tape can be placed on the floor and the patella (top image), and the patient instructed to keep the two sets of tape in alignment during the landing movement (bottom image).

force) and gluteus muscle EMG activity during prelanding and early landing.[39] These results support the idea that the application of a resistance band around the lower extremities may provide a training strategy for hip abductor strength and activation during dynamic activities.

Additionally, if frontal plane knee alignment during jump landing is the goal of training, pieces of tape may be placed on the floor and the patella, and the patient instructed to keep the two sets of tape in alignment during the landing movement (Figure 2). This type of training promotes motor learning and the effective use of automatic processing or unconscious control.[40] Likewise, the patient can learn to use the newly developed hip strength, which may help to improve function and decrease risk of reinjury to the knee.

In a related study, 12 female Division I soccer players completed a 10-week augmented feedback neuromuscular training program and demonstrated improved hip and knee mechanics (decreased knee valgus) during a stop-jump task, as well as increased isometric hip extension strength.[41] The results reinforce the importance of feedback in relation to quality and efficiency of movement as a means of both improving performance and preventing injury.

Conclusion

Although the data in the literature supporting hip strengthening following ACLR are limited at this time, emerging evidence suggests a protocol that includes isolated hip strengthening exercises during the early stages of postoperative rehabilitation can improve single-limb balance and neuromuscular control at the three-month mark.[27] These improvements demonstrated during a single-limb squat may provide a platform on which to build in the later stages of postoperative ACL rehabilitation and may predict future performance on functional hop tests at the time of return to sport.[42]

Similarly, once hip strength has been established following ACLR, feedback and technique training using an external focus[38] may be important for the functional implementation of the hip strength development during dynamic movement tasks that must be mastered prior to returning to sport.

The fact that altered hip and knee kinematics are among the potential biomechanical and neuromuscular risk factors for injury to the ACL[1,35,36] suggests that hip strength may play a role in the mechanism of injury and reinjury. Therefore, there is a need for continued research that examines the effects of hip strengthening following ACLR, particularly the potential benefits that may be seen at the time of return to sport. ler

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Elastic therapeutic tape: The search for evidence

Athletes swear by it, but quality studies on elastic therapeutic tape are hard to come by, and the literature is littered with conflicting or inconclusive findings about the technique's efficacy. That means practitioners in many cases have to rely on their own clinical experience.

By Cary Groner

Researchers, clinicians, and athletic trainers continue to disagree over the purported benefits of elastic therapeutic tape (ETT), sometimes known as kinesiology tape. Since its invention by Japanese chiropractor Kenzo Kase in the late 1970s, ETT has been touted, dismissed—and finally, more recently, studied.

Research results are all over the map, however, and few in the field seem to agree about what they signify. This hasn't stopped ETT from spreading wildly through the ranks of sports professionals, who are always looking for an edge. Volleyball player Kerri Walsh wore it at the 2008 Beijing Olympics, David Beckham has worn it on the soccer field, Serena Williams sported it at Wimbledon, and the list goes on.[1]

Extravagant claims about ETT's effects may partly explain athletes' eagerness to embrace it. The tape does have unique properties, including water resistance and skin adhesion that may last for up to five days.[2] But claims about physiological effects such as improved muscle function, pain control, and better circulation of the blood and lymph have proved difficult to substantiate.

Part of the problem is that it's challenging to devise a way to conduct blinded studies of ETT, given that study participants will always know there's something on their bodies.

"A lot of studies have not been of very good quality," said Ed Le Cara, DC, PhD, ATC, who practices sports medicine in Dallas and is the director of transglobal education for RockTape, a maker of ETT based in Campbell, CA. "For example, if I want to see whether kinesiology tape has a clinically significant effect on pain, I have to create some kind of sham, put something else on the control group. But even if I use a different type of tape, I'm still affecting the system. You may see no difference between the kinesiology taping and the sham taping, though there was an overall reduction in pain in both groups."

In fact, despite his commercial affiliation, even research Le Cara has conducted along with academic investigators has found that ETT may offer little advantage over other treatments for pain. In a

> Doing research on elastic therapeutic tape is complicated by the inability to blind participants to treatment and the challenge of controlling their activities outside the lab.

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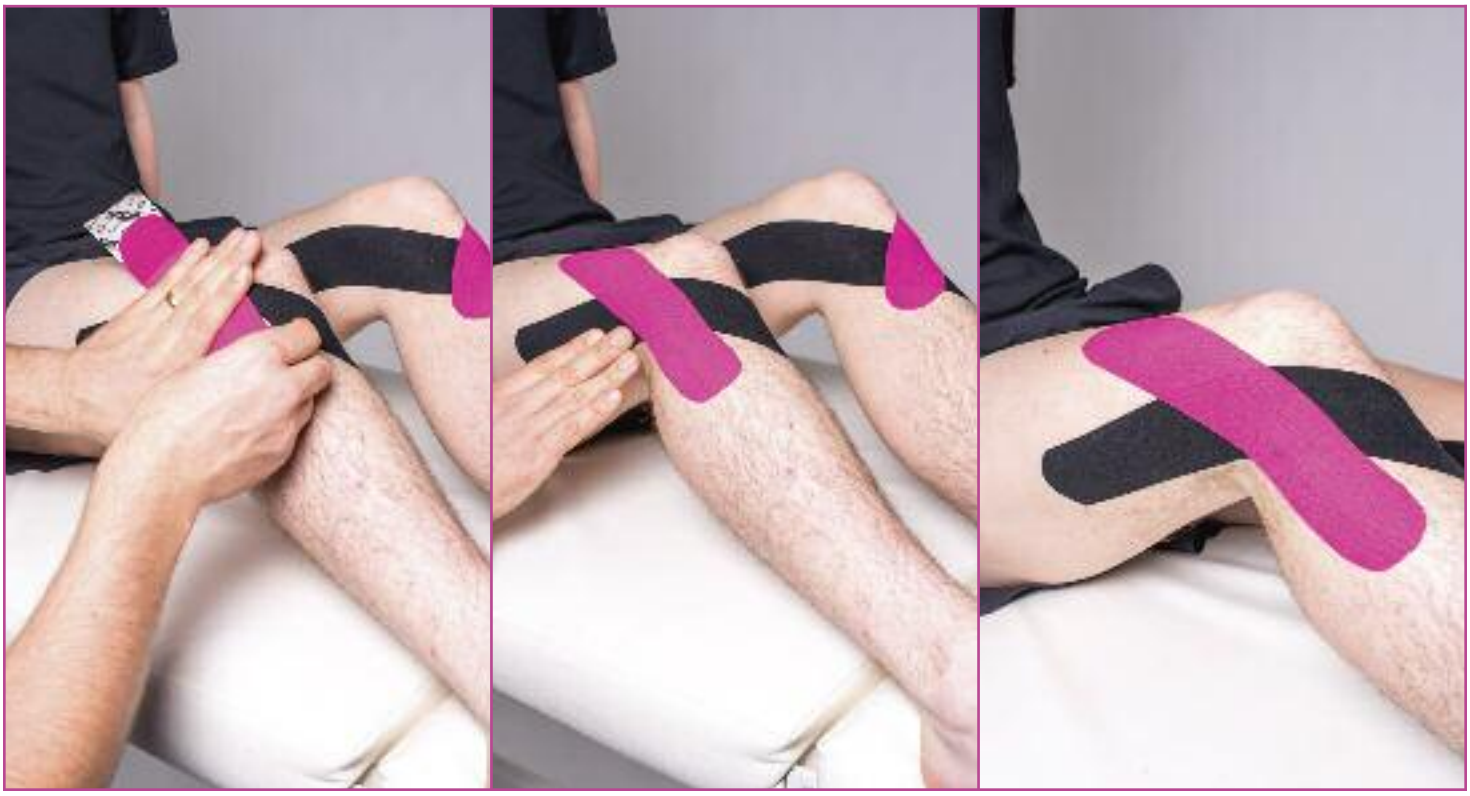

Elastic therapeutic taping application for distal iliotibial band syndrome. (Photos courtesy of RockTape UK.)

meta-analysis published last year,[3] he and his coauthors reported that ETT "may have limited potential to reduce pain in individuals with musculoskeletal injury; however…the reduction in pain may not be clinically meaningful." They went on to note that ETT did not reduce specific pain measures any better than other modalities, and suggested that ETT be used either instead of or in conjunction with more traditional therapies pending further research.

Le Cara's coauthor, Alicia Montalvo, PhD (ABD), ATC, an assistant professor in the athletic training program at Florida International University in Miami, agreed that there are methodological problems with existing research.

"It's not an appropriate placebo model to use a different type of tape or a different taping technique," she said. "There are too many factors influencing results, and you can't tell fact from fiction."

Montalvo admits that research into ETT is also complicated by the difficulty of controlling participants' activities outside of the lab. In one protocol she's used, people come in for baseline testing, then on day three have the tape applied and repeat the tests immediately. They then wear the tape for five days and return to the lab for final testing. The problem is that she can't control what happens between sessions.

"In a perfect world, I'd lock these people up in the lab and not let them do any physical activity," she joked. "But unfortunately, they go on with their lives—run marathons, lift weights, do whatever they do—and when they come back their knee pain is worse. Or on the other hand, maybe they sat on the couch watching movies all week, and they come back and they feel and perform great. It's just completely random, and the results are all over the place."

