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LOWER EXTREMITY REVIEW
April 15 / volume 7 / number 4

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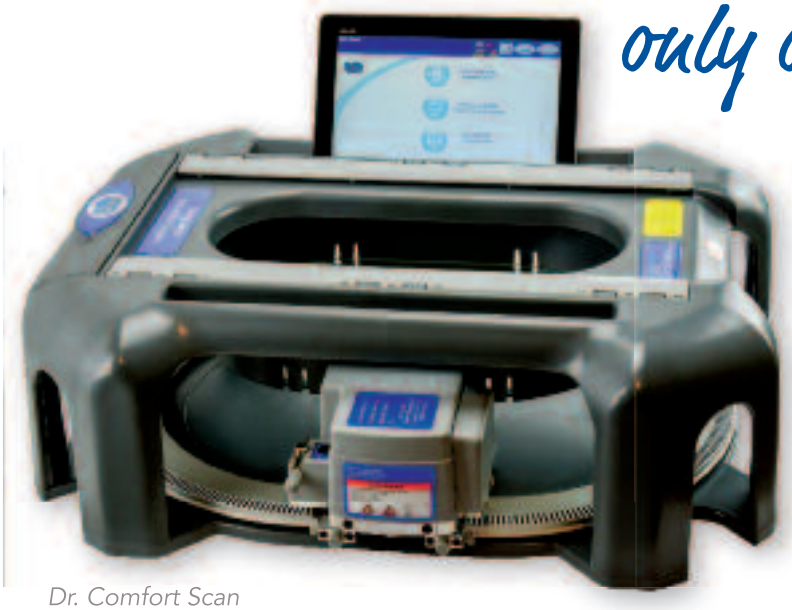

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16 COVER STORY
The PERILS of POSES:
Yoga-related injuries

Yoga is becoming increasingly popular with students looking to improve strength, flexibility, balance, and well being. But those who do too much, too soon are at risk for injury.

By Emily Delzell

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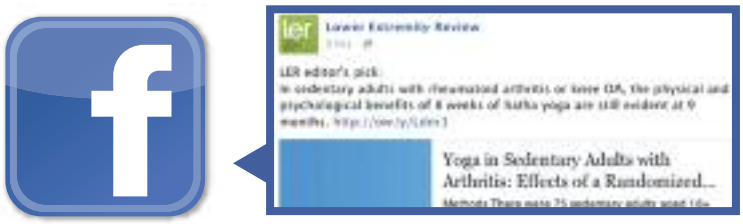

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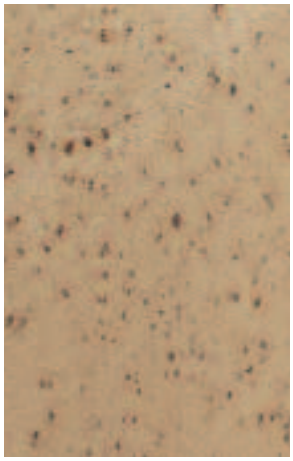

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out on a limb:
Better than average

It happens all the time: The medical literature fails to support the effectiveness of an intervention, even though practitioners know for a fact the intervention actually does have a positive effect in some patients. But a new study suggests some researchers are now starting to look beyond the averages at factors that predict those positive responses. And that's good news for practitioners who treat patients with knee osteoarthritis (OA).

It's not unusual for studies of knee OA interventions to report that some patients have a positive response, some have a negative response, and some have no response. In terms of statistical significance, the inevitable conclusion is that the intervention being studied has no effect. In terms of clinical relevance, this type of study underscores the heterogeneous nature of the knee OA population and suggests that any intervention is probably worth a try if nothing else seems to work.

Researchers from the University of Salford in the UK found a similar range of outcomes in their recent study of lateral wedge orthoses in patients with medial tibiofemoral OA, which was epublished in March by *Osteoarthritis & Cartilage*. Sure enough, they found that, compared with a shoe-only condition, walking with lateral wedge orthoses was associated with a decreased peak external knee adduction moment (EKAM)—suggesting a positive response—in some patients, but an increased peak EKAM in other patients.

For the group overall, the peak EKAM did decrease significantly, but only by 5.85%. By comparison, when only those who experienced a decrease in peak EKAM were analyzed, that mean decrease was a more impressive 11.39%.

But the Salford investigators didn't stop there. They analyzed the participants' gait mechanics more closely, and found that those with a greater peak ankle eversion angle or a greater ankle angle at peak EKAM were more likely to respond positively to the intervention (see "Inclination insights: Ankle motion predicts wedge insole effects," page 13).

Of course, these findings are still a bit removed from clinical application. They need to be replicated in a larger population, and it has yet to be determined whether the same ankle angle variables would also be predictive of longer-term effects of lateral wedge orthoses. And, given that most clinicians do not have regular access to sophisticated gait analysis equipment, it will also be important to identify variables that correlate with the predictors identified in the study—and can be easily measured in the clinic.

> Knowing the knee OA population is heterogeneous isn't as helpful as knowing which patients will respond to which interventions.

But the implications of this study go beyond its specific findings. Instead of asking simply whether an intervention was or was not effective for a population, the Salford researchers asked which patients were most likely to respond to an intervention, and why. That's a fundamentally different approach to this problem, and one that I hope will be applied to studies of offloading braces, footwear, gait retraining, strength exercises, and other potential interventions for knee OA.

Knowing the knee OA population is heterogeneous isn't nearly as helpful, clinically, as knowing which patients will respond to which interventions. The Salford study represents an important step toward achieving that goal.

Jordana Bieze Foster, *Editor*

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By Jordana Bieze Foster

At-risk youth

ACL revisions plague pediatric populations

Two large studies presented in late March at the annual meeting of the American Academy of Orthopaedic Surgeons (AAOS) added to the evidence that pediatric patients have an elevated risk of surgical revision after anterior cruciate ligament (ACL) reconstruction, and a third study suggested that returning to sports too early may be a contributing factor.

Researchers from several Kaiser Permanente Medical Group locations in southern California retrospectively reviewed more than 21,000 cases of primary ACL reconstruction and stratified them by age group. The revision-free survival rate at five years was highest in patients older than 40 years and lowest in patients aged 21 years and younger; the five-year revision rate of 9% for the latter group was 7.8 times higher than for the former.

Within the youngest group of patients, factors associated with higher risk of revision included male gender, body mass index of less than 30 kg/m^2, and white race. Allografts were associated with higher risk of revision than bone-patellar tendon-bone (BPTB) autografts in all patients younger than 40 years, and hamstring autografts were associated with a higher risk of revision than BPTB autografts in those younger than 21 years.

"Understanding the age-related risk factors associated with revision after ACL reconstruction may help with patient counseling and optimal graft choice," said Gregory B. Maletis, MD, an orthopedic surgeon at Kaiser Permanente Medical Center in Baldwin Park, CA, who presented the findings at the AAOS meeting.

In a separate AAOS presentation, researchers from the Hospital

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Most NFL players successfully return from Lisfranc injury, but it takes time

Almost all National Football League (NFL) players who sustain tarsometatarsal (Lisfranc) joint injuries return to competition, but very few do so quickly, according to research from the University of Pennsylvania School of Medicine in Philadelphia.

Of 28 players (11 offensive, 17 defensive) who suffered Lisfranc injuries between 2000 and 2010, only two never returned to NFL competition. The median time to return was 11.1 months from the time of injury, and only three players returned in less than three months.

Offensive power ratings (total touchdowns/6 + total yards/10) and defensive power ratings (total tackles + total sacks x2 + total interceptions x2) decreased slightly in the three seasons postinjury compared with the three seasons preinjury, but the decrease was not statistically significant. Similarly, the change in performance in the Lisfranc-injured players was greater than for a comparison group of players in similar positions from the 2005 season, but that difference was also not statistically significant.

The findings were presented in late March at the annual meeting of the American Academy of Orthopaedic Surgeons. (ler)

Source:

McHale KJ, Rozell JC, Milby AH, et al. Outcomes of Lisfranc injuries in the National Football League. Presented at the American Academy of Orthopaedic Surgeons annual meeting, Las Vegas, NV, March 2015.

Habitual foot strike patterns may persist in older runners after switch from shoes

Experienced runners older than 30 years are less likely than adolescents to change foot strike pattern when switching from traditional running shoes to barefoot running, which may increase their risk of injury, according to a study from the University of Kansas in Kansas City.

Researchers analyzed 26 runners (16 men), all of whom were older than 30 years and had more than 10 years of shod running experience, as they ran on a treadmill at various speeds while barefoot and while wearing conventional running shoes. They found that 40% of the men and 20% of the women persisted with their habitual rearfoot strike pattern even while barefoot running, across all speeds. The findings were presented in late March at the annual meeting of the American Academy of Orthopaedic Surgeons.

By comparison, a similar 2013 study from the same group found that competitive adolescent runners landed heel-first 70% of the time while shod and less than 30% of the time while barefoot. (ler)

Sources:

Mullen SM, Toby EB, Mar D, et al. The effect of training shoes on running kinematics in older runners. Presented at the American Academy of Orthopaedic Surgeons annual meeting, Las Vegas, NV, March 2015.

Mullen S, Toby EB. Adolescent runners: The effect of training shoes on running kinematics. J Pediatr Orthop 2013; 33(4):453-457.

Continued from page 11

for Special Surgery (HSS) in New York City analyzed a New York State database and identified nearly 24,000 patients younger than 21 years who were at least one year removed from primary ACL reconstruction (median follow-up time, 6.7 years). They found that 8.2% of those patients had undergone additional ACL reconstructions and 14% had undergone additional non-ACL knee surgery. The side of the operation was not noted in the database, so it is unclear how many of those additional ACL reconstructions were revisions of the primary reconstruction and how many involved the contralateral knee.

Risk factors associated with revision included younger age at the time of primary ACL surgery, male gender, white race, private insurance, higher hospital ACL procedure volume, and higher surgeon ACL procedure volume. Graft type and surgical technique were not noted in the database.

"Younger children may participate in more risky activities than older children, and ACL reconstruction for open physes may be less reliable than in skeletally mature patients," said Emily R. Dodwell, MD, a pediatric orthopedic surgeon at HSS, who presented the findings at the AAOS meeting.

But a third study presented at the meeting suggests young athletes may be at higher risk for revision ACL surgery because they are returning to sports before they have recovered the functional movement skills needed to do so safely.

Researchers from Duke University in Durham, NC, assessed Functional Movement Screen (FMS) and Lower Quarter Y-Balance Test (LQYBT) performance in 39 adolescents and 16 adults who had undergone ACL reconstruction nine months earlier.

The composite FMS scores for all participants, regardless of age, were low enough to suggest an increased risk of injury based on the cutoff score of 14 published in several unrelated FMS studies. The 17 skeletally immature patients in particular scored lower on the straight leg raise (SLR) test than the skeletally mature adolescents or the adults. On the LQYBT, there was a wider range of anterior reach asymmetry in the adolescents than in the adults.

"The adolescent's musculoskeletal system is different from the adult's," said Matthew J. Boyle, MD, now a pediatric orthopaedic fellow at Boston Children's Hospital, who presented the findings at the AAOS meeting. "The SLR results probably reflect some sort of core weakness. More of a rehab focus on core strengthening would improve their scores, and hopefully improve their outcomes." ler

Sources:

Maletis GB, Chen J, Inacio MC, et al. Anterior cruciate ligament reconstruction: Age-related risk factors for revision. Presented at the American Academy of Orthopaedic Surgeons annual meeting, Las Vegas, NV, March 2015.

Dodwell E, McCarthy MM, Pan T-J, et al. Long term follow up of pediatric ACL reconstruction in New York State: High rates of subsequent ACL reconstruction. Presented at the American Academy of Orthopaedic Surgeons annual meeting, Las Vegas, NV, March 2015.

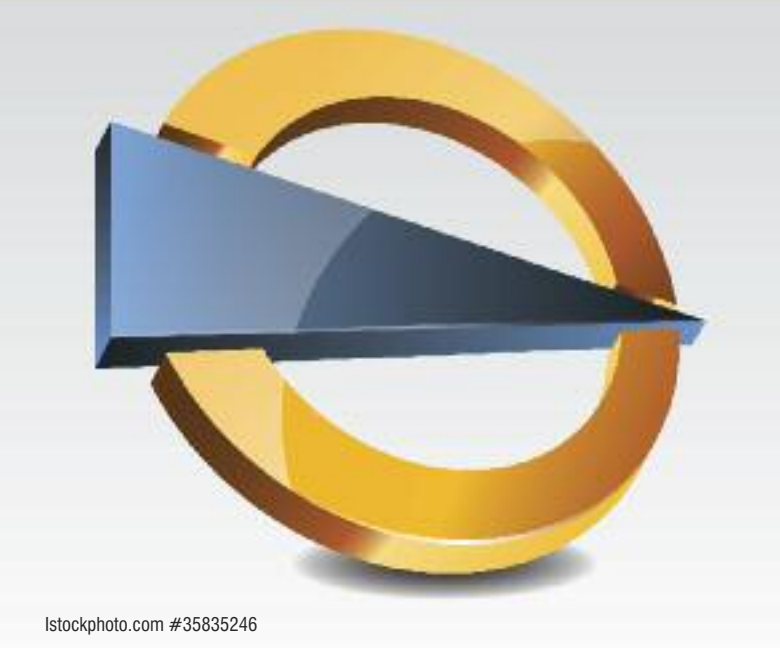
Boyle MJ, Butler RJ, Queen RM. Functional movement recovery after anterior cruciate ligament reconstruction in adolescent patients. Presented at the American Academy of Orthopaedic Surgeons annual meeting, Las Vegas, NV, March 2015.

By Larry Hand and Jordana Bieze Foster

Inclination insights

Ankle motion predicts wedge insole effect

Motion analysis of the ankle joint complex may predict how a patient with medial knee osteoarthritis (OA) will respond to using a lateral wedge insole, according to a new study from the University of Salford in the UK.



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The investigation, an ancillary study to a larger ongoing clinical trial, included 70 individuals (27 women) who had experienced unilateral medial knee pain while walking on a flat surface within the previous week. They were aged an average of 60.3 years and an average body mass index of 30.5 kg/m^2. Individuals with radiographic information available had an average Kellgren-Lawrence severity score of 2.63.

Researchers used a 16-camera 3D motion analysis system and a force plate to assess the participants as they walked while wearing a shoe with a lateral wedge insole on the affected side and while wearing shoes only. The ethylene vinyl acetate lateral wedge insoles extended from the heel post to the fifth metatarsal head and did not include medial arch support. All participants wore flat, thin-soled leather shoes.

"We used a five-degree lateral wedge, as this fits within the patient's shoes comfortably and has been shown in previous research by us to reduce medial knee loading in patients with medial knee osteoarthritis," first author Graham J. Chapman, PhD, a research fellow in knee biomechanics and injury at the University of Salford, told *LER* by email.

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MRI reveals cartilage change associated with altered kinematics after ACL injury

Altered tibial position during flexion and extension one year after anterior cruciate ligament (ACL) reconstruction is associated with early cartilage changes, according to research presented in late March in Las Vegas at the annual meeting of the American Academy of Orthopaedic Surgeons (AAOS).

Investigators from the University of California San Francisco (UCSF) performed two types of magnetic resonance imaging (MRI) on 25 patients (13 women) prior to ACL reconstruction and at six months and one year after surgery. Kinematic MRI was used to assess the joint anatomy in both knees during flexion and extension while the partcipant was loaded with 25% body weight; T1ρ imaging was used to detect early cartilage changes (higher T1ρ relaxation values are associated with decreased proteoglycan content).

Between-limb differences in tibial position during flexion and extension were significantly associated with degenerative changes in the reconstructed limb at one year.

"This relationship may provide insight into the implications for development of knee osteoarthritis after ACL reconstruction," said Musa Zaid, a medical student at UCSF, who presented the findings at the AAOS meeting. *–JBF*

Source:

Zaid M, Lansdown D, Su F, et al. Abnormal kinematics in the ACL reconstructed as a mechanism of early onset osteoarthritis. Presented at the American Academy of Orthopaedic Surgeons annual meeting, Las Vegas, NV, March 2015.

Ankle fracture patients have elevated levels of synovial biomarkers for OA

Patients with acute intra-articular ankle fractures demonstrate elevated levels of biomarkers that are commonly associated with osteoarthritis (OA), suggesting that the degenerative process that leads to OA in the majority of ankle trauma patients begins in the acute phase, according to research from Duke University Medical Center in Durham, NC.

