• DMO VS PMO FOR HALLUX VALGUS • NEUROMUSCULAR TRAINING • FPI-6 IN OLDER ADULTS • RUNNING-SPECIFIC PROSTHESES

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LOWER EXTREMITY REVIEW

March 18 / volume 10 / number 3

HOW EFFECTIVE IS ECCENTRIC EXERCISE FOR ACHILLES TENDINOPATHY?

DIABETIC FOOT

CONSIDER BOTH THE MECHANICAL PROPERTIES OF SOFT TISSUE, AND PROPERTIES OF FOOTWEAR

BIOMECHANICS

ACHIEVING MOVEMENT ACCURACY THROUGH SENSORY STIMULATION

FOOTWEAR

SHOE AESTHETICS CONTINUE TO MAKE STRIDES

MANAGING KNEE PAIN WITH FOOTWEAR

GUEST EDITORIAL

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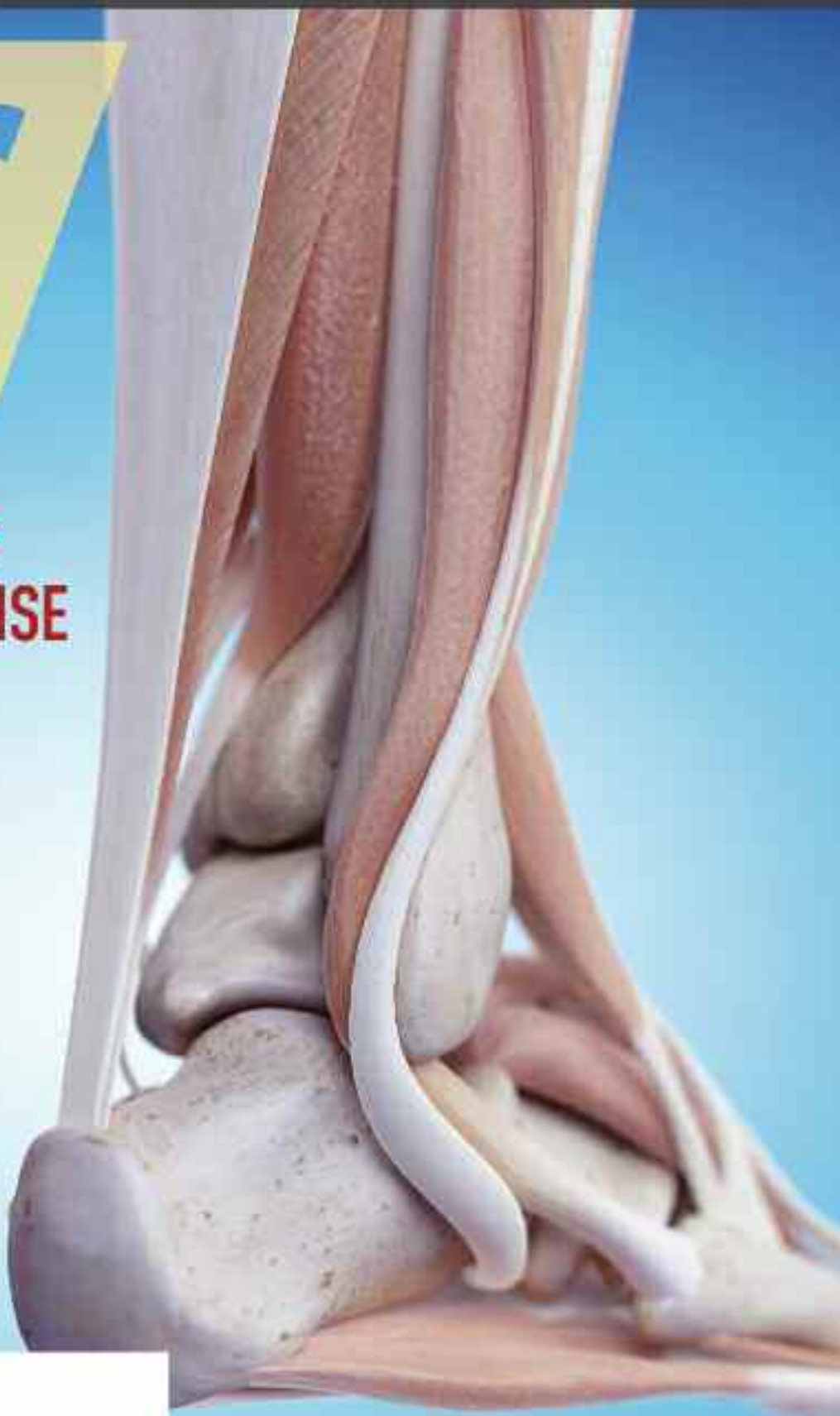

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Lower Extremity Review informs healthcare practitioners on current developments in the diagnosis, treatment, and prevention of lower extremity injuries. LER encourages a collaborative multidisciplinary clinical approach with an emphasis on functional outcomes and evidence-based medicine. LER is published monthly, except for a combined November/December issue and an additional special issue in December, by Lower Extremity Review, LLC.