The research

A meta-analysis published in 2012 reported that there was little quality evidence to support the use of ETT over other forms of taping.[4] Another, from 2013, concluded that it was no more effective than sham taping or usual care.[5]

Individual studies sometimes shed a little more light in specific areas, despite the methodological difficulties already noted. Researchers tend to examine ETT's effects in three primary categories: pain, muscle strength and function, and proprioception. A sampling of recent studies helps explain why experts disagree about ETT's efficacy.

In terms of pain, a 2013 study compared ETT and McConnell taping (a method that doesn't use elastic tape) in 20 individuals with unilateral anterior knee pain and found both approaches effective for reducing pain during stair climbing activities, with no significant difference between them.[6] In a 2014 paper, researchers were unable to establish the clinical effectiveness of ETT for improving single-leg hop function in individuals with patellofemoral pain syndrome (PFPS).[7] By contrast, another 2014 study reported that, in patients with knee osteoarthritis, ETT improved quadriceps torque and performance in a stair-climbing task, and reduced knee pain.[8] More recently, a 2015 meta-analysis found that ETT was no better than more traditional treatments for pain and disability in individuals with chronic musculoskeletal pain.[9]

Studies of ETT's effects on muscle strength and function have been similarly equivocal. For example, a 2012 paper found that—though it didn't inhibit overall performance when used in basketball

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players with chronic inversion sprains—in certain tasks (eg, standing heel rise, vertical jump), ETT led to decreased performance, whereas in another (single-limb hurdle), performance improved.[10] A 2013 randomized crossover trial reported that ETT didn't improve jumping and balance performance in 20 healthy college athletes;[11] another paper that year found no performance improvement in 18 young elite soccer players;[12] yet another reported that ETT didn't alter quadriceps neuromuscular performance in healthy individuals.[13] By contrast, one study found that ETT was associated with a significant increase in gastrocnemius peak force immediately after application, and with a similar increase in hamstrings peak force two days later. (This delayed effect has been observed in other studies but isn't clearly understood.) A 2014 study offered similar glimmers of hope, reporting that ETT shortened the time to peak torque generation during isometric knee extension, though it had no effects on other aspects of muscle performance.[14] This year, though, the news got worse again: one 2015 paper reported no effect on jumping performance in healthy female athletes,[15] and another found that ETT didn't help individuals generate higher peak torque, earlier onset peak torque, or greater total muscle work.[16]

For proprioception, tidings have been a little better. For example, a 2014 study found that ETT had no overall effect on knee proprioception in 12 young women during a 30-minute uphill treadmill protocol, but did significantly enhance proprioception in those who demonstrated poor proprioceptive ability at baseline.[17] Similarly, in 30 healthy individuals, ETT decreased the rate of knee repositioning errors associated with quadriceps fatigue.[18] Finally, in a study of 28 participants, half of whom had functional ankle instability (FAI), ETT had no immediate effect but 72 hours after application those with FAI had proprioception equivalent to those with healthy ankles.[19]

Clinical experience

Clinicians may be forgiven for scratching their heads. The result, not surprisingly, is that they tend to trust their experience more than their reading of the literature.

"I'm skeptical that [placing] this tape on the skin could have direct mechanical effects on the subcutaneous tissues that are so free to move relative to the skin," said Michael Gross, PT, PhD, a professor of physical therapy at the University of North Carolina at Chapel Hill. "[Although] there may be some effect on the neuromuscular system as the tape tugs on the skin and supplies afferent input into the system."

Gross uses ETT in patients with kyphotic posture requiring correction; vertical strips on the back provide a gentle tug that reminds them to stand up straight.

According to Jonathan Chang, MD, a clinical associate professor of orthopedics at the University of Southern California in Los Angeles, the tape may offer some proprioceptive effects but few mechanical ones. That's not to dismiss its value, he added.

"Proprioceptive effects can make a big difference to athletes in sports where the difference between ranking number one and ranking number one hundred is razor thin," Chang said.

In regard to findings noted above, that injured or otherwise inhibited individuals seem to benefit more from ETT than healthy ones,[17] Chang speculated that it may be a matter of degree.

"Something like this may have more effect on someone who has a deficit because of injury or decreased ability, versus someone at the top of their game," he said. "My patients are injured, of course, and they find that using the tape can sometimes enhance recovery, allowing them to do certain things sooner or better than the usual timetable would suggest."

Chang noted further that proper training in how to use the tape is critical.

"If you have someone with residual weakness after surgery, the tape can help them not only in proprioception, but can aid in the efficiency of using muscles in rehabilitation. If you put the tape in the wrong place, you may inhibit that," he said.

Ed Le Cara agreed that mechanical effects may be limited.

"We think it's more neurological," he said. "Your body senses something there, which causes the brain to respond with awareness. That improves proprioception."

Le Cara believes that studies showing increased effects in tired individuals[18] may offer important insights into ETT's best uses.

"When you see effects in people who are fatigued, it's important to consider when injuries happen," he said. "In soccer, for example, people tend to get injured most near the end of the halves, when they're tired. So the idea is that if we use tape in someone who is eventually going to get fatigued—say, a triathlete, a soccer player, or a marathon runner—it may not help in the beginning of the event. But if it brings more awareness and neurosensory control later on, when those athletes are tired, maybe they'll be less likely to roll their ankles, because they're not allowing their joints to fall into improper positions. It's not conclusive; we need more research. But that's what it looks like."

This emphasis on proper positioning applies to efficiency as well as injury avoidance, Le Cara noted.

"When we use kinesiology tape with CrossFit athletes, it's not necessarily to make the muscle contract harder or use more force," he said. "You want to put them in a position that allows their joints and muscles to work ideally. It's a matter of asking the right question: What are we going to do for performance? You're not going to take a weightlifter from four hundred and fifty pounds to five hundred by using tape. But you can put him in a position so that his muscles are at increased advantage."

Le Cara told *LER* that he uses ETT in nine of 10 patients he sees. A typical case would be someone with plantar fasciitis, whom Le Cara would treat with a soft-tissue technique such as myofascial release, then apply tape.

"When we treat the tissue or the joint, it creates a physiological window of improved range of motion," he said. "Once I've mobilized the ankle, I want the brain to remember what it's like to have this improved range of motion, so it will accept that range as safe; otherwise it will start tightening up again. So I use the tape as an adjunct, not as a stand-alone treatment."

Le Cara said he's had particular success using ETT on the bottom of the foot, with calf strains, with Achilles tendinitis, and with mediotibial stress syndrome (MTTS, or shin splints).

"If I can make the brain more aware of the area by using tape, that may also help to get more muscle fibers to contract," he said. "Then, instead of all the force going along, say, ten fibers, maybe it's getting disseminated across twelve or fifteen, and hopefully healing can occur without overloading the system."

Le Cara doesn't discount the possibility of a placebo effect, but he also emphasizes that such an effect can be helpful in itself.

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"If they see the tape on their skin and it reminds them to do the things I've asked them to do, or to avoid certain things, then that's beneficial," he said.

"The placebo effect is real," agreed Alicia Montalvo. "The patient's expectations can mean the difference between a nonsignificant decrease in pain versus a significant decrease."

Montalvo thinks this type of placebo effect may partly explain why ETT seems to work better in injured or lower-functioning athletes.

"You don't expect to see pain reduction in someone who does not have pain," she said. "But you do expect to see it in someone who does. That reduction may come from somebody caring for them, touching them, or applying an intervention that they expect to help. It's also possible that we see benefits in people who are injured because the tape is actually doing something; we just don't know what it is."

Montalvo uses ETT on her husband and on her friends, and said they love it.

"It seems to provide enough feedback, enough stimulation, for them to not think about that pain," she said.

She's also using the tape in a way similar to that described above by Michael Gross, to cue patients when their bodies or joints are out of position.

"I'm experimenting with both verbal and tactile cuing for knee valgus, so when patients have that valgus collapse they feel the tape pulling and remember to get their knees out," Montalvo said.

Similarly, she said, those with patellofemoral pain frequently report that after a few days of wearing the tape they're more aware of the position of their knees.

Mechanical effects?

A few researchers have concluded that ETT's efficacy may lie more in its influence on mechanics, however.

According to Alan Needle, PhD, ATC, the tape can, in fact, have such effects—but surprisingly little impact on balance or proprioception. Needle is an assistant professor in the Department of Health and Exercise Science, and director of the Injury Neuromechanics Laboratory, at Appalachian State University in Boone, NC, where he and his colleagues have researched ETT's properties.

"We've looked at various measures in different studies," he said. "We've looked at ankle stiffness, dynamic and static balance, muscle activation, and plantar forces. When we look at proprioception and balance measures, we're really not seeing much effect."

For example, in a 2013 paper,[20] the researchers tested 30 healthy female volunteers for passive ankle laxity and stiffness, and time to stabilization after a multidirectional hop, before and after taping. They reported that ETT appears to improve static restraint in the ankle joint without altering peak motion or dynamic postural control. Another of their studies from that year did not support the use of ETT for improving postural control deficits in individuals with ankle instability.[21]

Studies of muscle activity and loading told a different story, however. In the former case, the researchers studied 22 healthy adults with no history of ankle injury and found that ETT decreased muscle activity in the ankle during a drop jump, even though no changes in ground reaction forces were observed.[22]

"It didn't change peak laxity, and it didn't change how far they moved; it just changed how the ankle absorbed forces," Needle said. "We decreased the amount of muscle activity needed to main-

tain the same biomechanics, and as far as I'm concerned that's mechanical support."