In 21 patients with unilateral acute intra-articular ankle fracture and no history of trauma or pain in either ankle, the investigators analyzed synovial fluid samples from both ankles at the time of open reduction and internal fixation, which on average was 17 days postinjury. They found that the affected ankle had significantly higher concentrations of three proinflammatory cytokines and four matrix metalloproteinases than the unaffected ankle. Similar biomarkers have previously been associated with degenerative OA, particularly in the knee.

"All healing is inflammatory, but not all of those biomarkers are part of the normal inflammatory response," said Samuel B. Adams Jr, MD, an orthopedic surgeon at Duke Regional Hospital, who presented the findings in late March at the annual meeting of the American Academy of Orthopaedic Surgeons. *–JBF*

Source:

Adams SB Jr, Bell R, Nettles DL, et al. Elevated synovial fluid inflammatory cytokines and matrix metalloproteinases after ankle fracture. Presented at the American Academy of Orthopaedic Surgeons annual meeting, Las Vegas, NV, March 2015.

Continued from page 13

Participants varied considerably in response to wearing the shoe with the wedge insole. Of the 70 individuals, 23 experienced a mean 8.5% increase in external knee adduction moment (EKAM) when wearing the insole. The remaining 47 individuals experienced a mean 11.39% reduction in EKAM. Ankle angle at peak EKAM and peak eversion ankle/subtalar joint complex angle in the control position predicted if using a lateral wedge insole was likely to be associated with a decrease in EKAM. The researchers did not test for the effect of radiographic severity, foot type, or pain and discomfort.

"The finding that people with a more everted foot when walking in the control condition were more likely to reduce their knee loading when wearing lateral wedge insoles was slightly surprising," Graham said.

The findings, epublished in March by *Osteoarthritis & Cartilage*, represent a first step that researchers hope will lead to clinical algorithms for matching subgroups of knee OA patients with treatments that are most likely to be effective.

"This is only the beginning for this area of work," said senior author and principal investigator Richard K. Jones, PhD, who is a professor in clinical biomechanics at the university. "More research is required to understand the role of the foot and ankle in knee loading and medial knee osteoarthritis in order to improve the clinical outcomes for patients suffering with this disease and to determine biomechanical response in these interventions."

Ryan Lewinson, who has studied the effects of wedged insoles as an MD/PhD student at the University of Calgary in Alberta, Canada, concurred with the UK researchers' acknowledgment that 3D gait analysis systems are currently too expensive and time consuming to be used regularly by most clinicians.

"Evaluation of the peak knee adduction moment and other associated biomechanical variables are likely to remain, for the most part, exclusive to research-based settings over the next few years," Lewinson said. "The next step is to identify methods that predict response to wedged insoles, but in clinical settings without three-dimensional gait analysis systems."

Peter Barrance, PhD, a senior research scientist at Kessler Foundation in West Orange, NJ, who has also studied the effects of lateral heel wedging, agreed.

"It will be important to also understand whether, in addition to the types of dynamic measures available in laboratory-based gait analysis, clinical measurements of standing ankle angulation can be used to help predict treatment efficacy," Barrance said. *–LH*

Sources:

Chapman GJ, Parkes MJ, Forsythe L, et al. Ankle motion influences the external knee adduction moment and may predict who will respond to lateral wedge insoles: An ancillary analysis from the SILK trial. Osteoarthritis Cartilage 2015 Mar 5. [Epub ahead of print]

Jones RK, Zhang M, Laxton P, et al. The biomechanical effects of a new design of lateral wedge insole on the knee and ankle during walking. Hum Mov Sci 2013;32(4):596-604.

Jones RK, Chapman GJ, Forsythe L, et al. The relationship between reductions in knee loading and immediate pain response whilst wearing lateral wedged insoles in knee arthritis. J Orthop Res 2014;32(9):1147-1154.

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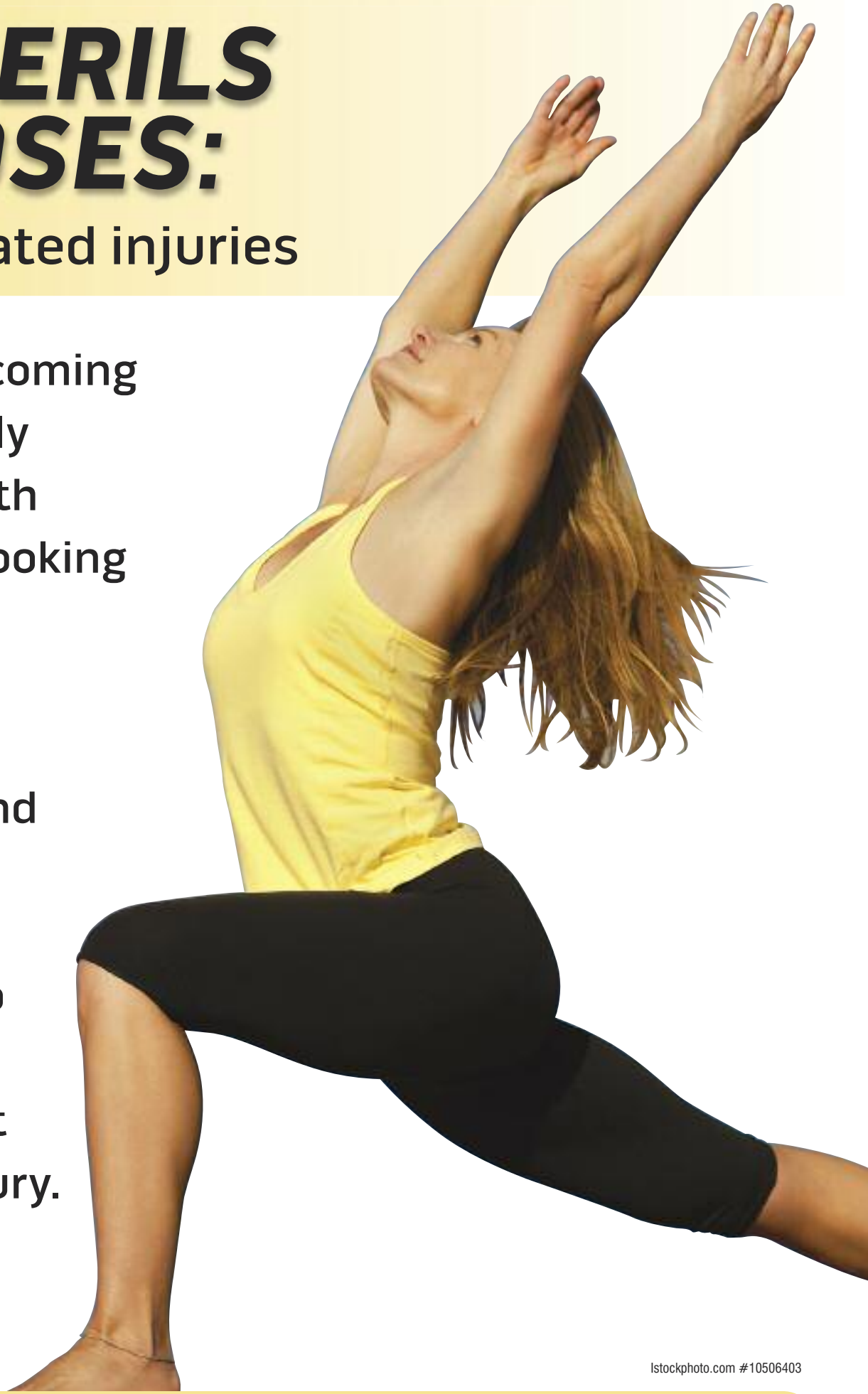
The PERILS of POSES:

Yoga-related injuries

Yoga is becoming increasingly popular with students looking to improve strength, flexibility, balance, and well being. But those who do too much, too soon are at risk for injury.

By Emily Delzell



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Raza Awan, MD, hadn't been practicing yoga long when he found himself in a class with a fairly advanced group of students. The instructor brought the students to the middle of the room to move into handstand pose (in Sanskrit, *adho mukha vrksasana*, or downward facing tree pose, Figure 1). The sports medcine physician said he thought he'd be more comfortable using the wall for support, but the instructor said he looked strong. Rising into an unsteady handstand (his first), he toppled over (despite an assist from the instructor) and broke his big toe.[1]

He was using yoga to rehabilitate from injuries unrelated to the practice, as well as investigating its potential as a tool for his patients.

"About a decade ago, I started seriously looking at utilizing yoga to enhance rehabilitation outcomes in my patients and began bringing yoga practitioners into the sports clinic to becomes part of our rehabilitation team," said Awan, a physiatrist and medical director of Synergy Sports Medicine & Rehabilitation in Toronto, Canada. "Ultimately, I wanted to ensure that, if I was recommending yoga to my patients, I knew both the risks and benefits of yoga practice."

As yoga gained popularity, he also started to notice more yoga-related injuries presenting in his clinic. The literature revealed little data on the injuries (and published data are still sparse) so Awan began tracking injuries in his patients to analyze patterns, identify high-risk poses, and improve clinical outcomes. Eventually, he began leading injury prevention workshops for teachers, studio owners, and students.

Traumatic injuries like the one Awan experienced aren't the most common type of yoga-related injury, but his story does illustrate an important risk factor for all types of yoga injuries: an instructor who pushes students too far, too quickly. This high-risk pushing can be physical as well as mental.

"Injuries can be caused by too vigorous hands-on adjustments from teachers who may not knowledgeable about the individual limits of their students' bodies," said Ann Wendel, PT, ATC, CMTPT, an American Physical Therapy Association spokesperson, Thai yoga therapist, and owner of Prana Physical Therapy in the Washington, DC, area.

Hand-on adjustments by yoga teachers are common, but not always benign.

"One of my clients who came to me to rehabilitate from a yoga injury got it during a retreat," said Wendel. "She was in wide-angle seated forward bend pose [*upavistha konasana*, Figure 2] and the teacher leaned heavily into her back to force her forward, deeper into the pose—she heard a pop, and ended up with hamstring and low back strains."

Most of the yoga-related injuries Awan has cataloged are from overuse.

"Performing the same poses over and over again over time can lead to repetitive strain and predispose to musculoskeletal injuries and conditions. In many cases the symptoms come on insidiously, and the patients may not make a causal link between the injury and yoga practice," he said.

Chasing a shape: ego and injury

The biggest risk factors for getting hurt doing yoga aren't pre-existing medical conditions or old injuries, but the students themselves, who often risk injury to reach full extensions in poses, or *asanas*, their bodies aren't ready for (and may never be ready for), as well as teachers, who may lack adequate training, may be instructing classes too large for close supervision, or who introduce an attitude of competition—including competing against oneself—into classes.

"Ego and not listening to your body are big risk factor for yoga injuries," said Cristina González, a yoga teacher from Toronto who describes her practice as "rooted in the Ashtanga system with a healthy dose of Iyengar sensibilities." Ashtanga yoga is a vigorous form of yoga with a specific sequence of poses (power and Vinyasa yoga are often variants of this type). Iyengar yoga emphasizes precise alignment in the pursuit of poses as well as the use of modifications, including straps, blocks, and other props, to achieve correct biomechanics and minimize the risk of injury.

"I injured myself quite a bit in yoga in my initial years of practice," said González, who said she strained her hamstrings, hip, and injured her shoulder severely. "I was chasing a shape rather than an action. I'm pretty typical in some ways of the hypermobile person—I enjoy the sensation of stretching, and I wasn't balancing it with proper muscular engagement."

Awan agreed that, in his experience, hypermobile people are at higher risk for yoga injuries than people with more average range of motion.

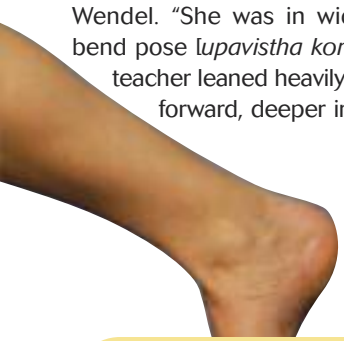

Figure 1. Handstand pose.

Continued from page 17

Figure 2. Wide-angle seated forward bend.

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"These patients may be drawn to yoga because they possess the range of motion to perform many common poses well, but hypermobility can be a particular risk factor for injury as the patients may not have good proprioception and may push too far into poses, which can cause damage to soft tissue structures over time," Awan said. "Hypermobile patients may also lack the muscle strength and endurance to support a pose well, contributing to injury."

Those with limited range of motion are at risk, as well.

"Hip and knee injuries can occur when people are trying to push their bodies into a pose," Wendel said. "For example, forcing yourself into lotus pose [*padmasana*, Figure 3] can result in injury to the meniscus. There are real bony constraints in the hip, but the knee is much more flexible, so people may try to crank on the knee to get into that position, and that's commonly how people tear their meniscus [in yoga]."

Meniscus injury is a documented risk of yoga. Chinese researchers reported in a 2012 study that women aged 20 to 49 years who practiced yoga (they didn't specify type or specific poses) at least one hour a day were at higher risk of meniscus injury than that conferred by jogging, badminton, or climbing hills, and that risk increased with longer duration of practice.[2]

Wendel noted that, practicing in the Washington DC area, she sees a lot of "type A personalities."

"They want to push, push, push and work out intensely, and when they take the mentality of pushing and competing and getting in a really vigorous workout into a yoga class, that's when injuries are likely to occur," she said.

A 2012 Australian survey, which included 2353 yoga practitioners who answered questions about practice-related injuries sustained in the previous year noted that the respondents commonly blamed themselves for injury, citing reasons that included "pushing it too far," not warming up, and being "ego-driven."[3]

Also potentially problematic are large classes in which it's impossible for teachers to see how every student is interpreting his or her cues.

"I often attend large group classes out of curiosity and for inspiration, and sometimes I'll look around the room and think, 'Isn't it interesting how many interpretations there are of that cue.' Some of the language can get pretty esoteric, and I can see why they've interpreted it that way, but often it's not good for the body," González said.

She began working as a yoga instructor 11 years ago teaching large group classes, moved to small groups of four people or less, and now teaches mainly one on one.

"I did this because, over time, I decided it was safer for my students," said González, who has taken Awan's yoga injury prevention workshops.

The type of yoga Wendel uses with her patients, Thai yoga, is also a one-on-one practice.

"It's kind of 'lazy man's yoga,' in which I actually assist the client into and out of different yoga postures, mostly to help with mobility and relaxation," she said.

Class styles, yogi practice patterns

Indian spiritual practitioners began developing yoga in the fifth or sixth century BCE.[4] More than 2000 years later, yoga gurus introduced it to students in the West, where, starting in the 1980s, it began to soar in popularity as an exercise form, leading to dozens of styles of this ancient practice.

Some more popular yoga styles now practiced in the West

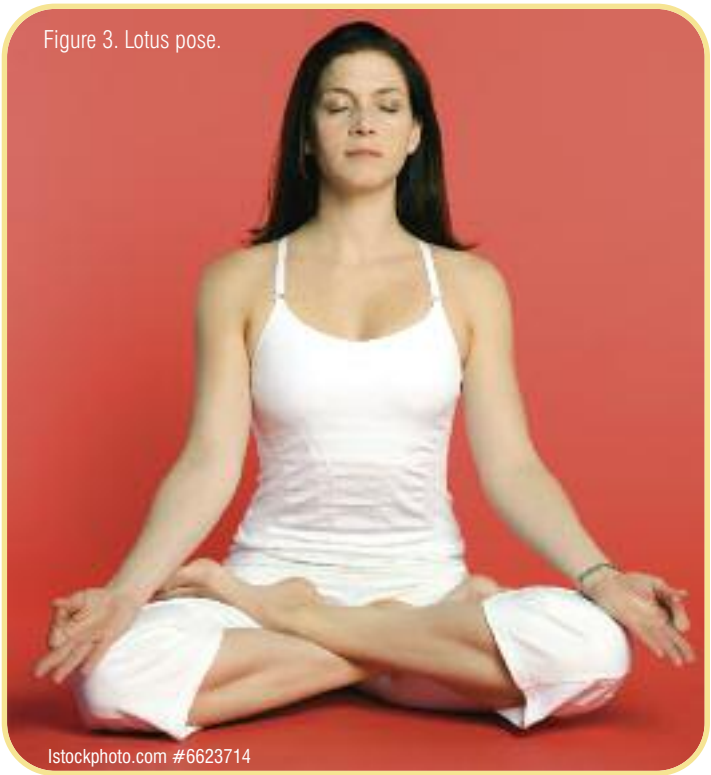

Figure 3. Lotus pose.