Subscriptions may be obtained for $38 domestic and $72 international by writing to: LER, PO Box 390418, Minneapolis, MN, 55439-0418. POSTMASTER: Please send address changes to LER, PO Box 390418, Minneapolis, MN, 55439-0418.

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GUEST *Editorial*

Lower Extremity Review
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Navigating disruption in the foot orthotics landscape—Are you ready?

Bruce Williams, DPM, DABPS

For more than 50 years the custom foot orthotic industry has pretty much stayed the same. Of course, change has occurred, such as the introduction and widespread adoption of digital casting and CAD/CAM production vs hand-poured plaster. Nevertheless, podiatrists and other medical professionals continue to follow a longstanding procedure for supplying orthotics to our patients; take cast, write prescription, receive the finished product at the office, provide device to patient, and receive payment.

But times, they are a-changing! A recent report predicts that the foot orthotic market will grow from $1.2 billion in 2016 to $1.7 billion by 2022, just in North America, while observing that the high cost of orthotic insoles may impede that growth.[1] The report foretells disruption in this market, noting that technological advancements in foot orthotic insoles will likely expose new avenues for the foot orthotic insoles market. As you read this editorial, the foot orthotic market is already undergoing this disruption.

Companies no longer sell-off-the shelf products to patients only through the big box chain stores, running shoe stores, and drug stores. They now offer customers the opportunity to take a picture or "scan" their foot using a smart phone that leads to the creation of 3D-printed devices that are then mailed to the customer's home. Or, a patient can have her feet scanned at a kiosk at the mall and have the devices 3D printed while they wait.

The disruption continues. This summer, a few specialty-running shoe stores will introduce foot pressure mapping and scanning that can result in a 3D printed comfort insole, or a custom-made device built into a market-leading, name-brand running shoe. In short, individuals who have foot discomfort will be able to obtain a custom-made foot device with no involvement from a medical professional who specializes in foot orthotics.

> Smartphone foot scanning, mall kiosks, shoe-store pressure mapping, 3D printing—where does the podiatrist fit in?

Don't panic just yet, however, because devices built for what is termed "customized comfort" do not necessarily affect foot and ankle biomechanics in the same manner as do medically-prescribed functional orthotics. We all recall the patients with heel pain who swore by the comfort afforded by their foam clogs, and yet were unable to realize relief from their heel pain. Comfort is not always the answer!

Medical practitioners know that a foot orthotic that is uncomfortable will not be worn, regardless of how well it improves a patient's foot function. And yet because comfort is specific to each patient, we have no reliable measure for it. This is where the crossover point lies in determining the futures of medically-prescribed devices and customized comfort insoles and shoes. Will patients 1 day have available to them the combination of individualized comfort with functional performance improvements, without undergoing a clinical examination by a foot orthotic specialist? Yes, I believe so.

Like it or not, disruption is underway, and although there will always be a need for medically-prescribed foot orthotics, many patients will find their solution at the running shoe store, the mall kiosk, or the internet. Increasingly, as people bypass medical professionals to acquire foot orthotics, companies that supply these devices will likely continue to improve both comfort and overall function.

We medical practitioners must do a better and more thorough job in improving our orthotic outcomes, or patients will go elsewhere. We can do this by continually educating ourselves regarding the most cutting-edge knowledge on how and why orthoses work. We must better appreciate the benefits and shortcomings of technologies used to quantitate foot function and gait, to better inform our decisions regarding their use, or at least, understand why it is used at all.

With patients' health insurance deductibles so high already, why would anyone spend more for a medical visit and device until that deductible is met? Why would you not try a device that is customized to your foot and has a high likelihood of mitigating your symptoms?

The disruption is here, and it is building. Will you be ready when it fully arrives?

> Devices built for customized comfort do not necessarily affect foot and ankle biomechanics in the same manner as do medically prescribed functional orthotics.

Dr Williams is director of gait analysis studies at Weil Foot Ankle and Orthopedic Institute, and president of Breakthrough Sports Performance in Chicago.