In another study, they found that the tape decreased the rate of medial loading in 200 MTTS patients.[23]

"We used a strip to support the tibialis posterior," he said. "The band goes down the inside of the shin, then passes anterior and posterior to the medial malleolus and goes under the arch of the foot. This provides extra support along the medial ankle to help slow pronation speed—and pronation causes MTTS. You've got the same amount of motion, but it slows you down."

Needle said runners might use the taping when increasing their mileage, for example, to prevent shin problems, particularly if they have a history of MTTS.

"I know there are studies[17,18] that show there is no effect on healthy people, while there is an effect on the injured," he added. "I think that reflects the fact that injured people have abnormal biomechanics, and we're correcting those."

Needle considers ETT a preventive tool at the ankle, as well.

"We can use the mechanical properties of the tape to get people in a more dorsiflexed and/or everted position so they're making ground contact in the right position," he said. "The idea is to position them correctly rather than stop motion."

Needle said he wears ETT when he runs for just this reason, and has found that he's much less likely to roll over his ankle as a result.

"It gives me that sensation, but it's not like I'm restricted and can't move my ankle," he said. "It just nudges me in the right direction to not injure myself. I wouldn't recommend this for a basketball player with a history of severe recurrent ankle sprains. But to give mild support to somebody who is generally stable, I think it's very useful."

When it was pointed out to Needle that what he described actually sounded more like a proprioceptive effect than a mechanical one, he paused.

"I shy away from calling it that based on the evidence, but I'll admit that it does feel like a proprioceptive effect," he acknowledged. "But if, by definition, proprioception is increasing the sensation from the ankle joint, the evidence isn't there that it's doing that. I'd argue that it's actually putting me in a more stable position, without the restriction associated with something like white tape. A mechanical effect is only applicable if you're crossing a joint, though. If the tape is just running along a single segment of the body such as the shin, we're probably not changing biomechanics, so any change we see is more likely proprioceptive."

Going forward

Further research will presumably continue to shed light on the ways in which ETT affects the body. In the meantime, as clinicians continue to refine their experience and techniques, one thing seems certain: As long as athletes perceive that the tape offers them an advantage, they'll be wearing those brightly colored stripes like a herd of neon zebras. ler

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Predicting recurrence after clubfoot treatment

In the search for factors that predict recurrence after use of the Ponseti method for successful treatment of idiopathic clubfoot, conclusive evidence is in short supply. However, the one factor that is consistently associated with the risk of recurrence is compliance with brace wear.

By Rachel Y. Goldstein, MD, MPH

Idiopathic clubfoot is a common congenital anomaly, affecting .5 to 2 infants per 1000 live births.[1,2] Throughout the 1970s and 1980s, the pervasive thought was that the rigid clubfoot deformity was not amenable to conservative treatment and that large posteromedial release was required.[3] Surgical treatment was bolstered by initially promising results.[4-10] However, it soon became apparent that extensive surgical releases resulted in stiff, painful, and arthritic feet that considerably impaired quality of life.[9-13] Additionally, these patients suffered from multiple postoperative complications, including skin necrosis, infection, deformity recurrence, pain, stiffness, overcorrection, and undercorrection.[9,10]

In 1963, Ponseti initially presented his technique for manipulation and serial casting in the *Journal of Bone and Joint Surgery*;[14] however, it did not generate much interest among orthopedists at that time. It was not until 1980, when Ponseti's group reported their long-term results with serial casting,[15] that some surgeons began to adopt his technique. This trend was bolstered by the unsatisfactory long-term results associated with surgically treated clubfeet being reported around the same time.[9-12] Later, the establishment of support group websites by parents of children with clubfeet treated by Ponseti furthered the popularity of this treatment method.[16]

In a 2003 survey of Pediatric Orthopaedic Society of North America (POSNA) members, 99% of respondents indicated they initially treat clubfoot with serial cast applications, and 65% use the Ponseti technique.[17] In the US between 1996 and 2006, the rate of extensive surgery to treat idiopathic clubfoot in patients younger than 12 months decreased substantially, from just over 70% in 1996 to just over 10% in 2006.[2]

While initial correction rates with the Ponseti method are greater than 90%,[18-23] researchers have reported recurrence rates of nearly 30%.[20,24,25] Predicting which patients are likely to experience recurrence, and will therefore require more diligent follow-up, is an important area of focus in the treatment of idiopathic clubfoot.

While initial clubfoot correction rates with the Ponseti treatment method are greater than 90%, researchers also have reported recurrence rates of nearly 30%.

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Ponseti technique

Ponseti postulated that other conservative techniques fail because attempts to correct the severe supination of the typical clubfoot by forcefully pronating the forefoot causes an increase in the cavus posture and a break in the midfoot.[26] This also leads to jamming of the anterior tuberosity of the adducted calcaneus against the undersurface of the head of the talus.[26]

Ponseti's technique differs from the previous conservative treatment methods in that the completely supinated foot is abducted under the talus.[16,26-29] The talus is secured against rotation in the ankle mortise by applying counter pressure with the thumb against the lateral aspect of the head of the talus. This manipulates the foot without holding the hindfoot fixed, allowing the calcaneus to rotate in relation to the talus.


Photo courtesy of MD Orthopaedics.

Serial casting to correct clubfoot deformity begins as soon after birth as possible. The technique involves a choreographed series of manipulations maintained with a long leg plaster cast.[16,27,30] The initial step involves correction of the cavus through elevation of the first ray of the forefoot and supination of the forefoot to recreate a normal appearing arch. Subsequent casts gradually abduct the foot underneath the stabilized talar head. After at least 60° of abduction, the equinus is corrected. If at least 15° of dorsiflexion cannot be achieved with manipulation, a percutaneous heel cord tenotomy is performed.

Once the final correction is obtained, it is maintained with a cast for three weeks. The foot is then held with a foot abduction orthosis (FAO). The FAO is usually worn 23 hours per day for the first three months, followed by nighttime and naptime wear for three to four years,[20,27] though some investigators have found it is difficult to get a child to wear the brace after three years.[18] Also, to date, no studies have determined how long the FAO actually needs to be worn.

Outcomes

Initial correction rates of idiopathic clubfoot with the Ponseti technique have been reported to be between 90% and 100%.[18-23] The Ponseti technique provides excellent early results and may limit the necessity of extensive surgical procedures in young children.[31]

At two years after initiating the FAO, one midterm analysis found that clubfoot correction was well maintained: 86% of patients required no further treatment, 13% required recasting, and only 1% of patients required extensive surgery.[18] In a randomized study of idiopathic clubfeet comparing the Ponseti technique with extensive clubfoot releases, Zwick and colleagues found that at three years the mean score for the Functional Rating System of Laaveg and Ponseti was higher in the Ponseti group.[32] They also found that passive dorsiflexion and passive inversion-eversion were greater in the Ponseti group. PODCI (Pediatric Outcomes Data Collection Instrument) scores and radiographic outcome measures were similar for the two groups.

In a long-term study of patients treated with the Ponseti technique, 74% demonstrated good to excellent results at 30-year follow-up.[15] In addition, more than half of the feet followed long term did not require any further treatment beyond additional casting and percutaneous Achilles tendon lengthening.[15] A different study noted good to excellent results at 25-year follow-up in 78% of patients.[33]

Predicting clubfoot recurrence

As mentioned earlier, while initial correction rates are greater than 90%,[18-23] authors have also reported recurrence rates of nearly 30%.[20,24,25] Ponseti considered recurrence of the deformity as part of the initial pathology, rather than a sign of undercorrection. He recommended recasting, repeat Achilles tendon lengthening, and, if there was marked supination, tibialis anterior tendon transfer.[14] Multiple studies[13,20,23,25,34-37] have attempted to determine which clubfeet will respond to manipulation and casting and which will not.[18] Numerous potential risk factors for clubfoot recurrence have been studied.

Atypical deformity. In 2005, Morcuende and colleagues described a new subset of clubfoot they termed the "atypical clubfoot."[34] These feet are characterized by a volar crease, a small bean-shaped foot, a shortened big toe, and a stiff foot. The group reported that these atypical clubfeet may be more resistant to manipulation and therefore at increased risk of failing conservative treatment.

In 1987, Bensahel and colleagues reported their results for a single stage posteromedial release in patients with clubfoot resistant to aggressive physical therapy.[35] They categorized the feet into idiopathic, neurologic, and "malformative," which they defined as clubfeet associated with other congenital deformities, such as arthrogryposis. The results varied with etiology, and the researchers reported that idiopathic feet had a "good" outcome 88% of the time but the malformative feet had a "good" outcome only 25% of the time.