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include Hatha, Anusara, Bikram (which falls under the larger umbrella of hot yoga), Vinyasa, Ashtanga, Iyengar, Flow, and Kripalu.[5] But these represent only a small sampling of the many variants.

"Yoga practices in which the same poses are done repeatedly [eg, Ashtanga] seem to carry a higher risk of injury, in my experience," Awan said. "Styles of yoga where certain high-risk poses are held for a very long time [as in Yin yoga] can predispose to injury. Conversely, faster styles of yoga [eg, Flow] where patients are going from pose to pose quickly without achieving good alignment can also predispose to injury."

Yoga done in deliberately hot environments such as Bikram, a popular and intense type of yoga done in a room heated to more than 100° F, can also create risks.

"Yoga performed in an extremely hot or humid environment carries risks of heat-related injury," he said. "There may also be a higher risk of musculoskeletal injuries in a heated room, as warm muscles can lead to patients inadvertently pushing too far into a pose. Yoga in a hot environment can also lead to poor judgment and potentially riskier behavior during a class."

In addition, said González, every studio has a different culture.

"While I believe that most teachers of yogasana act according to the principle of *ahimsa* [nonviolence], the economics of keeping a yoga studio afloat may sometimes influence studio owners/managers to act otherwise. I do not believe that anyone intentionally injures students, but the demands of certain practices and postures do elevate risk," she said. "For example, if a studio has a consistent client base that expects a 'physically challenging' class, the studio will likely continue to cater to that because it's paying the rent. Some studios may offer classes in a style that is too dogmatic—poses arranged according to an unmodifiable sequence, overzealous physical adjustments that take students too deeply and too quickly into a pose, and a kind of misinterpretation of what it means to practice *tapas* [yogic discipline, which can be misunderstood as mastering difficult poses]. This may be conducive to an atmosphere where practitioners tune out or doubt warnings their body is giving them. Some

Figure 4. Standing forward bend.

studios/practices may encourage complete release and acceptance. This too can be misinterpreted dangerously."

New yoga students who lack a fundamental understanding of the poses can be at risk for injury.

"Malalignment during poses and progressing to more advanced poses and classes before the body is ready can be risk factors for injury," Awan said.

A 2007 survey conducted by the International Association of Yoga Therapists (IAYT) and others found that, among 1336 responders who answered questions about their practice and related injuries, the most commonly cited causes of injury were poor technique or alignment, previous injury, excess effort, and improper or inadequate instruction.[5]

The frequency and intensity of an individual's practice can also create injury risks, Awan said.

"This may include taking weekend workshops or going on a yoga retreat," he said. "Someone who has experienced a sudden increase in their yoga practice, particularly if they perform the same poses repeatedly, can be at risk of injury from repetitive strain. Yoga teacher trainees can also be at risk, as they are not only required to attend formal training, but often substantially increase their own asana practice."

Common injuries, risky poses

The hamstrings and knees are common lower extremity sites for yoga-related injury.

"Proximal hamstring tendinopathy, patellofemoral pain, and meniscal tears are some of the more frequently encountered lower extremity injuries I've seen," Awan said. "Hip labral tears are not as common; however, they are important to identify, given the risk of long term disability if not diagnosed and treated effectively."

He noted that poses with extremes of hip motion, such as end-range hip adduction/internal rotation or hip flexion/abduction/external rotation, can predispose to hip labral tears.

"This is particularly true in patients with an underlying anatomical predisposition such as femoroacetabular impingement," he said. "Limiting the range of motion during these poses may potentially limit the risk of labral tears."

A study of imaging observations by Canadian radiologists found that, of 23 musculoskeletal yoga injuries identified in the database of a large tertiary care center, 34.8% were tendinous lesions, which in the lower extremity included Achilles partial-thickness tears


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Figure 5. One-legged king pigeon pose.

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Figure 6a. Warrior I.

(13%, 3/23) and peroneus brevis partial-thickness tears (4.3%, 1/23). A further 34.8% of all events were fibrocartilaginous injuries, and in the lower extremity included medial meniscus tears (8.7%, 2/23) and acetabular labrum tears (8.7%, 2/23).[6]

A survey of students in Finland who practice Ashtanga yoga found the lower extremity was the most common site for musculoskeletal injuries.[7] Of the 110 students who responded to the survey, 62% reported lower extremity injuries lasting longer than one month; the hamstrings and knees were the sites most often affected, accounting for 40% and 36% of the injuries, respectively. The majority of all injuries were sprains and strains, with a small number of dislocations (n = 2) and abrasions (n = 1), but no fractures.

When the researchers excluded pre-existing injuries and non-specific low back pain, the injury rate was 1.45 injuries per 1000 hours of yoga practice. This rate, the authors noted, is much lower than the rates associated with various other athletic activities, which ranged from 6.6 to 18.3 per 1000 hours of activity.

The Australian survey also found a relatively low incidence of events. Only 4.6% of respondents cited injuries sustained during unsupervised practice or attributed to pre-existing conditions and severe enough to require medical treatment or cause prolonged pain, discomfort, or lost work time. Injuries during supervised classes, including injury recurrences, were reported by 3.4% of

respondents, and new injuries occurring under supervision were reported by 2.4%.[3]

Awan and González both noted that seated and standing forward bends (*uttasana*, Figure 4) can be particularly risky for individuals with a predisposition to hamstring injuries, including those who have had previous hamstring injuries.

"These injuries are often caused by overuse and overstretching, and it can be really hard to keep students safe in these poses even you're being vigilant," González said.

Other potentially risky poses include lotus pose and one-legged king pigeon pose (*eka pada rajakapotasana*, Figure 5). Both involve hyperflexion and rotation at the knee, and can lead to meniscus injuries, particularly in people with tight hips, Wendel said.

"Using preparatory poses or props to limit the flexion and rotation of the knee may make these poses safer," Awan said.

The IAYT survey warrior I (*virabhadasana*, Figure 6a) and warrior II (Figure 6b), hero's pose (*virasana*, Figure 7), one-legged king pigeon pose, and lotus pose were the asanas most frequently associated with knee injuries. All involve knee flexion, and warrior poses combine this with weight bearing.[5]

A 2013 *PloS One* review of case studies and series also found lotus pose was a high-risk pose; lower extremity injuries associated with this asana included epiphyseal fracture of the distal tibia and lateral femoral cutaneous neuropathy.[8]

Evaluation, rehabilitation

As noted, yoga-related injuries can come on gradually or occur acutely.

"It's extremely important to understand the style of a patient's yoga practice and, for acute events, what they were doing when they sustained the injury—much like an injury sustained during any other sport," said Sameer Dixit, MD, an assistant professor of orthopaedics, medicine, and physical medicine and rehabilitation at Johns Hopkins School of Medicine in Baltimore, MD. "It's also important for practitioners to understand that you can injure yourself during yoga. My first exposure to a yoga injury was a young woman who tore her ACL [anterior cruciate ligament] while bending forward in hyperflexed position at the knee. I was surprised—I was working with a football team at the time and realized this type of injury can happen with yoga, as well."


Figure 6b. Warrior II.

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Dixit commonly sees patients in his practice who have injured themselves during yoga.

"I ask what they were doing, and find it helpful to Google the pose or poses in question with the patient so I know that's in fact what they were doing. By looking at the position, I get some idea of where the stresses were occurring," he said.

Cristina González advises practitioners who have patients with yoga injuries—or who are considering recommending yoga to their patients—to get some familiarity with the practice.

"I suggest some private or semiprivate classes with highly trained instructors," she said. "This way, they might better understand what modifications can be made to the general movement cues patients will encounter in large drop-in classes."

Pose modifications and avoiding repetitive movements are typical strategies used in the rehabilitation of yoga injuries.

"For proximal hamstring tendinopathy, avoiding repetitive forward bending is one of the first lines of treatment," Awan said. "Rehabilitation may focus on manual therapies, but also identifying and treating any weakness, tightness, and muscle imbalance. In many cases, weak gluteal and hamstring musculature may be contributing to the clinical picture. Restrictions in the posterior kinetic chain, such as tightness in the lower hamstrings or calf, may also need to be addressed."

In patients with patellofemoral pain syndrome, he suggests strengthening around the knee, where there is potential for patellar maltracking.

"In many cases, there is also hip weakness or tightness that is contributing to the clinical picture," he said. "Ensuring proper alignment of the patella during standing poses with knee flexion is important. Manual therapy and stretching and strengthening around the hip and knee joint are typically required in these cases."

With respect to rehabilitating from meniscal tearing, he said, it's crucial to initially avoid poses that involve hyperflexion, knee rotation, or both.

"During standing poses where the knee is flexed, it's also important to look at the tracking of the knee, as there may be significant rotation present. Strengthening around the knee joint may be helpful, but in many cases it's also important to look at the hip joint," Awan said. "Tightness or weakness in the hip can lead to malalignment at the knee joint in many poses and needs to be addressed."

"Many physical therapists incorporate yoga into treatment plans to assist patients in building strength and mobility," said Ann Wendel. "A physical therapist with expertise in yoga can assist clients and practitioners in finding appropriate modifications that reduce the risk of injury."

She recalled one of her teachers, who stopped a class because she saw people were trying to force themselves into one-legged king pigeon pose.

"She said, 'What I want you to understand is that pigeon is maybe sitting on the ground with your front leg bent with your hips and buttocks up on a block and your hip just slightly externally rotated; and this is also pigeon—taking the block away and just bending your knee and externally rotating the hip a little more; and this is pigeon, with your front knee fully bent and hip more externally rotated but your back leg straight; and then this is also pigeon, with the front knee bent fully and fully externally rotated, no block, and your back leg bent so your knee is bent, and your foot is coming up to your head.'"

Blocks, bolsters, blankets (folded for padding and height), and straps can all be used to modify yoga poses. *Yoga Journal* maintains an online yoga encyclopedia covering pose variations, modifications, contraindications, and other information at yogajournal.com/yogapedia.

"Yoga is really not about the ego and what we can make the body look like. If we keep the ego out of it as students and also as teachers, then we can bring those props and other modifications in as needed to keep everybody safe," Wendel said. "I tell my students, the best yoga class you can attend is the one where you don't know anything about anyone else there; you're just looking at the mat and are very focused on your own practice—that's how you're going to keep yourself safe." ler

Figure 7. Hero's pose.

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ACTIVE STANCE

A new triplanar paradigm for bunion management

By Paul Dayton, DPM, MS, FACFAS, and Merrell Kauwe, DPM

The most common paradigm in bunion surgery relies on one or more metatarsal osteotomies to correct the 1-2 intermetatarsal angle (IMA) and soft tissue balancing to align the first metatarsophalangeal joint (MTPJ), sesamoid apparatus, and hallux. Additionally, the most common approach to assessing and defining the anatomy in a bunion, and subsequently choosing the corrective procedure or procedures for bunion correction, utilizes commonly accepted measurements, such as the IMA, the hallux abductus angle (HAA), and the tibial sesamoid position (TSP).[1]

> Inclusion of frontal plane derotation as part of hallux valgus correction provides a powerful tool for the surgeon to more accurately correct this complex deformity.

In reality, these common measurements can be described collectively as a severity-based algorithm. In other words, we are defining a bunion deformity as a continuum of separate deformities, and we treat each individual case as unique. Ultimately, this approach results in a multitude of procedural options for each patient and deformity, depending on surgeon experience and opinion.[2] In fact, there is rarely agreement between surgeons regarding the best procedure for each patient, making the evaluation and management of bunions highly subjective. If one strictly applies the tenets of evidence-based medicine and reduction of clinical variability to bunion surgery, we could interpret the application of a wide variety of procedures or combinations of procedures to a singular deformity to be poorly reliable.

Although broadly accepted, this multiprocedural approach based on severity algorithms overlooks the most important component of any deformity, including the bunion, which is the primary level of the deformity. The metatarsal in a bunion is not deformed; rather, the structure of the forefoot deviates from normal anatomy in multiple planes at the level of the first tarsometatarsal joint.[3-7] The traditional approach to surgery does not always correct this primary deformity; instead, metatarsal osteotomies create a new deformity in the metatarsal itself.

The basic mechanics of metatarsal osteotomies are similar despite differences in the shape of the bone cuts for different techniques. It is important to realize that the correction provided by these osteotomies is largely limited to the transverse plane regardless of the geometry of the cut, the fixation selected, or the associated soft tissue balancing. Surgeons easily recognize the transverse plane component of the deformity (IMA), and this parameter typically receives the highest priority in preoperative decision-making. We talk to a lesser degree about the sagittal plane.[2] Historically, very little attention has been paid to metatarsal frontal plane position when operatively addressing hallux valgus.

Frontal plane rotation

We have found that the frontal plane rotation of the first metatarsal has a profound effect on the basic anatomy of the deformity, and that inclusion of frontal plane derotation as part of the corrective procedure provides a powerful tool for the surgeon to more accurately correct this complex deformity.

Examination of the literature reveals the clear and consistent presence of metatarsal frontal plane rotation associated with a bunion deformity, which was first recognized in 1956 by Mizuno.[8] Literature on the topic uses various terminologies to describe the same frontal plane position, which has created confusion in the discussion of the problem. Unless one is aware that eversion, valgus, and pronation can be used synonymously in reference to the frontal plane position of the first metatarsal, there can be a tendency to overlook some of the work that has been performed regarding metatarsal pronation in a bunion. This discrepancy in terminology was addressed in 2014 in a paper by Dayton et al.[9] In this article, the term pronation will be used to describe the frontal plane rotational position of the first metatarsal in the context of a bunion deformity (Figure 1).

In 1980, Scranton and Rutkowski[10] used sesamoid axial radiographs to observe the position of the metatarsal in both a control group and a group with bunion deformities. Their study found that feet with bunions had a mean of 14.5° of metatarsal pronation, while normal feet had a mean of 3.1° of metatarsal pronation. They concluded that three structural deformities present in a bunion must be corrected: the abducted hallux, the adducted metatarsal, and the pronated metatarsal. Mortier et al[11] in 2012 also used sesamoid axial radiographs to observe a mean of 12.7° of metatarsal pronation in feet with a bunion deformity. They concluded this rotation

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Figure 1. Metatarsal rotational position is described using various terms. Pronation, eversion, valgus, and external rotation are used equivalently when describing the rotational position of the first metatarsal in a foot with hallux valgus.

was due to metatarsal cuneiform instability rather than torsion of the metatarsal shaft, and that valgus metatarsal rotation in bunion deformities is systematically associated with sesamoid rotation.

Grode and McCarthy[12] took a similar view of the foot, using cryomicrotomy rather than radiographs. Their observations include the fact that, in a bunion, the position of the medial eminence or bump actually represents the dorsomedial surface of the head of the first metatarsal, which is "brought into prominence by rotation through eversion." The frontal plane microsections confirmed a pronated metatarsal head. Eustace et al[13] devised a way to measure pronation of the first metatarsal based on the observation of the location of the inferior proximal tuberosity of the first metatarsal base. They found that the degree of first metatarsal pronation is linearly related to the amount of medial deviation of the first metatarsal, and concluded that derotational surgical procedures should be further explored.

Mizuno[8] not only observed the pronated position of both the hallux and the metatarsal, he also proposed a derotational osteotomy of the first metatarsal, termed a "detorsional osteotomy" in his paper. Reports of rotational correction in the literature are sparse, though the idea has received recent attention.

Rotational correction

In 2013, Dayton et al[14] published a case series of 25 procedures in which rotational correction was incorporated as part of a modified Lapidus procedure. The addition of rotational correction to the Lapidus procedure resulted in a decrease of the IMA, but also

Figure 2. Observations of the metatarsal that help identify rotational position on AP radiograph include the lateral round sign of the first metatarsal head, the tibial sesamoid position, prominence of the medial eminence, lateral curvature of the metatarsal shaft, and lateral translocation of the proximal inferior first metatarsal tubercle.

significant decreases in the HAA, and TSP achieved without capsular balancing at the MTPJ. In addition, rotational correction produced a change in the proximal articular set angle (PASA), the angle between the estimated articular surfaces of the proximal phalanx and metatarsal head as observed on an anterior-posterior (AP) radiograph.[4]

In 2013, Okuda et al[15] described a proximal abduction supination osteotomy of the first metatarsal. They found that correction of metatarsal pronation produced a significant effect on the distal joint, including the HAA and the TSP.

In 2014, DiDomenico[16] described his procedural approach to multiplanar bunion correction, using the hallux to drive derotation of the pronated metatarsal via ligamentotaxis. As the hallux is supinated, the extensive ligamentous attachments between the proximal phalanx and the metatarsal head cause the metatarsal to move in a supinatory direction as well. This in turn aligns the metatarsophalangeal joint, reducing the HAA, PASA, and TSP.

Assessment of rotation

Metatarsal rotation cannot be seen clinically; radiographic assessment of rotational position, however, can be made using both AP views and axial views of the sesamoids. Aspects of the AP radiograph that can be used to qualify rotational position include the lateral round sign of the first metatarsal head,[15] the TSP,[15,17,18] PASA[14] (Figure 2), prominence of the medial eminence,[12] lateral curvature of the metatarsal shaft,[19] and lateral translocation of the proximal inferior first metatarsal tubercle.[13] Sesamoid axial images were the basis for quantifying pronation used by Scranton[10] and Mortier.[11] Although the techniques vary in terms of method of foot positioning and metatarsal rotational measurement, metatarsal pronation can clearly be observed with either option. Comparison of preoperative and postoperative AP and axial radiographs following derotational first tarsometatarsal joint arthrodesis are provided to illustrate observations of rotation (Figure 3).

There is a constant relationship between the fibular sesamoid and the second metatarsal described in the literature. This observation lends itself to a widely accepted hypothesis of a pathologic process wherein the first metatarsal deviates from a stable and stationary sesamoid apparatus only in the transverse plane. However, the appearance of the sesamoids on AP radiographs does not reflect the actual subluxation in relation to the median crista and the bisection of the metatarsal shaft through the median crista.[20] Pronation of the metatarsal alters how it is seen in the AP radiographic projection, much like an oblique radiograph of the foot does.[17,18,21]

Dayton et al[17] performed a cadaveric study in which the first tarsometatarsal joint was freed and the metatarsal was positioned in various degrees of pronation and supination. With pronation of the metatarsal, there was the appearance of lateral displacement of the sesamoids on the AP radiographs. With supination, the apparent sesamoid displacement was corrected. The metatarsal did not move off of the sesamoid apparatus; rather, rotation altered what was observed on the AP radiographs.

Although there is a component of AP sesamoid position that involves the transverse plane, with erosion of the crista and actual subluxation of the sesamoids that does occur,[11] by and large the appearance of displacement that one observes on AP radiographs is due to metatarsal pronation. The 2D radiographic findings are based on a 3D deformity, which includes frontal plane rotation.

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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.

A recent poster,[1] highlighting four patients with digit wounds on either the hand or foot, demonstrated the use of Ferris Mfg. Corp.'s latest product, the PolyMem® Finger/Toe dressing. The dressing was developed to be easily applied and removed and contains the same formulation of all PolyMem dressings, helping ensure less pain and more healing.

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.

Continued from page 28

Figure 3. The image on the left is a preoperative AP radiograph. The image on the right is a six-month postoperative AP radiograph. Note the observable signs of rotational position at the first metatarsophalangeal joint, including the lateral roundness of the metatarsal head, the tibial sesamoid position, the prominence of the medial eminence, the lateral curvature of the metatarsal shaft, and the abduction of the hallux. The corresponding sesamoid axial images are provided where clear alteration in rotational position is observed.

Shortcomings of osteotomy

Common and popular metatarsal osteotomy procedures do not address the primary level of the deformity, nor do they address the deformity in all three planes (Figure 4). Instead these popular procedures focus correction on a nondeformed metatarsal with the singular objective of correcting the transverse plane component of the deformity by reducing the IMA. Shaft osteotomies, regardless of their distal-to-proximal location, actually create a new deformity in the previously straight but deviated metatarsal. This is because these osteotomies are performed at sites away from the center of rotation of angulation (CORA). The CORA, as described by Paley,[22] is identified by the intersection of the distal anatomic axis and the proximal anatomic axis of a deformity.

If we do not address the deformity at the CORA, we will inevitably create secondary deformities in the bone. Although there are no data available on the percentage of metatarsal osteotomies that require significant additional attention to MTPJ realignment through soft tissue balancing, in our experience this is almost always the case with metatarsal osteotomies. In some instances, additional osteotomies of the metatarsal and hallux to align the first MTPJ properly are required, as well. We have noted in our clinical experience and in the literature that the addition of supinatory rotation during tarsal metatarsal fusion anatomically realigns the first MTPJ in the vast majority of cases without the need for MTPJ capsular balancing or any other adjunctive procedures.[15,16]

Despite a growing body of research confirming the existence

Figure 4. Commonly used metatarsal osteotomy procedures do not address the primary level of the deformity, nor do they address the deformity in all three planes. This figure highlights the retained pronated position of the metatarsal and high residual IMA following a distal metatarsal osteotomy.

of three distinct planar components of a bunion deformity, for many surgeons the priority is still focused on transverse plane correction through metatarsal osteotomy, typically followed by additional bone and soft tissue procedures at the MTPJ. In fact, the paradigm of metatarsal osteotomy and soft tissue balancing is so commonplace that any argument for a fundamental change to the approach becomes uncomfortable and seems unwarranted to most foot and ankle surgeons.

A new paradigm

In reality, frontal plane rotation, transverse plane deviation, and sagittal plane deviation of the first metatarsal act in concert to produce the anatomic structure of the bunion deformity. Each component may be present to a different degree in different deformities, but all must be considered in each case. We believe that improved outcomes in bunion surgery will require a fundamental change in our thought process, away from multiple procedures in the metatarsal to a paradigm that defines the basic anatomy of the deformity rather than a continuum of severity, and one that focuses correction at the true deformity or CORA.

The surgeon must be aware of the rotational position of the metatarsal and understand how to assess anatomic alignment intraoperatively (Figure 5). Without the knowledge of both the rotational position and how to assess this position, complete deformity correction is not consistently attainable. Based on published research and our experience, we propose this new paradigm for the management of the bunion deformity, which includes derotation of the first metatarsal. We believe this approach has the potential to improve the surgeon's ability to fully correct the deformity, as well as the potential to decrease deformity recurrence.

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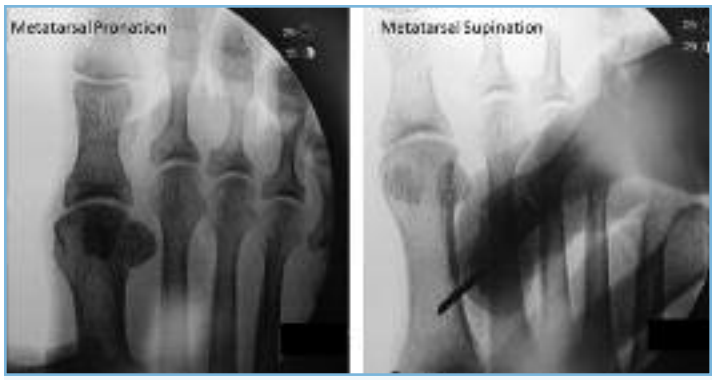

Figure 5. Intraoperative assessment of rotation using a K-wire inserted into the metatarsal shaft to act as a toggle for manipulation. When the metatarsal is pronated, one can observe changes at the MTPJ, including an increase in the sesamoid position, hallux abductus angle, distal metatarsal articulation angle, and prominence of the medial eminence. With supination, these measures are normalized.

Pentikainen[23] in 2014 presented a review of bunion procedures and noted a 73% incidence of radiographic recurrence at a mean follow-up of 7.9 years. Okuda et al[8] suggest that inadequate rotational correction plays a role in hallux valgus recurrence and that recurrence is correlated with incomplete reduction of the lateral round sign of the metatarsal head and the sesamoid position. Since investigations have shown both of these variables are products of rotational position, this suggests that incomplete reduction of rotational position is itself a risk factor for bunion recurrence. Corrections of the pronated position of the metatarsal with osteotomies or arthrodesis that impart frontal plane mobility allow the surgeon ultimate flexibility in obtaining complete and consistent deformity correction.

The fact that more than 100 corrective options have been studied and recommended for hallux valgus, as well as hundreds more options for procedure combinations, can be considered a sign of a deficiency in the conventional thought process and approach to hallux valgus correction. We believe successive or repeated minor modifications of metatarsal osteotomy surgical techniques do not represent innovation. Instead, our current multiprocedural mindset can be interpreted as a failure of the basic treatment paradigm.

Innovation requires a fundamental change in the thought process and approach to solving a problem. We believe triplane correction at the primary level of the deformity, along with rejection of previously established assessment and operative norms, are integral to future hallux valgus assessment and management. ler

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Risk of overuse injury in high school athletes

Roughly 60% of overuse injuries in high school athletes occur in the lower extremities, injuries that are increasing in number as more students participate in sports. Treatment involves rest and correction of biomechanical deficiencies, and should be individualized to each athlete.

By Allison Schroeder; James Onate, PhD, AT, ATC, FNATA; and Thomas Best, MD, PhD

The number of student-athletes participating in US high school sports has been gradually increasing, and reached a total of 7,795,658 student athletes (4,527,994 male and 3,267,664 female) in 2013-2014.[1] Many high schoolers play multiple sports or play year round and do not limit their sports to a single competitive season, with some athletes spending more than 18 hours per week participating in athletics.[2] There has also been a trend toward early and intense training, frequent competition, and single-sport specialization, with the goal of competitive success.[3,4]

It has been speculated that, as the popularity and intensity of high school athletics continues to increase, the number of athletes sustaining overuse injuries will also increase as a result of excessive tissue stresses combined with inadequate recovery periods.[5,6] Although there is no consensus on the definition of an overuse injury, it is generally accepted that these injuries result from repetitive microtrauma without sufficient time for recovery from the cumulative tissue loads.[5,7-10] Overuse injuries may involve the muscle-tendon unit, bone, articular cartilage, physis, or bursa.[6]

Epidemiology

The incidence and prevalence of overuse injuries are difficult to quantify because they may not result from time lost from sport or they may go undiagnosed as an athlete will play through them until end of the season and then improve with rest during the offseason.

Reports estimate that the proportion of all sports injuries due to overuse ranges from 45.9% to 54%.[8,11,12] During the 2013-2014 academic year, a summary report of 100 US high schools indicted that the overall rate of sports injuries, both acute and chronic, was 2.18/1000 athletic exposures (AE).[13] A five-year study from the same database revealed that overuse injuries represented 7.7% of all injuries, with an injury rate of 1.5/10,000 AE (1.26/10,000 AE in boys and 1.88/10,000 AE in girls).[14] A recent cross-sectional retrospective study by Stracciolini et al of 1614 patients aged 5 to 17

In perhaps the largest study to date, the body site most likely to be injured by an overuse mechanism was the lower leg, followed by the knee, shoulder, and foot.

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years indicated that 52% of the injuries sustained were related to overuse.[15] Fifty percent of overuse injuries cause less than one week of time away from sport, but 4.5% of these injuries have led to medical disqualification for the season.[14]

In perhaps the largest study to date, girls' track and field (3.82 injuries/10,000 AEs) and girls' field hockey (2.93 injuries/10,000 AEs) were the high school sports with the highest injury rates, with the lower leg and knee being the most frequently injured body sites, respectively.[14] Overall, the body site most likely to be injured by an overuse mechanism was the lower leg, followed by the knee, shoulder, and foot.[14] Overuse injuries to the lower extremities (including injuries to the thigh/upper leg, knee, lower leg, ankle, and foot) accounted for 62.6% of all overuse injuries.[14] The aforementioned study by Stracciolini et al indicated that 60.7% of all overuse injuries occurred in the lower extremities.[15]

Risk factors

Risk factors for overuse injury are typically divided into intrinsic and extrinsic causes.[6]

Intrinsic risk factors in high school athletes include prior injury,[16-18] weakness in bone and cartilage during skeletal maturation,[19-21] anatomic alignment abnormalities (pes planus, pes cavus, excessive lumbar lordosis, joint hypermobility),[22-24] changes in biomechanics with the growth spurt,[25,26] individual strength and conditioning levels,[27-30] and presence of the female athlete triad (inadequate caloric intake, amenorrhea, low bone mineral density).[31,32]

Extrinsic risk factors include increased volume and intensity of sports participation, less recovery time between bouts of exercise,[3,33] participation in sports involving repetitive movement (ie, running),[14,15] and improper sizing or poor maintenance of equipment (specific data are lacking).[6] Recently, sports specialization has been found to increase the risk of overuse injuries independently in athletes that specialize in a single sport (after accounting for age and number of hours spent training per week).[34]

Common lower extremity injuries

Patellofemoral pain syndrome (PFPS), stress fractures, and apophysitis are three of the most common overuse injuries of the lower extremities. PFPS is the most common diagnosis in sports medicine and is more common in female athletes and runners.[35,36] Pain is exacerbated by jumping, climbing stairs, and sitting for extended periods.[37]

Stress fractures represent bone's inability to repair itself through remodeling and are being recognized with greater frequency in the pediatric population.[37] Metatarsal stress fractures have been found to be more common in runners, while tibial stress fractures were found to be more common in tennis and basketball, but are also common in runners.[38,39] A sudden increase in training intensity is speculated to be a major risk factor for stress fractures, no matter the age of the athlete or the sport.[40-42]

It is important to identify high-risk stress fractures, which comprise up to 10% of all stress fractures and include fractures of the tension side of the femoral neck, the patella, the anterior tibia, the medial malleolus, the talus, the tarsal navicular, the sesamoids, and the base of the fifth metatarsal. If not treated properly, these injuries can result in nonunion, chronic pain, or both.[6,43,44]

Apophysitis injuries occur because, in the adolescent, the site of attachment between the tendon and bone is weaker than the tendon itself.[45] These injuries most commonly occur at the tibial tubercle, distal patella, calcaneus, and the base of the fifth metatarsal. Osgood-Schlatter disease (tibial tubercle apophysitis) typically presents when patients are aged between 10 and 15 years, is often bilateral, is exacerbated by impact and deceleration (running, jumping, cutting), and is more common in boys and those undergoing a rapid growth spurt.[46-48]

Sinding-Larson-Johansson syndrome (apophysitis of the inferior pole of the patella) typically presents when children are aged between 9 and 12 years and is aggravated by jumping and running. Sever disease (calcaneal apophysitis) is the leading cause of heel pain in adolescent athletes and leads to 8% of all pediatric overuse injuries.[49] It is most commonly seen in sports requiring running, jumping, and plantar flexion.[50] Iselin disease (fifth metatarsal apophysitis) typically appears in athletes aged between 8 and 15 years and is more common in cutting sports that create inversion stress on the ankle and require activation of the peritoneal muscles.[49,51,52]

Although tendinitis is less common in adolescents than in adults, iliotibial band (ITB) tendinitis is encountered in adolescent runners and cyclists.[53] Lower extremity varus alignment, overpronation from high arches, and lateral tilt of the pelvis predispose athletes to ITB tendinitis.[54]

Treatment

The mainstay of treatment following an overuse injury is traditionally rest and physical therapy (PT) to address physical deficiencies.

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Although many practitioners recommend "rest" and "activity modification" following an overuse injury, there is not an exact formula that can be used to calculate when it is safe for an athlete to return to modified activity and when to return to full activity.

The amount of rest and activity modification depends on many factors, including the injury type, severity, and level of intensity of play to which the athlete wishes to return. The athlete's pain level should be frequently assessed and the treatment plan modified as necessary throughout the return-to-play and rehabilitation process. There is currently debate regarding whose decision it should be to allow an athlete to return to play (physician, athletic trainer, physical therapist, parents, coach, athlete, etc), though shared medical decision-making has been historically recommended.[55,56]

The use of objective evidence-based screening assessment processes to address biomechanical asymmetries and movement deficiencies is vitally important in the treatment of overuse injuries. Clinicians are often focused on asymmetrical movement patterns indicating a stability or mobility impairment, but caution should be noted that overall movement performance assessment is critical to proper movement assessment and subsequent treatment plans.

A clinical example would be the use of the single-leg hop for distance test to assess for functional deficits following a lower extremity injury. A patient may have large asymmetries with significant performance deficits in the injured leg due to lack of strength, range of motion deficits, or dynamic postural control inefficiency. However, even if movements are symmetrical, this does not mean they have adequate movement efficiency to avoid injury. A current clinical phenomenon that we are evaluating in our research laboratory is that individuals with overuse injury may have created a bilateral compensation pattern that may cause degradation in performance while maintaining symmetry across limbs.