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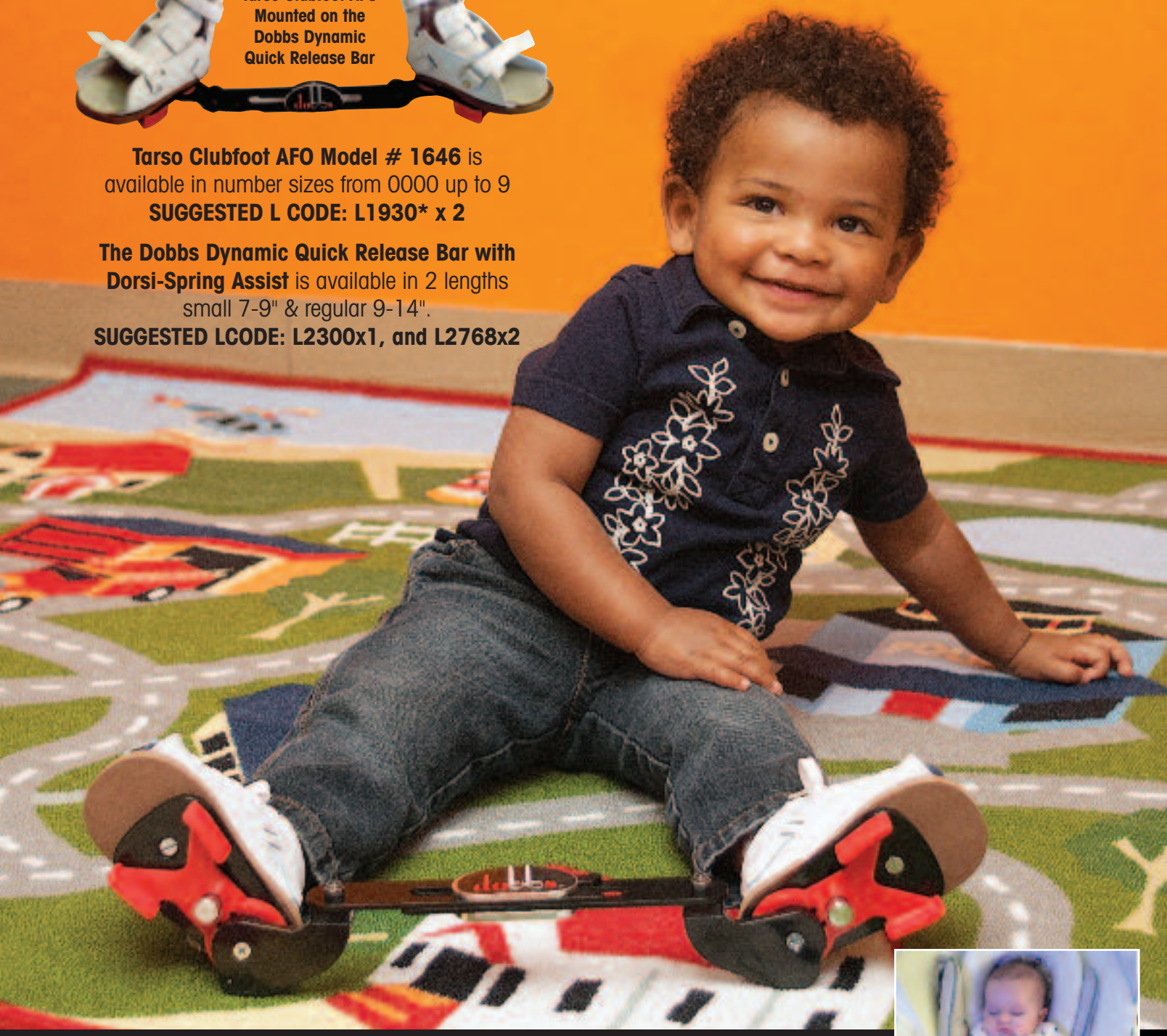

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Several demographic characteristics, including sex, race and ethnicity, and age at initial visit, also have been postulated to contribute to the risk of recurrence.

Sex. Most studies report a higher prevalence of idiopathic clubfoot deformity in male patients, with male-to-female ratios ranging between 2.5:1 and 6:1.1.[1,38,39] And, in a study of nonidiopathic clubfoot, the predilection for male patients was also found across a diverse array of neuromuscular and genetic causes of clubfoot.[40] Kruse et al suggested that, given the higher prevalence of clubfoot in male patients, female patients may require a greater number of genes, or more potent genes, to inherit clubfoot.[41] They found that affected female patients were 5.5 times more likely than male patients to transmit idiopathic clubfoot to their children and suggested this finding indicates the less commonly affected sex carries a higher genetic load.[41]

Several studies have reported no significant relationship between sex and risk of clubfoot recurrence.[23,25] However, in a 2014 study, Goldstein and colleagues found in a logistic regression analysis that female patients were 5.3 times more likely than male patients to need surgery for clubfoot recuurence.[36]

Race/ethnicity. There is clear variability in the prevalence of idiopathic clubfoot with respect to race/ethnicity. The prevalence of clubfoot in whites is 1 to 2 per 1000 live births, but there is a lower prevalence in Chinese of .39 per 1000 live births, and a higher prevalence in Pacific Islanders of 6.5 to 7 per 1000 live births.[38] However, Dobbs and colleagues, looking at whites versus nonwhites, found no relationship between race and risk of recurrence.[25] And, in a 2006 study of clubfoot patients in New Zealand, Haft found the high recurrence rate of 41% found in their study could

not be attributed to the high proportion of clubfeet seen in patients of Polynesian descent.[42]

Age at initial visit. Although Ponseti recommended that manipulation be started as soon as possible after birth,[27,30] various recommendations have been made regarding the upper limit of age at treatment initiation. Several authors have reported the Ponseti technique can be effective in treatment of idiopathic clubfoot in patients aged up to 9 years.[43-45] And Morcuende et al reported no increased difficulty in obtaining correction of the deformity with the use of the Ponseti technique in children aged up to 2 years.[20]

Despite these reports, there is some controversy over whether older age at initiation of treatment is associated with an increased risk of deformity recurrence. Lehman and colleagues reported that patients whose treatments were initiated when they were older than 7 months appeared to have an increased probability of poor results.[31] Abdelgawad similarly described that initiating treatment in infants older than 6 months was associated with a higher rate of early failure.[18] However, multiple authors have described no significant association between age at initial visit and risk of recurrence.[20,23,25,36,46]

In a 2009 study, Alves and colleagues looked at 102 clubfeet and compared those beginning Ponseti treatment when older than 6 months with those younger than 6 months.[46] They found no significant difference between the groups in the number of casts needed to achieve the initial correction, the rate of relapse, the need for posteromedial release, and the need for tibialis anterior tendon transfer during the follow-up period. In both groups, correction was achieved in all patients using the Ponseti method.

Previous treatment. Multiple studies have reported that idiopathic clubfoot deformities previously treated with nonoperative interventions respond well to Ponseti manipulation and casting.[20,43,46] Similarly, no association has been found between previous nonoperative treatment and risk of recurrence after Ponseti treatment.[25,36,47]

Parental factors. A 2004 study by Dobbs et al examining risk factors for recurrence found that parental education at the high school level or below carried a tenfold increased risk of clubfoot recurrence after Ponseti treatment.[25] However, they found no significant relationship between parental marital status or parental income and risk of relapse.[25] Similarly, researchers haven't found an association between the source of medical insurance and the risk of relapse.[25,36]

Initial classification. Numerous classification systems have been proposed to predict treatment course and outcomes of clubfoot deformity. Two of the more commonly used classification systems include the Catterall/Pirani system[48,49] and the Dimeglio/Bensahel system.[50,51] Both systems identify key components of the deformity and assign a numerical score, and in both systems a higher score indicates more severe deformity. Both classification systems demonstrate excellent interobserver reliability after a short learning curve.[52]

Catterall's system initially identified a group of feet in which a "limited posterior release" performed early was sufficient for complete correction of an idiopathic clubfoot, and the authors explained that "assessment of the fixed deformity may define indications for limited and radical releases."[48]

Modifications by Pirani altered the classification system. In the system of Catterall/Pirani, the components of posterior crease,

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empty heel, rigid equinus, curvature of the lateral border, medial crease, and reducibility of the lateral head of the talus are each scored 0, .5, or 1. The first three components are summed to calculate a hindfoot contracture score and the other three components comprise the midfoot contracture score. Later studies found that the Catterall/Pirani score could be used to estimate the number of weekly casts required,[53] and that the hindfoot score could be used to predict the need for tenotomy.[53,54]

Dimeglio described his classification system as allowing a better understanding of the type of feet that require extensive posteromedial release, conventional posteromedial release, or limited posterior release.[51] He reported that the classification allows one to predict the impact of functional treatment, follow its progress, and establish the most beneficial surgical treatment.[51] In the Dimeglio/Bensahel scoring system, the components of dorsiflexion, hindfoot varus, midfoot rotation, and forefoot adduction are scored from 0 to 4. The components of posterior crease, medial crease, cavus, and abnormal underlying musculature are scored as present (1) or absent (0). In a comparison of the classification systems of Ponseti and Smoley, Harrold and Walker, and Catterall and Dimeglio, the Dimelgio system had the greatest reliability in clubfoot categorization.[55]