Therapeutic interventions focused on asymmetry and performance outcomes should clinically emphasize sequential movement focus areas with initial focus on proper muscle activation, followed by an emphasis on the development of proper joint stability and mobility. Following the acquisition of proper muscle activation and stability and mobility, a movement focus, depending on the biomechanical deficiencies and movement demands of the individual, should be addressed to acquire adequate strength, power, endurance, and sport skill application specific to the activity's demands.

Therapeutic interventions focused on the traditional specific adaptations to imposed demand (SAID) principle[57] should be adhered to when developing therapeutic intervention plans with proper flexibility in programmatic sequence based on the patient's physical (eg, muscle soreness or inflammation) and mental responses (eg, fatigue or boredom). A multifactorial approach to PT allows individuals to focus on the wide array of potentially contributing factors that often lead to overuse injuries; dosage, technique, fatigue, activation patterns, asymmetries, performance outcomes, anatomical alignments, neurological demands, etc.[58-60]

Modalities and bracing are often used as an adjunct to rest and PT, but limited studies have examined their use in adolescents. Their risks and benefits have been inferred from studies in the adult population and are based on use in clinical practice. Ice and heat are commonly used following injury. Oral acetaminophen may be helpful for short-term pain relief. Several small randomized trials support the use of topical nonsteroidal anti-inflammatory gel for short-term pain relief, but it has not been shown to have long term benefits.[61]

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Glucocorticoid injections may reduce pain initially, but have worse long-term outcomes in children than adults and carry the risk of tendon rupture; their use in adolescents who still have open physes is contraindicated.[62,63]

Massage therapy and myofasical release have been found to result in faster healing of sprained and strained muscles, and also relieve muscle tension and stiffness, reduce muscle pain, and increase joint flexibility and range of motion, all factors that can contribute to the treatment and prevention of overuse injuries.[64,65] However, the utility of massage in injury prevention is still unknown.[66]

Injury-specific bracing may also be useful in the treatment of overuse injury, for example, bracing has been shown to prevent anterior knee pain.[67]

Footwear, foot orthoses, and massage have also been used as therapeutic interventions for overuse injury treatment and prevention. A systemic review and meta-analysis of 23 studies concluded there is little evidence to support the use of foot orthoses in treating overuse injuries, but there is more evidence to support the use of orthoses in preventing lower limb overuse injuries, though many studies included in the meta-analysis were of poor quality.[68]

An additional study indicates that 20% of lower extremity overuse injuries can be prevented with foot orthoses.[69] The study reported no difference between custom and prefabricated foot orthoses in the prevention of lower extremity overuse injury, but it is important that they are contoured to the foot and are not just shock-absorbing insoles.[68] The main reason athletes discontinue the use of foot orthoses is discomfort.[68,70] Some studies also point to the use of minimalist footwear and gait retraining as new methods to reduce lower extremity overuse injuries, especially in runners.[71]

Prevention is the best form of treatment

It is believed that the majority of overuse injuries are preventable; therefore, being able to adequately identify athletes at greatest risk is very important.[6] In spite of the preventable nature of these injuries, studies outlining successful overuse injury prevention methods are lacking.[6]

A 2014 position statement by the American Medical Society for Sports Medicine (AMSSM) gave several recommendations for consideration in overuse injury prevention.[6] However, these statements were based on only inconsistent or limited patient-oriented evidence or consensus, usual practice, or expert opinion.[6] The AMSSM recommended limiting training workload by limiting participation time and scheduling rest periods and individualizing these modifications based on the athlete's age, growth rate, and injury history.[6] They supported preseason strength and conditioning training as well as prepractice neuromuscular training to reduce the risk of lower extremity injuries.[6]

A recent systematic review and meta-analysis by Lauersen et al indicated that strength training was more effective than proprioceptive training for preventing overuse injuries, while stretching before or after exercise showed little effect on the prevention of overuse injuries.[72] The AMSSM also recommended use of proper fitting equipment, especially since ill-fitting equipment can alter biomechanics.[6]

Finally, it is important to identify prior injury patterns, assess for early sports specialization, and determine menstrual (dys)function in female athletes.[6] The National Athletic Trainers Association (NATA) also published a position statement on the prevention of overuse injuries in adolescent athletes.[11] The strongest evidence supported the recommendation for education of pediatric athletes, parents, and coaches about the signs and symptoms of overuse injuries, and athletes being instructed to notify an adult when such symptoms occur, as ways to prevent overuse injuries.[11] The NATA position statement also found strong evidence to support the statement that preventive training programs, both preseason and in-season, that focus on neuromuscular control, balance, coordination, flexibility, and strengthening of the lower extremities may also reduce the overall risk for overuse injuries, especially among athletes with a previous overuse injury.

According to a recent study, athletes and their parents should also be counseled on the increased risk of overuse injuries in young athletes who specialize in a single sport.[34]

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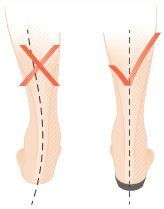

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APTA's revised heel pain guidelines spur dialogue

The American Physical Therapy Association has updated its 2008 guidelines on the nonsurgical treatment of heel pain with a bolstered evidence base, but lower extremity practitioners continue to debate the clinical merits and most effective applications of certain newer therapies.

By Hank Black

New treatment recommendations for heel pain published recently by the American Physical Therapy Association[1] (APTA) update the group's 2008 guidelines[2] and continue the lower extremity community's efforts to base practice guidelines on recently published scientific evidence.

Although there are no transformative changes to the previous APTA document, the new one includes stronger evidence for manual therapy and antipronation taping, among other changes.

Heel pain, specifically plantar fasciitis, is the most common of foot ailments and affects more than two million people in the US at any time. Some 10% of the population will be hobbled by chronic heel pain over the course of a lifetime.[3] One report found that plantar fasciitis accounts for 15% of all adult foot complaints requiring professional care and is widespread in both athletic and nonathletic populations.[4]

The 2014 APTA guidelines address heel pain with a mechanical etiology rather than neurologic, arthritic, or traumatic causes.

Not all groups of specialists who treat heel pain offer clinical practice guidelines. The American Orthopaedic Foot and Ankle Society (AOFAS), for example, does not, while the American College of Foot and Ankle Surgeons (ACFAS) published its latest version in 2010.[5] While the APTA and ACFAS clinical recommendations dovetail into a relative synchrony of tiered actions in an attempt to base clinical practice on published evidence, differences over some topics continue to spur discussion.

As one would expect, differences in clinical perspective are at the root of a number of the disagreements. The scope of physical therapy practice obviously does not include surgery, corticosteroid injection, and some other types of treatment. And, even among individuals in surgical disciplines, there is disagreement about when or even whether to initiate corticosteroid injection and whether treatments such as extracorporeal shock wave therapy (ESWT) should be offered to patients. In addition, some clinicians are using newer treatments such as radiofrequency coblation, while most are

> Adhering to practice guidelines is not mandatory, of course, but insurance auditors often use clinical guidelines to determine the appropriateness of payment.

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awaiting additional accumulation of evidence before employing it.

Practice guidelines of the APTA and others rank evidence and make recommendations in similar ways. For example, the APTA grades evidence from Level I (the highest, based on randomized controlled trials) to Level V (expert opinion). The highest degree of recommendation is grade A (considered strong evidence based on Level I or II studies) and the lowest is grade F, which is based on expert opinion.

Rob Roy Martin, PT, PhD, one of the APTA guideline authors and a professor of physical therapy at Duquesne University in Pittsburgh, said, "I was excited to see the range and level of research support for some physical therapy interventions, particularly for manual therapy, stretching, and therapeutic taping, as well as the use of orthoses."

Martin, who was also a coauthor of the 2008 APTA guidelines, said one of the goals of guideline development is to make physical therapy practice uniform, particularly when there's evidence to support it.

"Different therapists may, based on their clinical practice, offer some different ways of treating the patient, but there should be at least some uniformity in the interventions," he said. "Basically, patients should receive some type of manual therapy in the form of joint and soft tissue mobilization, as well as some form of arch taping. And hopefully the physical therapist will pay attention as evidence-based research is developed, and make it part of their routine practice."

Guidelines prompt research

The development of earlier clinical guidelines may have helped spur research on particular treatment methods, Martin said.

"It's good to see evidence accumulate and point toward additional standard modalities, whether or not the guidelines provoked or motivated people to research those areas," he noted.

The development of a strong recommendation for manual therapy in the new document, for example, was supported by studies including a 2011 randomized clinical trial[6] that found that exercise plus soft tissue mobilization techniques directed to gastrocnemius and soleus trigger points was superior to exercise alone. The 2008 guidelines had found minimal evidence to support the use of manual therapy.

The new document provides general guidance–perhaps too general, said Michael Gross, PT, PhD, FAPTA, who is a professor in the Department of Physical Therapy at the University of North Carolina at Chapel Hill.

"I'm in agreement with most of the guidelines," Gross said. "I like the emphasis on stretching but would like details on what kind of stretches to do. I use a standing heel-cord stretch, taking advantage of the windlass mechanism by having a towel roll propped under the toes so they are maintained in extension."

The new evidence supporting longitudinal arch taping is also welcome, Gross said, particularly for recalcitrant cases.

"However, the technique requires some expertise, and many patients or family members may not be able to apply the tape effectively," he said.

Gross also thinks practitioners need to determine the point in the gait cycle at which pain is most prominent in order to provide the most effective treatment.

"If pain occurs when the heel strikes the ground, the problem is compressive stress, so you need a soft, deformable material under the heel to attenuate the ground force and increase contact area," he said. "But, if the pain comes when you're pushing off, the heel is off the ground and the metatarsophalangeal joints are going into extension. That indicates that the windlass mechanism, in combination with a tight plantar fascia, is probably resulting in excess tensile stress within the fascia. In that case, heat and stretching of the fascia, along with a stiffer toe-break in the shoe and a rocker-bottom configuration, will probably help."

Practice guidelines, of course, are not mandatory, and practitioners are expected to depend on their clinical judgment, as well. Martin noted, however, that insurance auditors often use clinical guidelines to determine the appropriateness of payment.

Martin said the new recommendation to provide weight-loss counseling is part of the APTA's desire to consider the patient as a whole rather than just as someone with a painful foot problem.

"There hasn't been a study to say that losing weight will improve foot pain, but it is a recognition that if you are overweight you are more likely to develop this problem," he said. "We felt there is enough evidence[7,8] to at least get in a conversation about it and remind the patient that this might be consequential to their foot health as well as their life as a whole."

The physical therapy association's guideline authors also pinpointed pain-related fear of movement as the greatest single contributor to disability in people who have plantar fasciitis and called for more research on pain-related fear.[9] Additionally, the group

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noted the widespread, growing acknowledgement that chronic plantar foot pain involves a degenerative process and should be termed fasciosis rather than fasciitis, reserving fasciitis to describe acute inflammatory events.

Pathways and interventions

The APTA guidelines recommend pathways for diagnosing, evaluating, and treating plantar heel pain of mechanical origin. They noted that the physical exam should include palpation, talocrural joint dorsiflexion range of motion, tarsal tunnel syndrome and other peripheral nerve entrapment tests, and the windlass test, as well as functional assessment of joints and muscle groups from the gastrocnemius-soleus complex to the trunk, buttock, and thigh.

Initial interventions may include activity limitation, stretching of the plantar fascia and calf muscle, taping, night splints, heel cups, and prefabricated or custom foot orthoses. Also included are therapeutic exercises and neuromuscular re-education, which are expected to strengthen and train muscles to reduce pronation[10,11] and improve weight management. For patients who present with acute pain, physical agents such as iontophoresis and phonophoresis may be recommended.

The APTA guideline authors formally evaluated research up to January 2013. Although the use of trigger point dry needling was not recommended based on those studies, the authors published a supplemental note concerning a 2014 randomized clinical study by Cotchett et al that found a significant effect of decreased pain and improved Foot Health Status Questionnaire scores at a six-week follow-up compared with sham dry needling.[12]

"It will be interesting to see if more research arises to support dry needling [so that it may possibly be included] in the development of future guidelines," Martin said.

He said he believed the recommended APTA practices are generally similar to those practiced by specialists and noted that a surgeon was a coauthor and a professor of medicine was a reviewer. Disagreements among the practitioners include interventions such as ESWT, corticosteroid injections, and certain surgeries.

"There's not a whole lot of evidence to support injections; we think the potential harm outweighs potential benefits," Martin said. "Also, the better quality studies we evaluated found that ESWT was not the favored treatment and found the potential for adverse effects associated with it. ESWT did not appear to be more effective than stretching for reducing pain."

Injection controversy

The 2010 clinical guidelines published by the ACFAS include the possibility of an anti-inflammatory injection in Tier 1 of the organization's three-stage progression of treatment. Brandi Johnson, DPM, FACFAS, who practices in Brandon, FL, said her practice choices are driven by patient presentation, and if the pain level is extremely high she may inject on the first or second patient visit.

"It is rare to give more than two injections, and if they don't provide relief we know we should look for other causes of the heel pain," Johnson said. She mentioned spondyloarthritis, tarsal tunnel syndrome, and entrapped Baxter nerve as potential other causes.

Short of corticosteroid injection, Johnson uses oral anti-inflammatory medications in Tier 1 along with stretching, icing, over-the-

counter heel cups, and prefabricated foot orthoses, and also considers taping regimens.

Of the ACFAS's Tier 2 interventions, she may prescribe custom foot orthoses, night splints if the patient can tolerate them, and, if indicated, a second corticosteroid injection. In Johnson's experience, some 95% of patients with heel pain due to plantar fasciitis find relief of symptoms from nonoperative techniques. But, after a year of insufficient pain relief or functional disability she goes to Tier 3, including open or minimally invasive fascia release surgery.

"I primarily use the endoscopic release technique, but no surgery is justified except as a last resort due to the prolonged recovery period and a small risk of injury," Johnson said.

If she does commit to fascia surgery, she said, she often concurrently performs a gastrocnemius recession if the patient presents with a tight heel cord.

Johnson noted that evidence[13-15] is beginning to accumulate in favor of using platelet-rich plasma (PRP) treatments for heel pain, particularly in sports medicine applications. Neither set of heel pain guidelines have addressed this potential treatment, however.

"Although this intervention is not yet included in our recommendations, research is generally favorable and has no major side effects," she said. "I have seen patient improvement in extremely recalcitrant cases after use of PRP."

While Johnson does not believe evidence for dry needling[12] is strong enough to support its use to bring healing cells into the chronically degenerative process of fasciosis, she said PRP, a form of wet needling, accomplishes the same result. A similar mechanism is used with ultrasound debridement and radiofrequency coblation, neither of which Johnson currently uses due to lack of evidence of efficacy, she said.

As for ESWT, which also causes microscopic damage to the fascia to enable new blood vessel formation and increased delivery of nutrients to the affected area, Johnson echoed the ACFAS guidelines' conclusion that there is insufficient evidence for its use, and noted that many insurers do not reimburse for it. Yet, some other practitioners disagree. ESWT is sometimes prescribed by Robert Anderson, MD, FAOFAS, a past president of the AOFAS, who practices in Charlotte, NC. Anderson, however, concurred with Johnson's assessment of its reimbursability.

"Both low- and high-energy ESWT are difficult to get approved. The three-thousand dollar price tag, however, is prohibitive for many who must pay cash," Anderson said.

Whereas Johnson depends primarily on endoscopic surgery for fascia release, Anderson leans toward the open technique, usually performing a distal tarsal tunnel release and a partial plantar fascia release. When a tight Achilles tendon can't be sufficiently stretched with physical therapy, he said, "I may opt to offer not a plantar fascia release but gastrocnemius recession surgery, releasing the gastroc tendon and leaving the soleus muscle intact so the Achilles complex is not overly weakened." A recent publication by Molund et al described results and complications associated with this procedure.[16]

Anderson estimated that about 95% of patients he sees with heel pain experience reduced pain and increased mobility with the initial treatments, which include activity modification, shoe inserts, icing, heel pads, foot orthoses with good arch support, and over-the-counter nonsteroidal anti-inflammatory oral medication.

"The heart of the initial treatment is Achilles tendon stretching

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to take the tension off the plantar fascia, along with windlass stretches," he said.