Multiple studies have attempted to utilize these scoring systems to predict outcomes and risk of recurrence.[20,25,36,37,47,53,54] Most of these studies have found the initial severity classification is not related to treatment success, which may be because different feet respond differently to manipulation.[20,30] Additionally, these studies have found that no correlation between initial severity and the number of casts needed for correction[37] or the need for surgical intervention.[47]

Number of casts. Several authors have attempted to link the number of casts required for correction with the risk of recurrence after successful Ponseti treatment.[20,25,37,42,47,54] While Dobbs found the more severe the initial deformity, the greater the number of casts required for correction,[25] Morcuende reported the number of casts required for full correction was not a long-term prognostic factor for recurrence after treatment.[20] However, other authors have found a significant difference in the number of casts required for those who eventually required a surgical intervention for clubfoot recurrence compared with those who did not.[36,42,47]

Brace wear. The one factor the literature consistently and inarguably demonstrates is associated with the risk of recurrence after successful treatment of idiopathic clubfoot is compliance with the FAO.[18,20,23-25,36,42,46,47] In a study of risk factors for recurrence, Morcuende and colleagues found that noncompliance with the FAO was associated with a 17 times greater odds of relapse and that FAO noncompliance was the only studied parameter independently associated with recurrence.[20] In patients who had completed serial casting, Dobbs found a 31% relapse rate when they were aged 6 months, and determined all of them had been noncompliant with the FAO.[25] The risk of recurrence in FAO-noncompliant patients has been reported to be anywhere from six to 183 times that of FAO-compliant patients.[20,25,36]

Several authors have pointed out that FAO noncompliance may actually be brace intolerance.[25,42] Parents not using the FAO in the prescribed manner may reflect a gradual inability to comfortably brace the foot as clubfoot recurrence is taking place. Despite this, currently available clubfoot scoring systems have failed to demonstrate a link between increased severity scores at initiation of FAO use and brace noncompliance.[36,42] In studies of FAO compliance, parental education at a high school level or below was the only risk factor associated with FAO noncompliance.[25] No significant relationships were noted between FAO noncompliance and source of medical insurance, parental income, parental marital status, family history, or ethnicity.[25,42,56]

Conclusion

While introduction of the Ponseti method has substantially reduced the number of surgical interventions required for treatment of idiopathic clubfoot, recurrence after successful treatment remains an issue. Numerous studies have explored factors that contribute to recurrence.

Ideally, factors that could identify patients at increased risk for recurrence at presentation would be beneficial in counseling parents about the expected course of treatment. However, at this time, FAO noncompliance or intolerance is the only reliable indicator of increased risk for recurrence. Parents need to be counseled about the importance of continuing with prescribed brace wear.

Rachel Y. Goldstein, MD, MPH, is an assistant professor of pediatric orthopaedics at Children's Hospital Los Angeles in California.

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[1]Guideline for the Prevention of Falls in Older Persons
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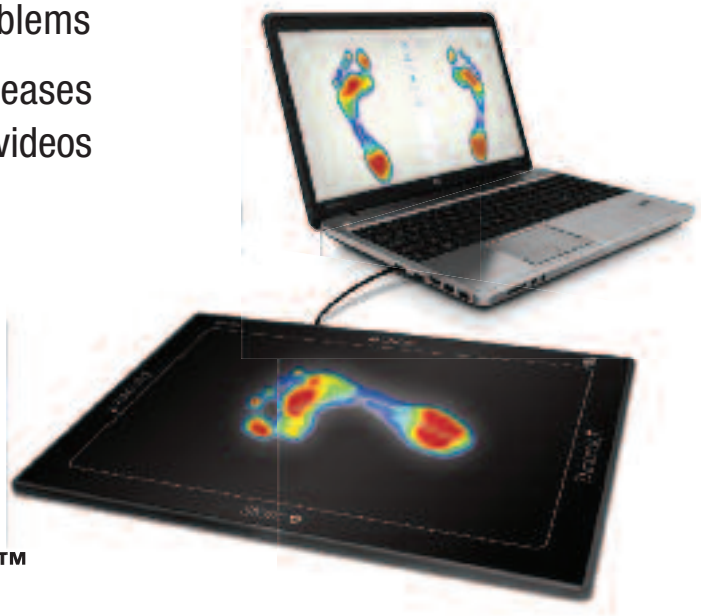

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Low back pain and risk of lower extremity injury

Low back pain is associated with kinematic and kinetic alterations that can increase the risk of lower extremity injury, particularly in the presence of fatigue. New research suggests neuromuscular training programs can be designed to help reduce injury risk in patients with low back pain.

By Ram Haddas, PhD

Lower extremity injuries and low back pain (LBP) pervade everyday life. Injuries are often associated with physical, emotional, and economic costs, including loss of work time, and quality of life.[1] Hamstring muscle strains, anterior cruciate ligament (ACL) injury, and ankle sprain are the most common sports injuries.[2,3] Low back pain can also significantly influence an individual's quality of life; estimates of the incidence of LBP in athletes vary depending on the sport, but range from 10% up to 80%.[4] Despite apparent advances in the diagnosis and management of LBP, this disorder is a large burden on individuals and society.[5] Additionally, LBP can alter functional ability and increase the risk of lower extremity injury.[6-8]

Failure of the abdominal and lumbar musculature to provide adequate support to the lumbar spine during loaded positions and movements is considered a contributing factor to the persistence of LBP and dysfunction.[8-10] Individuals with LBP demonstrate impaired postural control, delayed muscle reflex latencies, and abnormalities in trunk muscle recruitment patterns.[7-12]

Low back pain and injury risk

Trunk muscle function is altered in LBP sufferers.[7-8] As a result, these individuals may not be able to produce sufficient pelvic stability to provide a stable base for lower extremity motion and control. Proximal alterations in the operation of this kinetic chain linkage may increase injury risk at more distal regions. This relationship between LBP and altered lower extremity movement control has been observed in several studies.[6,8-10]

Zazulak et al,[6] for example, found that a history of LBP, along with trunk displacements and proprioception, were significant predictors of overall knee injury in female athletes and knee ligament injury in male athletes. Individuals with LBP demonstrated impaired postural control, delayed muscle reflex latencies, and abnormalities in trunk muscle recruitment patterns. Additionally, decreased neuromuscular control of the spine appears to influence dynamic stabilization of the knee joint and increase lower extremity injury risk.

> Modifications to equipment, training, or preparation may be warranted for women with low back pain, and for both genders under fatigued conditions.

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Low back pain was a significant predictor of knee injury and impaired lower extremity control. Patients with low back pain have diminished lower extremity strength, flexibility, and range of motion,[9] as well as altered lower extremity biomechanics and neuromuscular control.[11] These changes may increase lower extremity injury risk.

Prospective clinical studies have linked LBP history with lower extremity injuries, and a history of lower extremity injury with LBP. Zazulak and colleagues[6] found that a history of low back pain was a significant predictor of knee injury in both female athletes and knee ligament injury in male athletes. Nadler and colleagues[12] observed that athletes with a history of lower extremity overuse or ligamentous injury were significantly more likely to be treated for LBP during the following year.

Fatigue is also a major risk for injury that alters muscle shock-absorbing capacity and coordination of the locomotor system, observed by decreased lower extremity muscular maximum voluntary contraction strength, ground reaction force (GRF), and initial impulse and increased quadriceps latency stretch reflex activity and knee flexion at contact.[13] Fatigue can affect neuromuscular input pathways, commonly observed as proprioceptive alterations,[14] as well as neuromuscular output pathways, as evidenced through a delay in muscle response. Fatigue may reduce maximum voluntary muscle force and work capacity, altered movement control, and delayed muscle reaction time during the performance of dynamic maneuvers.[15] Muscle fatigue has been linked to a variety of lower extremity injuries.[16]

Our research

Three studies[8,10,17] conducted by the author and colleagues in the past year at Texas Tech University Health Sciences Center in Lubbock examined the effect of fatigue on biomechanics in individuals with LBP and how those effects are modified by core muscle activation, gender, and movement task.

The purpose of the first study[10] was to test the hypothesis that core muscle activation would modulate the effects of lower extremity fatigue on lower extremity and trunk mechanics, as well as neuromuscular control during landing, in people with and without recurrent LBP. Thirty-three healthy individuals (age = 20.94 ± 2.27 years, height = 1.69 ± 9.62 m, mass = 71.18 ± 14.50 kg) and 32 with LBP (age = 21.16 ± 2.77 years, height = 1.69 ± 13.02 m, mass = 74.47 ± 14.22 kg) performed a series of 12 double-leg landing trials. They did six trials with and without core muscle activation activity (three each) in random order. The fatigue protocol included dynamic squatting in a squat machine with 15% of body weight until task failure, defined as altered squat performance (ie, increased forward trunk lean or altered forward knee position relative to the ankle) or inability or unwillingness to continue. After the fatigue protocol, participants performed another series of six landing trials, three each with and without core muscle activation, in a random order.

This study's findings demonstrated that core muscle activation and fatigue were associated with altered landing mechanics in healthy and LBP groups and that there were differences between groups. Semitendinosus onset exhibited a significant three-way interaction between groups, core muscle activation, and fatigue conditions.

The results of this study suggest core muscle activation appears to create a protective advantage for the knee and lumbar spine.

Figure 1. Motion analysis animation shows the airborne phase of landing.

Earlier semitendinosus activation, which occurred during the core muscle activation conditions for the .30-m drop vertical jump landing, could potentially help to prevent injury if a perturbation is encountered during a landing task.[18] In addition, these changes suggest that core muscle activation prior to initial ground contact may enable the neuromuscular system to better prepare for encountering stresses imposed by the landing sequence. Core muscle activation was also associated with significantly decreased lumbar kinematic angles, suggesting that core muscle activation helps sustain the natural lumbar curve in both groups during the landing task.

In summary, this study's results provide evidence that a core muscle activation strategy performed during a fatigued landing sequence decreases exposure to biomechanical factors (ie, spinal instability, latency in muscle recruitment) that can contribute to lower extremity injury, particularly ACL injury. This apparent protective response was observed when both healthy individuals and those with LBP land from a .30-m height. Incorporating core muscle activation during dynamic stressful activities, with and without the presence of fatigue, appears to improve sensorimotor control and facilitate positioning of the lower extremity, while also protecting the lumbar spine. Clinicians can use this information when designing neuromuscular control training programs for people who have recurrent LBP to improve lower extremity control, spine stability, and response to a fatiguing activity, thus potentially decreasing injury risk.

The role of gender

The purpose of the second study[8] was to determine the effects of lower extremity fatigue and gender on knee mechanics, neuromuscular control, and GRF during landing in people with recurrent LBP. It used the same landing and fatigue protocols as the previous study[10] and included 15 women (age = 20.60 ± 1.85 years, height = 1.62 ± .14 m, mass = 65.47 ± 12.41 kg) and 17 men (age = 21.65 ± 2.30 years, height = 1.75 ± .80 m, mass = 82.42 ± 10.48 kg).

The study found the biomechanical responses were generally similar to those reported in previous landing studies of populations without LBP.[19-20] When performing .30-m landings, women with recurrent LBP landed differently than their male counterparts. Women tended to have a greater knee flexion angle at initial contact but no

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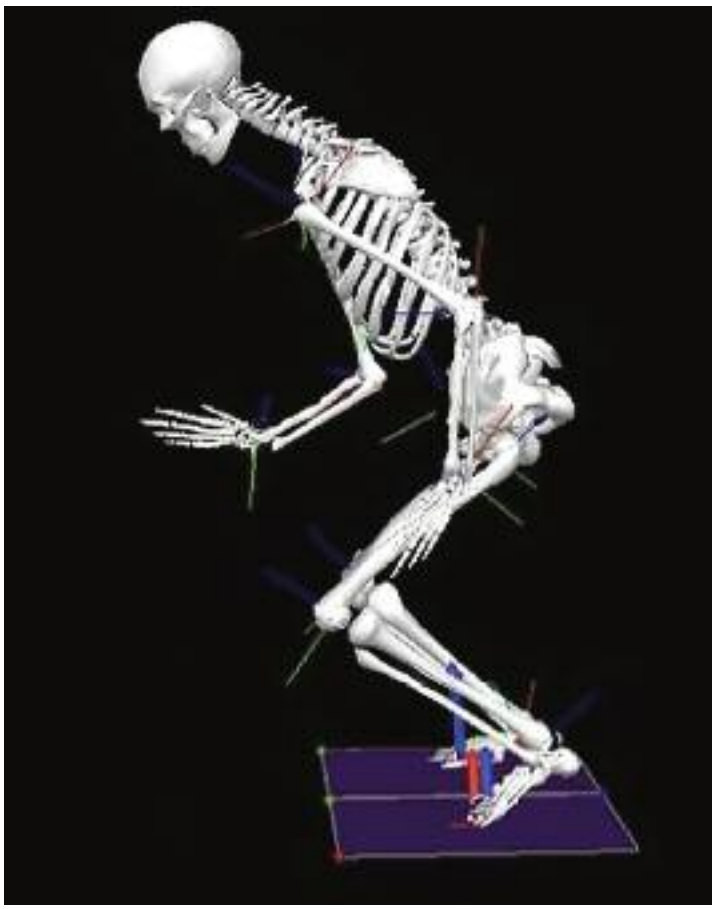

Figure 2. Motion analysis animation shows the end of the eccentric phase of landing.

difference in maximum knee flexion angle compared with men, which indicates less knee flexion range of motion than men during the eccentric landing phase. However, GRF impact was lower in women than in men, and maximum GRF was not different between genders; therefore, it is unlikely that the reduced knee flexion in women resulted in an overall stiffening of the lower extremity. Instead, the women may have utilized a landing strategy that relied on joints other than the knee to absorb landing energy. Additionally, women with recurrent LBP tended to have a greater maximum knee internal rotation angle during the landing phase compared with men, a finding that agrees with published studies that have examined landing in women without LBP.[19-20] Excessive knee internal rotation has been associated with increased ACL injury risk.[21]

Women with recurrent LBP exhibited a greater maximum knee flexion moment than men, who had an extension moment. This might be explained by previous research showing that women land with a more erect trunk posture than men,[22] although trunk position was not examined in our investigation. Women with recurrent LBP tended to have smaller knee adduction and ankle inversion moments than men with recurrent LBP, which could indicate different hip-knee-ankle alignments and an increased risk of ACL injury.[23]

In addition to impaired postural control, delayed muscle reflex latencies, and abnormalities in trunk muscle recruitment patterns, decreased neuromuscular control of the spine appears to influence dynamic stabilization of the knee joint and increase lower extremity injury risk, a finding observed mainly in women.

The third study[17] was designed to determine the effects of lower

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extremity fatigue and gender on knee and trunk mechanics, GRFs, and knee moments during unexpected landing and cutting in people with recurrent LBP. It included 16 women (age = 20.87 ± 2.61 years, height = 1.70 ± .05 m, mass = 64.31 ± 9.89 kg) and 16 men (age = 22.31 ± 1.89 years, height = 1.81 ± .09 m, mass = 82.57 ± 9.08 kg). The fatigue protocol was the same as in the two previous studies, but the landing protocol differed slightly. The landing trial was started when the participant stepped forward with the right foot and dropped down from a box, landing with each foot on a separate force platform simultaneously, and then immediately either performing a maximum vertical jump or cutting 45° to the left, pushing with the right leg. An electronic board was used to instruct participants to either cut or jump when landing. A pressure sensor on the .30-m box allowed the directional command to be relayed only once the participant was airborne, providing an element of surprise.

The study results showed fatigue altered landing mechanics, with differences between genders for landing and cutting performance. When landing before a jump, women had smaller maximum knee flexion angles, greater knee adduction angles at maximum knee flexion, greater knee external rotation angles at maximum knee flexion and at initial contact, greater trunk flexion angles at maximum knee flexion, and smaller maximum knee flexion moments. Furthermore, during the cutting task, women had greater knee adduction angles at maximum knee flexion, greater knee external rotation angles at maximum knee flexion and at initial contact, greater trunk flexion angles at maximum knee flexion, and smaller trunk side flexion angles at maximum knee flexion. Fatigue resulted in smaller trunk flexion angles at initial contact for the jumping task, and greater trunk extension and trunk side flexion angle at maximum knee flexion, smaller maximum vertical GRF on the right leg, and maximum knee adduction moment when cutting 45° to the left.

The results of the last two studies provide evidence for gender and fatigue differences in landing and cutting mechanics and neuromuscular control in individuals with LBP. The majority of the gender- and fatigue-related differences are consistent with results from similar studies of individuals without a history of LBP.[6-11] Fatigue is associated with altered landing and cutting mechanics, changes that are consistent with an increased risk of ACL injury. Women who suffer from recurrent LBP also demonstrate biomechanics during landing from a .30-m height and 45° cutting that may result in a higher risk of ACL injury than in men with recurrent LBP.

Conclusion

Accurate identification of potentially risky movement behaviors is important for appropriate conditioning, treatment, and rehabilitation. Our results should be considered and may serve as a guide for modifications to equipment, training, or preparation practices for women with recurrent LBP, and for both genders during fatigued landing events. In particular, clinicians can use this information when designing neuromuscular control training programs for female athletes with recurrent LBP to potentially reduce the incidence of biomechanical factors associated with lower extremity injury risk. ler

Ram Haddas, PhD, is director of research at Texas Back Institute Research Foundation in Plano.

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866/273-2230 cc-mfg.com

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855/692-9444 cyberkinetics.us.com

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800/999-8866 darcointernational.com

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877/728-3450 drcomfort.com

Delcam 43
877/335-2261 orthotics-cadcam.com

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800/765-9636 polymem.com

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800/544-2723 hapad.com

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800/779-3668 footmaxx.com

JMMR 48
800/236-5166 blountsdisease.net

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823/962-6300 kineticr.com

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800/564-LEVY (5389) levyandrappel.com

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Retro-Style Summer Sandals

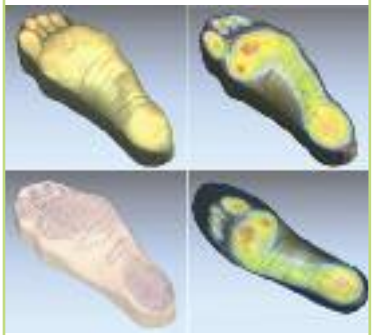
Arcopedico USA is introducing Retro-Style Summer Sandals for 2015. Ellie is a 60s-inspired peep-toe design featuring a metallic leather upper and an adjustable Velcro ankle-strap closure for a secure fit. Modern updates include an ultra-lightweight 2" thermal rubber wedge sole for a durable, antislip step. Stella is the newest addition to Arcopedico's cork sole collection. This casual sandal features double-broad straps with an adjustable Velcro closure, a 1¾" cork-contoured wedge with rubber grip soles, and suede lining. The sandals feature soft, lightweight, and flexible Montana leather in five colors.