If patients have insufficient relief from these initial treatments, Anderson refers them to physical therapy for deep tissue massage, a more formal stretching regimen, physical agents, and night splints or casting. At this point he may provide a single intralesional corticosteroid injection (ICSI).

"I avoid a second injection because studies have shown it may lead to spontaneous rupture of the fascia," he said. The ACFAS guideline[5] includes ICSI in its Tier 1 and Tier 2 pathways; the APTA guidelines state that systemic reviews failed to find evidence of a substantive clinical benefit of ICSI and that fascia rupture is among its potential adverse effects.[17,18]

Foot orthoses

The 2008 APTA heel-pain guidelines recommended that practitioners "may use" prefabricated or custom foot othoses to give pain reduction and function improvement for up to three months. Now, based on a number of studies,[19-21] the recommendation is that clinicians should use arch-supporting and heel-cushioning features for periods as short as two weeks and as long as a year.

Anderson includes prefabricated shoe inserts or heel cups as part of his initial treatment, but if those are not effective he presents custom orthoses as an option for chronic pathologic conditions of the plantar fascia.

"Although custom orthoses are expensive and sometimes not covered by insurance, they are very beneficial, in particular for people with underlying cavus foot, pes planus, and other conditions," he said.

Rob Sobel, CPed, who practices in New Paltz, NY, and is the president of the Pedorthic Footcare Association, believes prefabricated insoles are sufficient for some patients.

"If a patient has multiple bouts of plantar inflammation, chances are it's a biomechanical issue, which custom foot orthoses are designed to correct," Sobel said.

Orthosis design should be influenced by the patient's weight, lifestyle, and other factors, he said.

"The thickness of the polypropylene shell varies depending on a patient's weight, and if the shell is too hard for the patient to tolerate, we may shift to a higher durometer EVA [ethylene vinyl acetate] to provide more 'give' but still maintain proper foot position," he said.

In determining the best type of orthosis for a given patient, it's helpful to have as much input from possible from other practitioners, Sobel said.

"When you have multiple practitioners working toward the same goal from different perspectives, the result is a better outcome for the patient," he said. ler

Hank Black is a medical writer in Birmingham, AL.

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The psychology of returning to sports after ACL surgery

Psychological factors are responsible for delayed return to sports after anterior cruciate ligament reconstruction in a significant number of patients despite successful physical rehabilitation, but questions remain as to the most effective ways to address these issues.

By Trevor A. Lentz, PT, SCS, CSCS

Anterior cruciate ligament (ACL) rupture is a common sports-related injury, with multiple physical, psychological, economic, and social consequences. Those who suffer an ACL tear often choose to undergo surgical reconstruction, as this is thought to provide the best chance of returning to unrestricted sports participation.[1,2] Indeed, the development of arthroscopic reconstruction techniques and the subsequent emergence of accelerated rehabilitation protocols have made return to preinjury levels of sports participation a very realistic possibility for most patients.[3-5] But how effective are we as sports medicine professionals at returning patients to preinjury levels of sports participation and performance?

Recent studies have clarified the current state of return to sport following ACL reconstruction, and the results are discouraging. In a large meta-analysis, Ardern et al[6] found that, while 81% of people returned to some level of sport after surgery, only 65% returned to their preinjury level of sport and 55% returned to competitive sports after surgery. Many studies have identified potentially modifiable factors as a primary barrier to return-to-sports participation. These potentially modifiable factors often include psychological factors.[7-10] In fact, psychological factors are often the most prevalent reason for not returning to sports, with numerous studies reporting that roughly half of those who do not return to sports, or approximately 20% of all patients undergoing ACL reconstruction, cite psychological factors as a primary reason.[7,8,10-12]

Psychological factors as a barrier

The prevalence of psychological factors inhibiting return to sport is not surprising. Across other anatomical regions and diagnoses, psychological factors are regarded as some of the strongest and most consistent predictors of pain and disability, often more so than commonly assessed physical factors.[13-16] More surprising, however, is that most established ACL rehabilitation guidelines and return-to-sport criteria fail to include specific assessment or intervention recommendations for psychological factors,[17-20] and

> Our ability to consistently provide patients with a strong, stable knee has outpaced our ability to consistently provide them with psychological readiness for sports.

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these factors are not often recognized by clinicians as barriers to sports participation.[21]

The relatively high prevalence of psychological factors as a barrier to sports participation may be due to many reasons. First, accelerated rehabilitation programs that place a heavy emphasis on early range of motion, weightbearing, quadriceps strengthening, and neuromuscular retraining have reduced the risk of developing physical limitations that impede sports participation. Patients are typically allowed to begin sport-specific training three to four months after reconstruction, and get clearance for return to unrestricted sports participation around six to nine months postsurgery.[20] However, as a result of these impairment-focused accelerated rehabilitation programs, our ability to consistently provide patients with a strong, stable knee has outpaced our ability to consistently provide them with psychological readiness, thus leading to a relatively higher prevalence of psychological barriers.

Another reason for the relatively high prevalence of psychological barriers is that surgical success has historically been defined by objective outcomes (eg, knee ligament laxity, graft integrity, knee range of motion, knee strength), with less attention on the ability to return to sports. Presumably, this focus has been the result of inherent difficulties in quantifying return to sports, or the assumption that resolution of objective knee impairments necessarily facilitates a return to unrestricted sports participation. However, multiple studies have now shown that resolution of knee impairments is a poor proxy for return-to-sport status.[10,22] For instance, Ardern et al found that, while 90% of people undergoing ACL reconstruction achieved normal or nearly normal knee function postoperatively (mean, 41.5 months) using impairment-based outcomes, only 63% had returned to their preinjury level of participation, and 44% had returned to competitive sports.[10]

The extent to which variance in return-to-sports outcomes is not explained by physical factors commonly addressed in rehabilitation provides a compelling argument for reevaluating whether our current rehabilitation approaches and return-to-sports criteria that focus on objective outcomes should also include consideration of psychological factors.

Psychological contributors

The concept of psychological factors as barriers to return to sports is not new.[23,24] In the mid-1980s, researchers applied grief and loss and cognitive appraisal models to sports-related injury to describe psychological adjustments and emotional responses throughout recovery.[23] In the mid-to-late 1990s, specific considerations emerged for psychological responses to ACL injury and reconstruction.[23] Since then, our understanding of psychological factors as they contribute to poor sports performance and the ability to return to sports following injury has grown considerably.[25]

Fear-avoidance beliefs. "Fear-avoidance beliefs" is a broad term referring to the avoidance of activities based on fear.[26] In patients who have undergone ACL reconstruction, the most common fear-avoidance beliefs are those regarding fear of movement (kinesiophobia) and fear of pain. The fear avoidance model has been proposed to describe the development of fear of pain, anxiety, and disability as the result of a painful experience or injury.[27] A full description is beyond the scope of this article; interested readers are referred to reviews by Vlaeyen and Linton and Leeuw et al.[27,28]

While the fear-avoidance beliefs model was initially developed to describe the transition from acute to chronic pain in patients with low back pain, the inherently painful and destabilizing nature of an ACL injury lends itself to the theoretical application of this model in patients who have undergone ACL reconstruction, and recent studies provide empirical and statistical evidence to support the validity of the fear avoidance model in this population.[29,30]

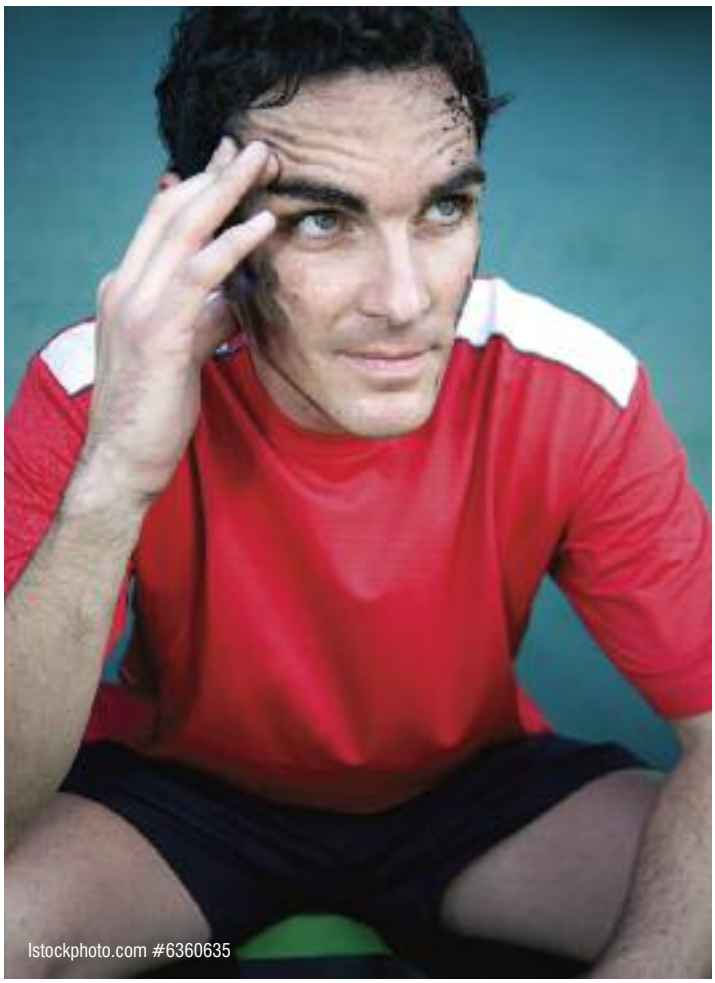
Empirical support for the fear avoidance model is found in numerous studies reporting on self-described reasons for not returning to sports. Many of these have found that fear of reinjury is the most common reason for not returning to sports, more common than knee instability or pain.[2,7,8,10] Other studies have identified fear avoidance beliefs as a significant contributor to knee function in multivariate analysis. Ross et al[31] showed that fear avoidance beliefs related to physical activity contributed significantly to knee function and sports-related activity after ACL reconstruction, even after accounting for injury-related variables and physical impairment measures.

A similar study by our research group found that kinesiophobia was a significant contributor to self-reported function in a multivariate analysis, after accounting for common physical impairment and demographic variables in patients who had been cleared for return to sports at six months and one year post-ACL reconstruction.[32] In a cross-sectional study of patients within the first year of ACL reconstruction, Chmielewski et al found higher levels of kinesiophobia in the first three months after surgery than after six months; however, kinesiophobia after six months was significantly associated with knee function.[33] This study included patients in both the early postoperative and late return-to-sports stages of rehabilitation and did not distinguish between patients who had and had not been cleared to return to sports in the late stage. Collectively, these findings suggest that fear-avoidance beliefs contribute to functional limitations following ACL reconstruction and should be considered a target for rehabilitation after surgery.

Pain catastrophizing. Knee pain typically decreases over time following ACL reconstruction, and is generally low in the late postsurgical stages of rehabilitation.[9,33] However, despite relatively low levels of pain following surgery, the presence of pain is a common impairment-related barrier to sports participation and a significant predictor of function throughout rehabilitation.[9,11,33] In addition to fear of pain, pain catastrophizing may be one mechanism by which even low levels of pain can contribute to significant functional limitations following ACL reconstruction.

Pain catastrophizing is an exaggerated response to actual or anticipated pain.[34] Catastrophizing behavior as it relates to pain is one of the central mechanisms driving avoidance behavior in the fear-avoidance model and may be a significant factor for people following ACL reconstruction who have pain or anticipate pain as the result of a functional activity. Clinical studies have identified pain catastrophizing as a significant predictor of pain intensity in the early postsurgical phases of rehabilitation; however, its influence on function in later stages of rehabilitation, including return to sports, is not as clear.[30,35] Pilot data suggest early postoperative and one-year differences in pain catastrophizing between patients who return to sports after ACL reconstruction and those who do not due to fear of reinjury, but those data require confirmation in larger studies.[36]

Psychological resilience. While most studies have focused on negative factors that confer psychological vulnerability to injury or pain, less attention has been paid to positive factors that enable patients to adaptively cope with their injury or pain. Positive psychological resources, such as self-efficacy or optimism, may have a significant influence on return to sports after ACL reconstruction and should be considered an important adaptive psychological factor. Chmielewski et al,[30] for example, found that early improvements in self-efficacy following surgery were associated with greater reductions in pain and function, while other studies have linked preoperative resilience factors—such as psychological readiness to return to sports (measured with the ACL-Return to Sport after Injury [ACL-RSI] scale, internal locus of control, and positive expectations—with significantly higher odds of returning to sports.[37]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In a systematic review of psychological predictors of ACL outcomes, Everhart et al[38] found that early measures of self-efficacy, self-motivation, and optimism were predictive of return to sports and knee function. Resilience factors are independent of negative psychological factors, such as fear avoidance and catastrophizing, and therefore should be assessed and addressed independently in the clinical encounter.

Identifying patients at risk

Recovery of function and sports performance following ACL reconstruction is a multidimensional, complex process. For some patients, psychological factors may represent a significant barrier to regaining knee function or sports performance. Others will not have any significant psychological barriers. One of the most important limitations in our current knowledge is how to prospectively identify patients who are at risk for poor return-to-sports outcomes due to psychological factors.

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Unfortunately, no threshold values have been firmly established for psychological questionnaires when determining risk for failure to return to sports after ACL reconstruction. Some studies, however, have reported questionnaire means for groups of patients who do not return to sport, and these provide some direction for identifying patients with elevated fear of reinjury.

Our research group found that patients who were unable to return to sports had mean scores of 20 points on the Tampa Scale for Kinesiophobia (TSK-11), while their counterparts who were able to return to sports reported mean scores of 15 points.[8] Those who were unable to return to sports due to fear of reinjury, specifically, scored slightly higher, with a mean of 21.5 points.[9] A small pilot study examining TSK-11 cut-off scores found that decreased odds of returning to sports after ACL reconstruction were associated with TSK-11 scores greater than 19 points; this threshold, however, should be confirmed in larger studies.[39] In addition to the TSK-11,[40] other questionnaires that may be used to assess psychological factors include the Pain Catastrophizing Scale (PCS),[34] Knee Self-Efficacy Scale (K-SES),[41] and ACL-RSI scale.[42] Based on available evidence, psychological factors should be evaluated early on in rehabilitation, tracked throughout the rehabilitation process, and assessed as a criterion for return to sports.

There is limited information specific to ACL injury populations that can be used to drive evidence-based recommendations for psychological treatment approaches. However, extensive research on treatment of patients with low back pain may provide some guidance. In low back pain populations, psychologically informed practice has been presented as a secondary prevention approach for the development of chronic pain and disability. Briefly, this approach incorporates screening for psychological factors and implementation of cognitive behavioral approaches into activity-based interventions. Interested readers may refer to a review by Nicholas and George for more information on this approach.[43]

Psychologically informed practice has shown promise for improving function in patients with low back pain who display clear signs of fear of pain or reinjury,[44] and may be beneficial for patients demonstrating similar issues following ACL reconstruc- tion. However, this approach has not been examined in the published literature involving clinical trials of ACL reconstruction. Unfortunately, researchers and clinicians have a limited understanding of when negative psychological factors emerge and how they change over time. It stands to reason, however, that psychologically informed practice approaches may be most beneficial if started early in rehabilitation and continued through return-to-sports stages for patients with high levels of fear-avoidance beliefs, high levels of catastrophizing, or low psychological resilience.

Perhaps the most important aspect of evaluating and managing psychological factors following ACL reconstruction is for clinicians simply to talk with patients about this potential barrier. For some patients, early education on the healing process and risk factors for reinjury may help relieve fears that develop shortly after surgery. Discussing pain mechanisms and the expectation that recovery can take many months may help to reduce the early catastrophizing that often accompanies the experience of pain.

Often, the best way to assess specific psychological barriers is to ask. Most patients will discuss activities or movements that elicit fear, and graded exposure to these movements may be a good way to reduce those fears and improve self-efficacy. For other patients, return to sports may not be a priority. In fact, a sizeable percentage of patients do not return to sports after ACL reconstruction due to a change in lifestyle or a change in priorities.[2,7,8] Ultimately, establishing realistic goals and expectations, as well as maintaining open communication between patient and clinician, can go a long way toward assessing and managing psychological barriers in rehabilitation.