Arcopedico USA
775/322-0492
arcopedicousa.com

Ottobock 6Y87 Skeo 3D TF Liner

Ottobock announces the newest member of the Skeo liner family, the 6Y87 Skeo 3D TF for transfemoral amputees. Skeo 3D liners feature ASG (Anatomy Specific Geometry) technology, which reflects the complexity of the lower leg anatomy and optimizes the liner's medical and functional purpose, including protection, flexible movement, superior skin comfort, time savings, and sense of security. The new liner has a conical distal shape and cylindrical proximal shape for improved fit. The textured inner surface helps to channel moisture away from the skin, and the full-length zero-stretch matrix reduces pistoning.

Ottobock
800/328-4058
ottobockus.com



OrthoModel Software Updates

Delcam announces the 2014 R3 version of its OrthoModel software for the design of custom orthotic insoles. The software includes an updated user interface and the ability to display multiple 2D images and a 3D model simultaneously. A new page to capture, import, and present multiple images, plus extra display utilities on the alignment and design pages, improve the user experience and enable quick, accurate orthotic design decisions. The system now also allows users who purchase a Delcam iQube scanner to send orders that contain either scan data or the finished design to a range of on-line labs.

Delcam
877/DELCAM1 (335-2261)
lz.orthotics-cadcam.com

Dr. Comfort Exos Inserts

Dr. Comfort has expanded its custom functional insert line to include Exos advanced technology—a thermoformable material that allows practitioners to make adjustments quickly and easily in their own offices. Exos bondable material is thin, strong, easy to grind, and has a low thermosetting temperature that allows for adjustments to be made efficiently. The inserts come with an Exothermix heat patch that allows the practitioner to apply heat to the specific part in need of adjustment, at a temperature much lower than a heat gun. Most inserts are delivered less than one week from the time an order is placed.

Dr. Comfort
800/556-5572
drcomfort.com

roducts

AlterG Bionic Leg

AlterG offers the AlterG Bionic Leg, a robotic assistive device that is activated by patient-initiated movement, with benefits for both the therapist and patient. The Bionic Leg is designed to enhance the rehab process in patients with neurological and orthopedic gait disorders, including those recovering from stroke, orthopedic injury or surgery, incomplete spinal cord injury, or traumatic brain injury, as well as patients with multiple sclerosis or general lower extremity weakness. The Bionic Leg is designed to provide stability and assistance during gait training and to help improve patient mobility and strength.

AlterG
510/270-5900
alterg.com

pedCAT X-ray Views

An update for the CurveBeam pedCAT weight-bearing CT (computed tomography) imaging system introduces a feature that could eliminate the need for plain radiographs of the foot and ankle. The pedCAT now automatically generates all standard x-ray views of the foot and ankle, in addition to full 3D volume and multiplanar slices. This means a practitioner can capture any x-ray series in a single scan. Because the x-ray views are computed from the pedCAT 3D data, they are anatomically accurate. pedCAT scans are ultra-low dose, with the same radiation exposure in one scan as in three to seven plain film images.

CurveBeam
866/400-0035
curvebeam.com

3D Flat Premium Compression

Pro-Tec Athletics has introduced its 3D Flat Premium Compression collection of supports for the ankle, knee, and calf. The 3D flat stitching facilitates 3D shaping of the fabric, which allows for full range of motion while maintaining a high level of support. The knee support is recommended for of tendinitis, patellar pain/tracking, arthritis, minor soft tissue tears/strains, and general knee pain. The calf support is recommended for minor to moderate calf tightness and strains. The ankle support is recommended for minor to moderate ankle sprains and strains. All three products are available in four sizes (S, M, L, XL).

Pro-Tec Athletics
800/779-3372
pro-tecathletics.com

Aircast Bunion Aid

New from Aircast, a DJO Global company, is the Bunion Aid. The product is a three-in-one aid that provides the benefits of a daytime device and a night splint for bunion pain relief, bunion protection, and bunion correction. Bunion Aid is a hinged splint with adjustable straps and a comfortable gel cushion that is designed to protect irritated tissue, distribute pressure, and provide corrective support. It can be used to manage bunion pain and mild or moderate malpositioning of the big toe, potentially delaying surgery. It can also help to maintain post-surgical fixation, which will improve surgical outcomes.

DJO Global
760/727-1280
djoglobal.com

Visit lermagazine.com/products for more products and to submit your new product listing.

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Therapeutic Plus Diabetic Insoles

Barefoot Science has introduced Therapeutic Plus insoles for patients with diabetes. The 3D two-tone mesh top layer, designed for enhanced durability and adaptability, is also impregnated with Celliant to improve circulation. The Poron midlayer provides cushioning and breathability, and the body of the insole is made from VitaFoam, a natural cork ingredient known for breathability and enhanced antifungal properties. Although designed for patients with diabetes, Therapeutic Plus insoles are also popular among users with cold feet or circulation issues, and athletes looking for faster recovery times.

Barefoot Science Products & Services
877/651-3668
barefoot-science.ca

Home Heart Beats AFO Assist

The Original AFO Assist from Home Heart Beats is a lower body dressing aid used by stroke survivors, patients with multiple sclerosis or cerebral palsy, and other physically challenged individuals to independently don an ankle foot orthosis (AFO) and shoe. The Original AFO Assist holds the AFO and shoe in a stable position to facilitate one-handed donning, reducing or eliminating the need for caregiver assistance. Rehabilitation professionals and other practitioners can use the Original AFO Assist as an adaptive dressing training aid in inpatient, outpatient, subacute, school-based, and home care settings.

Home Heart Beats
888/612-1696
homeheartbeats.com

StabiloGen Eco Knee Brace

Bort-Swiss Orthopedic Supply offers the new StabiloGen Eco (114 520J)—a knitted knee brace designed to prevent knee pain and provide patellar stabilization. The knee brace is engineered to be adjusted as the patient progresses through rehabilitation. The device features pressure-reduced areas at the edges and the hollow of the knee and a patella-supporting silicone pad that provides compression and comfort. A thigh strap provides increases stability. It has one removable hinge and one removable lateral splint on each side. The brace is available in six regular sizes (S-XXXL) and five plus sizes (M-XXXL).

Bort-Swiss Orthopedic Supply
864/231-9144
bort-swissortho.com

Ring Lock Knee Joint 1402-B

The design of the Modular Ring Lock Knee Joint, model 1402-B, is intended to minimize size and weight without compromising strength or durability. Universal coronal and sagittal contours reduce the overall profile of the joint, while the ring lock features improved grip for patients with poor hand dexterity and increased rigidity to resist stretching over time. The Modular Ring Lock Knee Joint also features casted holes for optional ball catches (included), which can be easily installed at any time without machining or the use of specialized tools. Model 1402-B accepts both 3/16" X 5/8" and 1/4" X 5/8" uprights.

Becker Orthopedic
800/521-2192
beckerorthopedic.com

market mechanics

By Emily Delzell

OHI expands lower extremity offerings with Apex foot health division purchase

Ronkonkoma, NY-based Orthotic Holdings Inc (OHI) has purchased Aetrex Worldwide's Apex Foot Health & Wellness division, the companies reported on March 3. The new entity will be known as Apex Foot Heath Industries, LLC, and will stay at Apex's current location in Teaneck, NJ.

The acquisition will allow OHI to increase its lower extremity offerings, said Ivan Sabel, CEO of OHI.

The transition should be seamless, with no disruption to customers or patients, and Aetrex's management team will continue to serve as senior strategic advisors to OHI, according to an Aetrex release.

A 20-year relationship between the two companies paved the way for the sale, according to Larry Schwartz, Aetrex Worldwide CEO.

"Together, we've served thousands of customers and millions of patients whose consequent outcomes have benefitted measurably through the partnership. I'm fully confident that such relationships and patient outcomes will continue to thrive under the OHI umbrella," he said. ler

Olympic marathoner's family sues Vibram

The family of Olympic marathon runner Abebe Bikila in February filed a lawsuit in Tacoma, WA, federal court seeking up to $15 million in damages from minimalist footwear maker Vibram for its unauthorized use of the athlete's name for its FiveFingers Bikila models.

Bikila was born in Ethiopia and ran barefoot for their Olympic team during the 1960 marathon in Rome, winning that race as well as the marathon at the 1964 Tokyo Olympics, which he ran shod, and his name is an important one in barefoot running lore.

His family claims that Vibram, which trademarked "Bikila" in 2010, had neither the deceased runner's permission nor the permission of his surviving family to use the name.

Bikila died in 1973 from complications of a car accident four years earlier that left him a paraplegic.