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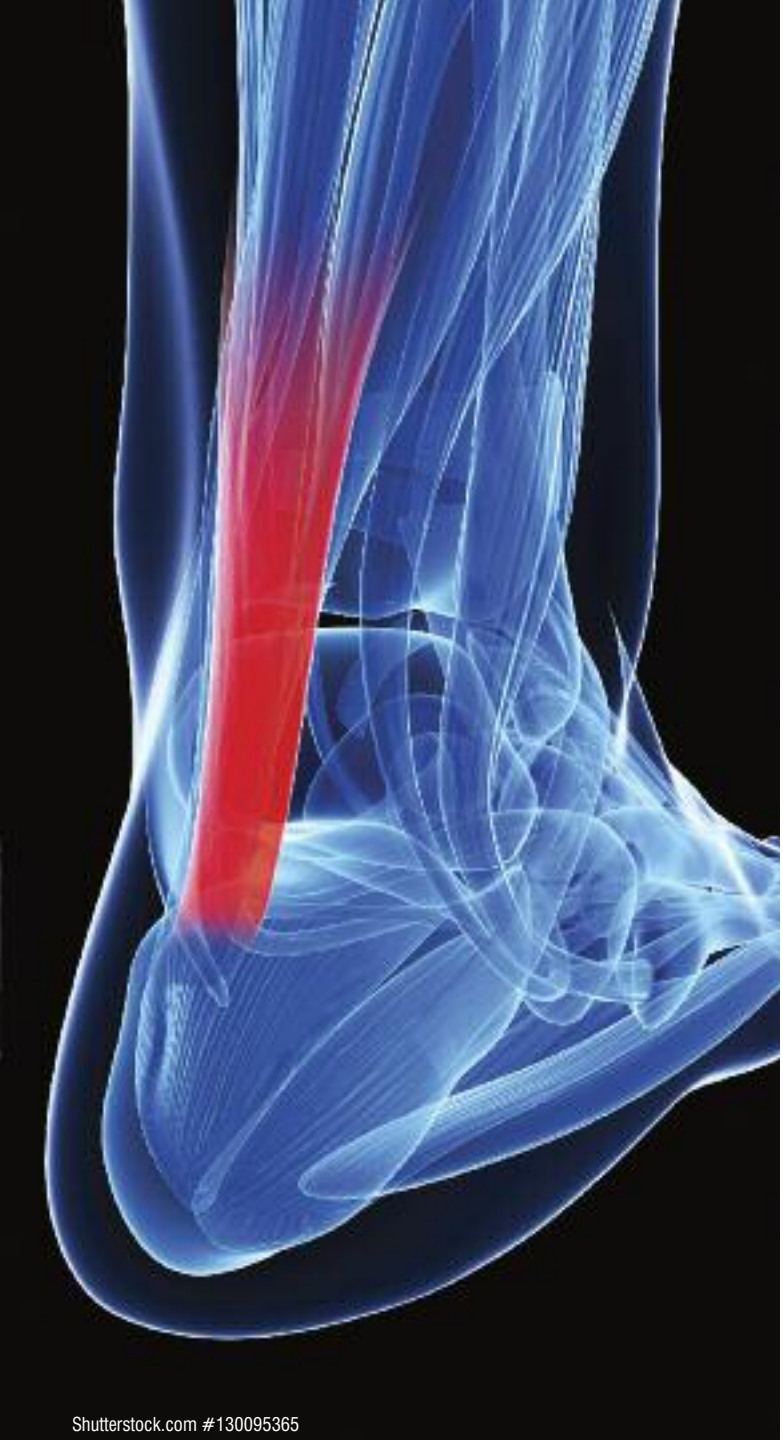

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Early weight bearing after Achilles tendon repair

Early mobilization and weight bearing after Achilles tendon repair is associated with improved patient satisfaction and faster return to work and sports, with no significant increase in rates of tendon rerupture or postoperative wound and nerve complications.

By David P. Taormina, MD, and Nirmal C. Tejwani, MD

Achilles tendon pathology can present at any age, but epidemiologic studies have shown that men aged between 30 and 50 years are at greatest risk.[1] The annual incidence of Achilles tendon rupture is approximately one in 5000 and has increased in recent decades.[2-4] While there are well known risk factors, including the use of certain antibiotics (fluoroquinolones[5]) and steroid injections,[6] the classic history that precedes rupture is that of the episodic athlete—the "weekend warrior."[7]

When the injury is the result of sports activity, research has shown that the sport being played at the time of injury varies by geodemographic distribution. In the US, those afflicted are more likely to have been injured while playing basketball, tennis, or football,[7] whereas Europeans are more likely to suffer an Achilles injury playing soccer or volleyball.[1,2,8] In most of these instances, the deconditioned athlete attempts to perform and exercise at or near their previous level of activity without accounting for the consequential deterioration of connective tissues associated with aging and physical quiescence.

With hyperacute tensile stress across the Achilles tendon, albeit volitional or associated with trauma, sudden plantar flexion or the violent dorsiflexion of a plantar flexed foot forces the largest tendon in the body[9] to the brink of failure. The tendinous bridge between the gastrocnemius-soleus complex (GSC) and the calcaneus is at greatest risk for failure at the hypovascular region found approximately four to six centimeters proximal to its calcaneal insertion.[10]

The resultant "pop," which is so often reported by patients, results in the sudden onset of pain, weakness, and difficulty with ambulation. Upon examination in the emergency setting or the physician's office, a lack of plantar flexion force and unopposed dorsiflexion of the anterior leg musculature, become a primary finding on inspection, especially when the patient is lying prone. Confirmation can be made with palpation of a gap between the GSC and heel along with weakness or inability to stand on one leg. The Thompson test,[11] a failure of foot plantar flexion with a squeeze of

Each of the studies the authors reviewed identified advantages of early postoperative mobilization and weight bearing with, at worst, equivocal complication rates.

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Table 1. Results of the two groups

Result	Group A (n = 32)	Group B (n = 30)	P
Rerupture, n (%)	0 (0%)	0 (0%)	–
Wound complication, n (%)	1 (3.2%)	6 (20%)	.04[a]
Nerve injury, n (%)	4 (12.5%)	0 (0%)	.043[a]
Mean incision length, cm	2.5	7.2	–
6 Weeks			
Mean dorsiflexion	8.9°	2.8°	.0002[a]
Mean plantar flexion	19°	26.9°	.011[a]
Mean range of motion	28°	30.1°	.52
3 Months			
Mean dorsiflexion	16.5°	13.3°	.021[a]
Mean plantar flexion	29.7°	33.3°	.08
Mean range of motion	46.5°	44°	.42
6 Months			
Single heel raise, n (%)	23 (72%)	16 (53%)	.14
Return to driving, wk	3.8	11.75	.17
Return to sports/activities, mo	7	8.45	.52
American Orthopaedic Foot and Ankle Society score	93.3	96.7	.34

[a]Significant

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the calf, further confirms the diagnosis. In the rare situation that diagnostic imaging is required,[12] magnetic resonance imaging is the modality of choice.

Operative vs nonoperative management

The war of operative versus nonoperative management for Achilles tendon ruptures has been waged for well over 30 years.[13,14] The debate is fueled on one side by the advantages of surgery for decreasing risk for rerupture and quickening time to return to activity and work. On the other side of the debate, proponents of nonoperative management cite risks of scar adhesion, postoperative paresthesias, and skin sensitivity, and potential sequelae of superficial infections. In fact, these were the study conclusions from a recent meta-analysis by Jiang and colleagues published in 2012.[15] Despite an extensive investment of research time and a tome-sized plethora of publications, this well-powered review of 10 randomized clinical trials, which included nearly 900 patients, found insufficient evidence to support either operative or nonoperative management.

While the embers continue to burn from a smoldering debate between a prosurgery school of thought and proponents of nonoperative management of Achilles rupture in the general population, a number of studies have recommended that elite athletes and high functioning individuals undergo percutaneous or open surgical repair for a ruptured Achilles tendon.[16-22] The principal surgical methods described in the literature are percutaneous repair[23,24] through multiple portal incisions, a minimally invasive posterolateral approach[25] using a two- to six-cm incision, and the standard open six- to 18-cm posteromedial approach.[23]

Postoperative rehabilitation

While the literature is rife with publications describing modifications to the documented surgical techniques, this volume of surgical literature is still eclipsed by the number of postoperative protocol descriptions. Given the debate being resolved between operative versus nonoperative management, it would be ideal to have a postoperative plan that maximizes functional recovery and soft tissue healing while minimizing morbidity, including pain, Achilles rerupture, and associated prolonged hospital course.

The theoretical advantages of early mobilization after Achilles surgery include hastened return of tensile strength to the repaired tendon. There is, however, also a risk for increased rupture end gapping, rerupture, or both. In addition, another proposed advantage is that early motion prevents formation of adhesions that may ultimately block final range of motion.[26]

Several studies have described the outcomes of patients who were made nonweight-bearing for six weeks after surgery.[27] In fact, a meta-analysis performed by Suchak and colleagues included six randomized trials that compared patients made partial weight bearing on postoperative day one versus patients with conversion to weight bearing at three, four, and six weeks postoperatively.[27-32] Focusing on rates of Achilles rerupture, subjective patient satisfaction, range of motion (ROM), strength, wound infections, and other minor postoperative complications, their meta-analysis compared a cohort of 315 patients treated with early mobilization (n = 159) versus late weight bearing (n = 156) after operative repair of Achilles tendon rupture.

Ultimately, early functional treatment protocols were associated with patients who were subjectively more satisfied (88% rated postoperative satisfaction as excellent vs adequate or poor) than delayed mobilizers (62% rated satisfaction as excellent, $p < .0001$). There was no statistically significant difference between the rates of Achilles rerupture, which occurred in 2.5% of the early function group and in 3.8% of the immobilized patients ($p = .47$). These rates nearly mirrored the incisional infection rates, as well, which were 2.6% in early mobilizers versus 3.9% in the latent mobilizers ($p = .63$). Finally, analysis of an amalgamated variable for other postoperative complications (including sural nerve injury) found that early weight bearing was actually associated with significantly lower complication rates than immobilization (5.8% vs 13.5%, $p = .01$).[27]

Studies documenting strength and range of motion after early versus delayed rehabilitation have been less than convincing with regard to recommendations for optimizing patient outcomes. Meta-analysis of available data has shown that early functional protocols were associated with improved calf tone and plantar flexion in one study, but these findings failed to find support in the majority of available literature.[27] Similarly, advantages in range of motion for early rehabilitation have been supported, at best, inconsistently in the literature.[27]

Using an animal model (rats), one study has shown that early physical activity increases the speed of tissue healing after acute Achilles rupture.[33] Bring and colleagues used histochemical staining to first identify the postoperative period of peak tissue and nerve regeneration, which occurs between weeks two and four. Using this information, they then chose the four-week time point to compare three groups of rats that were treated with different postoperative physical activity protocols: wheel running, plaster treatment, and a control group (no strict physical activity protocol). They found that the wheel-running group did best, showing 94% greater ($p = .001$) and 48% greater ($p = .02$) diameter of newly organized collagen than plaster-treated and control rat groups, respectively. Histologic staining demonstrated the wheel-running group also had signs of earlier neuronal ingrowth.

A study by our group compared the outcomes of 63 consecutive patients who presented with acute closed Achilles tendon ruptures, 62 of whom had a minimum of six months follow-up after

being treated with either minimally invasive open or standard open surgical repair for an acute Achilles tendon rupture.[19]

After surgery, the patient was immobilized in a 10° to 20° equinus splint (minimally invasive group) or removable boot with a 30° heel wedge (standard group) for two weeks. All patients (33 treated minimally invasively, 30 treated with standard open procedure) were then encouraged to begin weight bearing at two weeks postoperatively, as tolerated, with a controlled ankle movement boot fitted with a 20° heel wedge. We theorized that postoperative rehabilitation should be delayed approximately two weeks to allow for the start of early tendinous fibrous union and to stabilize the soft tissues of the ankle in the postoperative period while incisional wound healing occurred. At six weeks postoperatively, all patients were converted to a regular shoe with a heel lift. Range of motion, surgical complications (including rerupture and poor wound healing), and sural nerve injury, were assessed postoperatively at the six-week, three-month, and six-month (with GSC strength assessment) time points. The findings are summarized in Table 1.

There were no reruptures identified throughout the postoperative course of the 63 patients. Superficial infections were more prevalent in the standard open group (six patients, 20%) than in the minimally invasive group (one patient, 3%, $p = .04$). All soft tissue issues resolved without requiring return to the operative suite. Sural nerve deficits were documented in four patients (12.5%) in the minimally invasively treated patients versus none in the standard open group ($p = .04$). Three of these four nerve deficits resolved by the six-month follow-up visit, which raises the suspicion that they were sequelae of traction.

Functional outcomes at final follow-up in 62 patients, using the American Orthopaedic Foot and Ankle Society Scores, did not differ significantly between the groups. Patients had similar arcs of motion during their postoperative course (28° vs 30.1° at six weeks, $p = .52$) though the minimally invasive group had greater dorsiflexion (8.9° versus 2.8°, $p < .01$) while the standard open group had greater plantar flexion (26.9° vs 19°, $p = .01$); this may have been because the well-molded posterior plaster splints positioned the foot in 30° of equinus (for the open group) versus 10° of equinus (for the minimally invasive surgical group).

Regarding postoperative strength and conditioning, at six-month follow-up, we found that 23 patients (72%) in the minimally invasive group were able to perform a single heel raise (five of the nine who failed to perform heel raise had 4+/5 GSC strength), versus 16 of the 30 standard open patients (53%; eight of 14 who failed conditioning testing had 4+/5 GSC strength). Although the data trended toward better results with minimally invasive treatment, the differences were not statistically significant ($p = .14$).

The findings of our group continue to support the existing literature on the early rehabilitation of patients after surgical repair of Achilles tendon rupture.[34-38] In fact, each of the studies we reviewed identified advantages of early postoperative mobilization and weight bearing with, at worst, equivocal complication rates. Furthermore, earlier mobilization was also associated in one study (Suchak et al[34]) with a quicker return to sports activity and a reduction in the number of lost workdays.

Although within our study we employed a two-week postoperative initiation protocol for the commencement of weight-bearing rehabilitation, there are other studies promoting partial weight-bearing exercises as early as postoperative day one.[23] We are unable to document the necessity of a two-week postoperative rehabilitation holiday using scientifically objective findings, but we do subjectively believe there may be a role for an early postoperative hiatus in order for early tendinous healing to begin bridging the Achilles rupture gap and for the early progression of the soft tissue healing process.

Conclusion

The available literature supports, unequivocally, early mobilization and weight bearing in patients after surgical repair of Achilles tendon rupture. Studies have found that early rehabilitation is associated with improved early range of motion. During the early postoperative course, rehabilitation has been shown to improve patient's subjective ratings of satisfaction, expedite return to work, and allow quicker return to sports activity. When comparing patients with early mobilization to those immobilized four to eight weeks postoperatively, there are no differences in Achilles tendon rerupture rates, and similar, or slightly improved, rates of postoperative wound and nerve complications. ler

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Cascade Dafo Strap Updates

Cascade Dafo announces two customer-driven improvements to the straps on its orthoses. First, both custom and prefabricated DAFO (Dynamic Ankle Foot Orthosis) solutions now have a clean, new look, thanks to upgraded Ultrasonic Welded Straps with rounded, sealed ends and die-cut rivet holes with built-in reinforcement. This design reduces bulk, improves durability, and a gives a more streamlined appearance. Second, orange is now available as a strap color choice for all custom DAFOs. A swatch of the orange strap color can be viewed in the Colors and Patterns section of the company's website.

Cascade Dafo
800/848-7332
cascadedafo.com

Pedors Genext Dress Orthotic

The new Genext Dress Orthotic from Pedors Shoes has been designed with a lower profile to fit into almost any dress or casual shoe. Using the original Genext cork and rubber shell for orthotic support, a memory foam component has been added to give the arch a softer, more cushioned feel. The thermoplastic polyurethane base layer provides durability, and the microfiber topcover finishes the device attractively. The Genext Dress Orthotic is available in men's and women's sizes with a neutral heel cup for rear foot stability and support, and with or without a metatarsal pad in the forefoot.

Pedors Shoes
800/750-6729
pedors247.com

FreeSport Knee Sleeve and Wrap

Breg has launched the FreeSport knee sleeve and wrap for athletes with mild to moderate discomfort, patellar maltracking, and related injuries such as runner's knee. The FreeSport knee sleeve and wrap were created as a solution to issues of patient compliance, with both a sleeve option and a wrap option for a higher level of customization. The FreeSport knee sleeve and wrap are made of breathable, ultra-lightweight Smart-Zone compression fabrics. The wrap, which can be used on either leg, can provide a cost-savings benefit to clinicians by helping them reduce stock and simplify inventory management.

Breg
800/897-BREG (2734)
breg.com

SenMoCOR Rehab System

SenMoCOR (Sensory Motor Control-Oriented Rehabilitation) offers the user and the clinician immediate visual feedback regarding sensory motor control with an easy-to-wear laser and laser targets. Developed by the International Academy of Orthopedic Medicine-US and available from OPTP, the SenMoCOR system stimulates implicit learning, allowing users to internalize their movement errors and self-correct. Using the three included straps, the laser can be positioned for hip, knee, or ankle control; the user can then aim the laser at the target and guide a feedback dot using controlled body movements.

OPTP
800/367-7393
OPTP.com

roducts

ProTech Met Foot Orthosis

Powerstep's new ProTech Met offers the stability, support and comfort of the company's ProTech Full Length Orthotic but has the added benefit of a built-in metatarsal pad, which helps spread and cushion the metatarsal heads to alleviate pain in the ball of foot. Other features include a strong, medical-grade foot support; double layer, shock-absorbing EVA (ethylene vinyl acetate)/Poron cushioning for comfort; friction-reducing, antimicrobial top-cover fabric; and a deep heel cradle and Poron heel pad to stabilize the heel during heel strike. This full length foot orthosis is available in nine sizes for men and women.

Powerstep
888/237-3668
powersteps.com

Spring Footwear From Spenco

Spenco introduces its new fashion-forward footwear for spring 2015. New this year are Crackle and Nightlight athletic slides, which capture the bright, rich color trend in popular footwear. Other sandals feature metallic embellishments, reptilian textures, Roman-inspired straps, and feminine floral patterns. Also, for the first time, two new wedge silhouettes will have a slight heel lift for a dressier look. The men's line has also been infused with color, with popular styles now in shades like olive and navy blue. The shoes retail for $49.99-$99.99 and will be available at running stores and on the company's website.

Spenco Medical Corporation
811/877-3626
spenco.com

Curbell Transfer Paper Website

Curbell Plastics is introducing myDesignOandP.com, a new website that allows patients to explore patterns and colors of transfer papers to personalize thermoplastic orthotic and prosthetic devices. Involving patients, and pediatric patients in particular, in the selection of colors and patterns that appeal to them increases the likelihood that they will wear their O&P devices as prescribed. The new website features a transfer paper gallery with an easy-to-use format that facilitates quick browsing of available patterns and colors for device customization. Many designs are specifically targeted toward children.

Curbell Plastics
888/CURBELL (287-2355)
myDesignOandP.com

Dynamic Chopart Gait Stabilizer

Hersco offers a new Dynamic Chopart Gait Stabilizer as the latest addition to its line of ankle foot orthoses (AFOs). The new Dynamic Chopart Gait Stabilizer is an AFO designed for Chopart amputees who wish to remain active. Addressing concerns about AFOs feeling stiff and unnatural, this new AFO features a hinged ankle and flexible foot plate with a segmented dynamic filler that allows flexion before providing a 'stop,' which protects the residuum and prevents shoe vamp collapse. The PTB (patellar tendon bearing) design and the anterior shell redistribute ground reaction forces up the kinetic chain.

Hersco
800/301-8275
hersco.com

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ler new products

ManukaMed Honey Dressing

ManukaMed USA has launched an improved version of its ManukaHD Lite honey-impregnated dressing, designed to provide active absorption of wound exudates and maximum exposure to medical-grade *Leptospermum scoparium* (Manuka) honey. The high sugar levels in the honey create osmotic pressure, which helps promote autolytic debridement of necrotic tissue. Improvements relate to the way Manuka honey is impregnated into the absorbent gelling fiber and to the standards of testing. ManukaHD Lite dressings are associated with Medicare billing codes A6196, A6197, and A6199.

ManukaMed USA
800/881-3654
manukamed.com

Expedition Foot Orthosis

Footmaxx has introduced the Expedition, a durable and lightweight orthotic device featuring a carbon fiber module, Poron XRD midlayer, and silver-infused X-Static topcover for improved performance. The Expedition foot orthosis is designed for those needing maximum orthotic support, including athletes and hikers. The carbon fiber module comes with a high strength-to-weight ratio. The flexible, lightweight Poron XRD midlayer offers high-strain impact protection. The topcover features X-Static, which uses the natural properties of silver to facilitate odor control, thermoregulation, and antimicrobial protection.

Footmaxx
800/779-3668
footmaxx.com

Techmax Epoxy Resin

Streifeneder USA now offers Techmax Epoxy Resin, a new adhesive formulated specifically for technicians in the orthotics and prosthetics industry. Techmax is a durable, high-performance resin that is low odor, antibacterial, and contains no volatile organic compounds (VOCs), which makes for a safer and healthier working environment. The product bonds quickly and is designed to work with cross sections as thin as 1.5 mm in thickness. Techmax Epoxy Resin is appropriate for use with knee ankle foot orthoses (KAFOs), hip knee ankle foot orthoses (HKAFOs), carbon braids, aramids, and spectra.

Streifender USA
800/378-2480
streifenederusa.com

Soft Opaque Now in Mulberry

Sigvaris offers one of the season's on-trend shades, Mulberry, in its Soft Opaque hosiery collection. With the softness of microfiber and durable, breathable construction, Soft Opaque hosiery is designed to look and feel like designer fashion tights and help keep legs healthy. It features graduated compression, which helps to improve circulation and prevent varicose and spider veins. The new limited-edition color is available in 15-20 mm Hg and 20-30 mm Hg compression levels in calf length, thigh-highs, and pantyhose. Other colors in the collection include Midnight Blue, Espresso, Graphite, Black, and Nude.

Sigvaris
800/322-7744
sigvarisusa.com

market mechanics

By Emily Delzell

CMS reimbursement delays threaten small O&P providers, backlog grows 15K weekly

Small O&P providers are at risk of being shut down due to Medicare reimbursement delays, according to a report issued March 19 and commissioned by the American Orthotic and Prosthetic Association (AOPA).

The analysis, conducted by Vienna, VA-based Dobson DaVanzo & Associates, found the backlog of Medicare reimbursement appeals by healthcare providers, currently growing by 15,000 a week, has shut down more than 100 small providers.

The report estimates the overall backlog at 1.5 million appeals and notes the Centers for Medicare & Medicaid Services (CMS) could save $12 million over a decade by postponing reimbursement of disputed payments until the disputes are resolved.

AOPA said a major side-benefit of such a step would be relief from the financial strain on small health care providers, such as O&P firms, that are unable to deal with uncertainty resulting from long-delayed Recovery Audit Contractor (RAC) appeals for disputed Medicare payments.

CGS Administrators, the contractor that serves as the Jurisdiction C DME Medicare Administrative Contractor, reported in March results of its ongoing prepayment review of claims for off-the-shelf diabetic shoes described by HCPCS code A5500. For the fourth quarter of 2014, the claim denial rate was 75%.

While the latest report continues to show a steady reduction in claim denials, from a high of 87% in the fourth quarter of 2013, a 75% denial rate remains too high for CGS to consider discontinuing its prepayment review.

AOPA noted that's important for members to thoroughly review the Local Coverage Determination and Policy Article that together govern Medicare coverage of diabetic shoes. The CGS website (cgsmedicare.com) has a report detailing the main reasons for A5500 claim denials. ler

Aortha 3D-prints insoles in an hour

Liverpool, UK-based Aortha unveiled its fast new 3D printing technology on March 20 at the British Association of Prosthetists & Orthotists conference in Manchester, UK, producing a pair of insoles in less than an hour.

The company's OrthaPrint with OrthaFlex material for 3D printing has enhanced elasticity for high-speed printing and enables a high degree of printing precision, according to a company release. ler

UI group ships clubfoot brace worldwide

The University of Iowa-affiliated group Ponseti International in March began shipping its low-cost Iowa Brace around the world, where it will eventually be used by up to 30,000 children with clubfoot.

Faculty at University of Iowa in Iowa City developed the brace, which is being manufactured in a Chinese factory through Clubfoot Solutions, a company established by Ponseti International.

The brace will cost about a tenth of the $500-$600 price that is typical in the US. Proceeds will go toward manufacturing more braces, with the goal of making the effort self-sustaining. ler

ACFAP welcomes new board members

The American College of Foot & Ankle Pediatrics (ACFAP) appointed two new board members at its first annual conference, held March 27-28 at Barry University School of Podiatric Medicine in Miami Shores, FL.

Nicholas Pagano, DPM, co-owner of Barking Dogs Foot and Ankle Care in Plymouth Meeting, PA, and Tracey Toback, DPM, owner of Toback Podiatry, which has locations in Highland and Kingston, NY, are new board members.

Almost 100 attendees, speakers, and sponsors took part in the conference, which featured continuing medical education lectures on nonsurgical and surgical approaches for many aspects of pediatric foot and ankle care.

The organization has more than tripled its paying membership in the last year, allowing it to reach a larger community with its pediatric foot and ankle education, according to an ACFAP release. ler

NFL ATs recognize Foot Management

The Professional Football Athletic Trainers Society (PFATS) awarded a crystal football to Pittsville, MD-based Foot Management on February 16 at the National Football League (NFL) Combine in Indianapolis, IN.

Houston Texans athletic trainer Roland Ramirez, ATC, LAT, PT, SCS, CSCS, gave a speech at the event recognizing Foot Management's 32 years of work with NFL athletic trainers.

Foot Management makes a variety of prefabricated and custom orthoses. ler

Boa, Click Medical ink closure system deal

Denver, CO-based Boa Technology announced on March 27 a partnership with newly incorporated Click Medical, based in Steamboat Springs, CO.

Together the two companies will provide solutions for custom O&P and adjustable cast medical devices, all powered by the Boa Closure System, which facilitates adjustment in 1-mm increments and is free of straps, ratchets, and fasteners.

By providing assembled kits of Boa components, specially designed and optimized for certain types of medical devices, Click Medical enables practitioners to create unique closure and adjustment solutions for the devices they provide their patients.

Boa will continue to provide its closure system to medical brands that produce ready-made medical devices and footwear, including Össur, DeRoyal, 3M, Exos, and Dr. Comfort. ler

Allard USA is Opie Integrated Supplier

Gainesville, FL-based Opie Software and Rockaway, NJ-based Allard USA announced in March that Allard is now an Integrated Supplier within the Opie Purchasing System and at oandp.com/shop.

The technological integration allows Opie and Futura Software users and visitors to the oandp.com website to view and place electronic orders for all Allard products.

Allard products are also available through Opie's other Integrated Suppliers. ler

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market mechanics

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NATA study shows AT access improving

Just over a third of US high schools have at least one full-time athletic trainer, the gold standard of care recommended by the National Athletic Trainers' Association (NATA), according to a study published in February in the *Journal of Athletic Training*, the association's scientific publication.

While 70% of US public high schools have athletic training services, only 37% have full-time athletic trainers, though 47% report full practice coverage each afternoon. A 1994 study found that only 35% of public high schools used athletic trainer services, meaning overall access has doubled over the past 20 years.

Athletic trainers worked most often at games and competitions rather than at practices, placing athletes at a substantial risk of injury during a large portion of sport participation, the authors noted.

According to the study, secondary schools without AT services rely on coaches and administrators such as athletic directors to determine proper medical treatment when injuries and emergencies arise during a practice or competition.

"While this significant increase is promising, the quality of care in secondary schools will continue to improve as the number of schools with athletic trainers—particularly full-time—increases," said Jim Thornton, MA, ATC, CES, NATA president. ler

Össur, CAF fund 2015 Mobility Clinics

Foothill Ranch, CA-based Össur and the San Diego-based Challenged Athletes Foundation (CAF) in March announced a new multiyear global sponsorship agreement that continues their decades-long collaboration to support people with limb loss.

Central to the Össur-CAF agreement is a series of Össur Running and Mobility Clinics for amputees presented by CAF and held annually across the US. Participants learn how to achieve their mobility goals working side-by-side with volunteer clinical professionals and world-class parathletes in a safe and encouraging environment.

Seven Össur-CAF clinics have been confirmed for 2015. Go to ossur.com/mobility for details about locations and dates. ler

First PFA President Saul Marmer dies

Saul Marmer, CPed, the first president of the Pedorthic Footcare Association (established 1958) died March 16. He was 90.

Marmer also ran Marmer's Shoes, a chain of family-owned shoe stores on Cincinnati's West Side, from 1946 to 1990.

The US Veterans Administration awarded Marmer, who served in World War II, for his work by helping Vietnam veterans with foot injuries.

He is survived by his daughter and two sons, a brother, and four grandchildren. ler

Lim gains partners for prosthetic socket

Lim Innovations reported in March that it has generated more than 10 clinical partners and providers for its Infinite Socket, which the San Francisco-based company launched in limited market release in September 2014.

The dynamic modular prosthetic socket is now being used by 55 amputees, according to the company. ler

JOSPT board names Abbott editor-elect

The Board of Directors for *JOSPT*, the *Journal of Orthopaedic & Sports Physical Therapy*, in an April editorial named J. Haxby Abbott, DPT, PhD, FNZCP, editor-elect of the publication. Abbott will replace editor Guy G. Simoneau, PT, PhD, ATC, who has helmed the journal since 2002.

Abbott is associate professor in the Dunedin School of Medicine at the University of Otago in New Zealand, where his research focuses on musculoskeletal clinical epidemiology and management of osteoarthritis. He has been a *JOSPT* associate editor since 2011 and for six years was editor-in-chief of the *New Zealand Journal of Physiotherapy*. He served on the Steering Committee for Physical Therapy from 2007 through 2012, its only non-US member during that period, and as an associate editor for the *Journal of Manual and Manipulative Therapy* from 2007 to 2011.

Abbott will begin working closely with *JOSPT* on July 1; the January 2016 issue will be the first published under his leadership. ler

Vionic founder Phillip Vasyli killed

Podiatrist Phillip Vasyli was stabbed to death in his home in Old Fort Bay on New Providence Island, Bahamas, on March 24. He was 59. Bahamian authorities have charged his wife, Donna Vasyli, with his murder.

The Australian podiatrist established several podiatry clinics in Sydney and later founded the Vionic Group, an orthotic footwear company based in San Rafael, CA. He also founded the Vasyli Foundation, which supports international charities working to improve healthcare in poor and underserved communities.

"We are deeply saddened by this sudden loss," said Chris Gallagher, Vionic Group CEO. "As a Vasyli/Vionic family, we'll work hard to continue his legacy of changing lives." ler

Ankle exoskeleton lowers energy costs

A letter published online April 1 by *Nature* reported that an unpowered exoskeleton reduces the metabolic cost of walking by 7.2 ± 2.6% for healthy human users under natural conditions, savings comparable to those with powered devices.

The device's inventors, scientists at the Department of Mechanical Engineering at Carnegie Mellon University in Pittsburgh and the Joint Department of Biomedical Engineering, North Carolina State University in Raleigh and the University of North Carolina at Chapel Hill, call their creation the "ankle exo."

The lightweight elastic device acts in parallel with the user's calf muscles, offloading muscle force to reduce metabolic energy consumed in contractions. It uses a passive mechanical clutch to hold a spring as it is stretched and relaxed by ankle movements when the foot is on the ground. ler

BOC wins sales, customer service Stevies

The Board of Certification/Accreditation (BOC), based in Owings Mills, MD, won three business awards in February at the ninth annual Stevie Awards ceremony in Las Vegas.

The BOC for a third consecutive year won the Sales & Customer Service Award, as well as a silver award for Innovation in Customer Service and a bronze award for Business Development Achievement. ler

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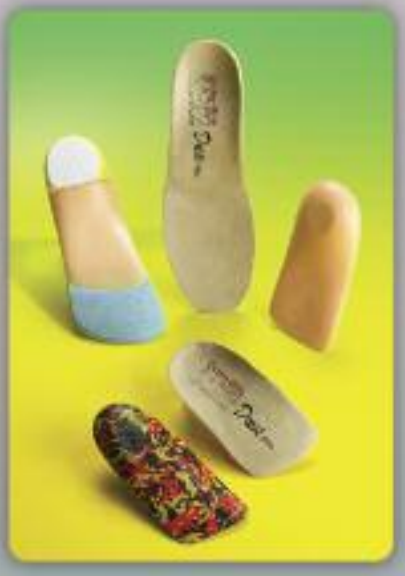

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