Vibram in 2014 paid $3.75 million to settle a class action suit that alleged the company made misleading and false claims about the benefits of its FiveFingers footwear. ler

AOPA invites O&P research proposals

The American Orthotic & Prosthetic Association (AOPA) on February 27 unveiled its slate of 2015 RFPs (request for proposals), inviting O&P research project submissions.

AOPA has awarded the annual grants, which range from $15,000 up to $60,000, since 2009.

Go to aopanet.org to view the list of 2015 research topics and download RFPs. ler

BOC is OPAF Silver Sponsor for 5th year

The Orthotic & Prosthetic Activities Foundation (OPAF) announced in February that the Board of Certification/Accreditation (BOC) is for the fifth consecutive year a Silver Level Sponsor with a $5000 contribution for OPAF and its First Clinics.

The First Clinics provide adaptive recreational opportunities for those with physical or mobility challenges. ler

Tenex minimally invasive fasciotomy system eases plantar fasciitis pain

Data presented at the Society of Interventional Radiology annual meeting in March in Atlanta show percutaneous ultrasonic fasciotomy using Tenex Health's technology relieves plantar fasciitis pain.

The Lake Forest, CA-based company's Tenex Health TX System combines ultrasound visualization with the TX MicroTip, a hollow 18-g needle tip that uses high-energy, low amplitude motions to emulsify tissue, which is then is extracted with a fluid inflow-outflow pump.

Interventional radiologists from Advanced Medical Imaging in Lincoln, NE, conducted a 100-person study of patients with chronic refractory plantar fasciopathy whose pain and other symptoms were not relieved with medications, activity modification, and arch supports.

The investigators collected Foot and Ankle Disability Index (FADI) data before and at several points after the procedure. At two weeks postprocedure, FADI scores improved 90%, and patients maintained improvements at six months. Patients also reported being highly satisfied with treatment and had no treatment-related complications. ler

Olympian opens Algeos Innovation Suite

Olympic heptathlete Kelly Sotherton on February 24 officially opened Algeos's £50,000 state-of-the-art medical technology center at Birmingham Metropolitan College's Matthew Boulton Campus in the UK.

Sotherton, who won a bronze medal for the UK at the 2004 Olympics, launched the Algeos Innovation Suite, which the college's podiatry students will use for training and providing consultations and treatment for 2500 patients annually at the 18-chair on-site private clinic.

Alegos, headquartered in the UK in Liverpool, has worked previously with the college as a research partner.

The Innovation Suite offers a range of technologies, including Clearanail for treatment of nail fungus, OptoGait gait analysis technology for movement analysis and functional assessment, and the Podotech Elftman Matrix, a small lightweight device for assessing lower limb activity.

The Innovation Suite's main focus is podiatry, but students from other fields, such as sport sciences, will be able to access the center's technology. ler

Sols offers direct-to-consumer insoles

New York City-based Sols announced in late February that it has secured $11.1 million in a Series B funding round to boost its consumer product pipeline.

The digital insole manufacturer will use the infusion of capital to prepare for its second-quarter launch of direct-to-consumer 3D-printed insoles, according to a company release.

Patients will be able to use a smartphone app to scan their feet, upload scans, and place insole orders online. Sols is positioning the insoles as a premium alternative to existing over-the-counter products. Since its July 2013 launch, the company has raised $19.3 million and established a network of 344 practitioners who provide medical-grade insoles. ler

Continued on page 66

JCSMS poster pick shows good results for percutaneous fibular fracture repair

The coauthor of the Joint Commission on Sports Medicine and Science's (JCSMS) pick for Graduate Student Fellow Poster presented his work on February 21 at the JCSMS annual meeting in Memphis, TN, showing good results for percutaneous fibular fracture repair compared with a standard open procedure.

American Academy of Podiatric Sports Medicine Fellow in Training Andrew Yun, DPM, presented "Percutaneous Plating of Fibular Fractures," which detailed the use of a minimally invasive percutaneous technique that uses a plate-screw construct for distal fibular fractures.

The poster's senior author and Yun's fellowship advisor, Amol Saxena, DPM, performed all but two of the 38 surgeries for displaced distal fibular (Weber B) fractures; 21 patients underwent open reduction and internal fixation (ORIF) and 17 had percutaneous plating of their fractures.

All fractures healed clinically and radiographically by eight weeks postsurgery with no delayed or nonunions. There was no difference between the groups in pre- and postoperative activity scores, which improved significantly in both groups. Return to activity was two weeks faster in the percutaneous group (4.3 ± 2 months) than in the ORIF group (4.8 ± 2.8 months).

Saxena and Yun practice at the Palo Alto Medical Foundation in California. ler

Becker Orthopedic consolidates ops

Becker Orthopedic announced in February that it is consolidating operations at Albany, OR-based Becker Oregon with Becker Orthopedic's main central fabrication services at the company's headquarters in Troy, MI.

Having a single, centrally located facility will increase efficiency, expand capacity, and improve customer and technical support, according to a company release.

The consolidation is scheduled for completion in 2015. ler

Spenco 2nd Skin sales on the rise

Waco, TX-based Spenco reported in early March that sales of its 2nd Skin first aid products have climbed steadily over the last two years, rising 9% in 2013 and 11% in 2014.

According to the company, the sales reflect an increasing interest in recreational running as well as potential boost from exposure in *Wild*, the 2012 bestselling memoir of Pacific Trail Crest hiker Cheryl Strayed that is now a movie starring Reese Witherspoon.

In the book, Strayed wrote that an outdoor store staffer encouraged her to buy a box of 2nd Skin gel pads. ler

AlterG partners with PT provider network

Fremont, CA-based AlterG reported on February 25 its new partnership with the national Physical Therapy Provider Network (PTPN), based in Calabasas, CA.

The collaboration will allow the PTPN's independent rehabilitation providers to get education about AlterG technology, which includes the Anti-Gravity Treadmill and the Bionic Leg, and advice for branding and marketing their businesses.

Go to alterg.com to learn more about joining the PTPN program. ler

Hewett to head Mayo sports med research

Sports medicine expert Timothy E. Hewett, PhD, will join the Mayo Clinic on July 1 as director of sports medicine research and biomechanics.

Hewett will join the Rochester, MN-based organization from Ohio State University (OSU) in Columbus, where he is professor in the departments of physiology and cell biology, family medicine, orthopaedics, and biomedical engineering and director of research for OSU's Sports Health & Performance Institute. His expertise includes molecular dynamics, biomechanics, and physiology, with an emphasis on knee injury prevention.

His move to Minnesota corresponds with the expansion of the Mayo Clinic Sports Medicine Center in Rochester and the addition of a second center in Minneapolis. ler

UK unis to host international PFP events

The University of Manchester and the University of Central Lancaster in the UK announced in February plans to host two international events on patellofemoral pain this September.

The fourth annual International Patellofemoral Pain Research Retreat is scheduled for September 2-4 in Manchester and the second annual International Patellofemoral Pain Clinical Symposium is set to take place September 5 at University of Central Lancashire in Preston.

For more information on the events, go to ipfrr.com. ler

NATA gives first youth sports safety awards

The National Athletic Trainers' Association on March 2 presented its inaugural Youth Sports Safety Ambassador Award to three recipients at the annual Youth Sports Safety Summit in Irvine, TX.

The awards are given to people or organizations demonstrating significant commitment to the health and welfare of secondary school student athletes.

The 2015 winners are: Dawn Comstock, PhD, associate professor of epidemiology in the Colorado School of Public Health at University of Colorado in Aurora, for her high school injury surveillance research and its influence on public policy and best practices; the NFL Foundation, for its commitment to youth athlete safety through leadership in several programs; and the Dallas Independent School District, for hiring one or more full-time athletic trainers for all high schools in the district, reinforcing its commitment to athlete safety. ler

Triton device debuts at Hanger event

Birmingham, AL-based Hanger on February 3 debuted its Triton smart ankle at the annual Hanger Education Fair and National Meeting in Las Vegas, where practitioners fit two amputee patients with the microprocessor-controlled prosthetic ankle-feet.

Eight pediatric amputees, recipients of a Hanger Kids Scholarship to Camp No Limits, helped kick off the event's February 4 opening ceremony. Hanger donated $100,000 in 2014 to establish the scholarship, which sends 100 pediatric amputees and a family member to one of the 2014-2015 camps for children with limb loss or limb difference.

More than 850 clinicians and therapists attended the event, which also featured continuing O&P education, the second annual "Women in Leadership" course, and 125 exhibits and 400 exhibitors. ler

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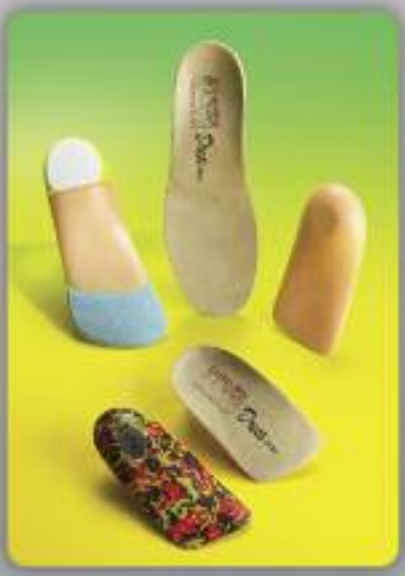

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