Reference

1. Zion Market Research. Foot orthotic insoles market by material (leather, polypropylene, and others) for sports, medical and other end users: North America industry perspective, comprehensive analysis, and forecast, 2014 – 2022. https://www.zionmarketresearch.com/report/foot-orthotic-insoles-market

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[2]Pradon 2011

From the LITERATURE

Study finds little difference between DMO and PMO for hallux valgus

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Guiding patients to make the most appropriate choice among options to correct hallux valgus has long been a challenge: Distal metatarsal osteotomy (DMO) is liked for its shorter incision, low level of invasiveness, lower complication rate, and its ability to improve pain and functionality across a wider range of deformities. Proximal metatarsal osteotomy (PMO), on the other hand, has better, more durable corrective power; however, it is a technically demanding technique that uses a longer incision, requires more operating time, and has a higher potential for complications.

Studies have shown both PMO and DMO to be effective, but sample sizes have been small. Now orthopedic researchers from Greece have conducted a meta-analysis that looked at nearly 700 cases from studies comparing the use of PMO to DMO in moderate to severe hallux valgus. Key outcomes included assessment of the first intermetatarsal angle (IMA).

While the meta-analysis showed both DMO and PMO was effective for the surgical treatment of hallux valgus in the short term (≤1 year), using a Cochrane risk of bias and ROBINS - 1 tools, the authors found a slight favor for the PMO group in the assessment of the IMA in the medium term (>1 year and <10 years). There were no significant differences between the PMO and DMO groups in the medium term for clinical and radiological outcomes, and the researchers did not find any significant differences between the groups.

Given the increasing prevalence of hallux valgus with aging, clinicians can expect to see more patients requesting correction. Understanding the long-term benefits of each procedure will allow for better patient engagement in the decision-making process. Long-term data will be particularly useful as more younger women present for this surgical choice.

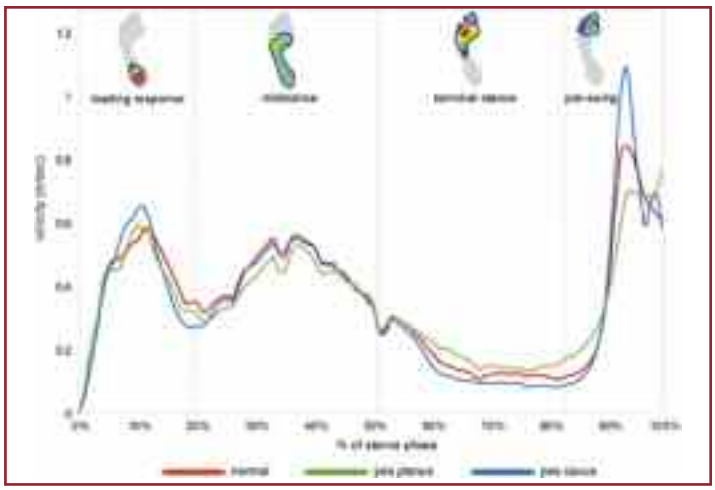
Source

Tsikopoulos K, Papaioannou P, Kitridis D, et al. Proximal versus distal metatarsal osteotomies for moderate to severe hallux valgus deformity: a systematic review and metaanalysis of clinical and radiological outcomes. Int Orthop. 2018;Feb 10. doi: 10.1007/s00264-018-3782-5. [Epub ahead of print]

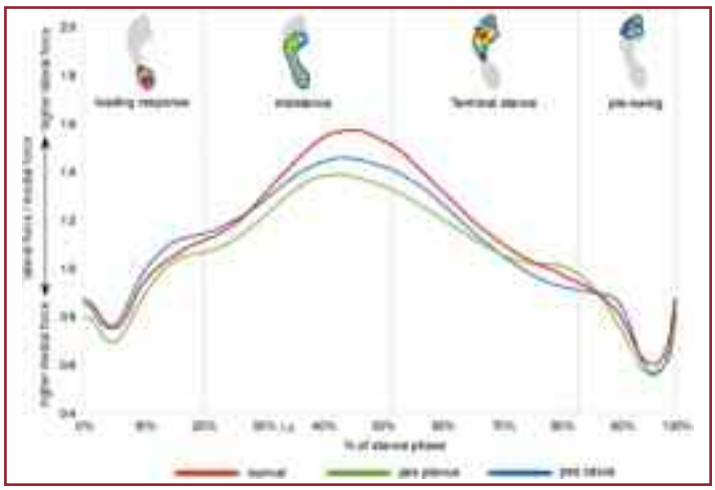
Center of pressure in normal, pes planus, and pes cavus feet

To better understand the association of non-normal foot postures with an increased risk of injury to the lower extremity, Australian researchers evaluated center of pressure (COP) in adults with pes planus, pes cavus, or normal feet. Measures for comparison included COP, lateral-medial force index, and COP excursion index.

After screening, 92 healthy adults (aged 18 to 45) had 1 foot selected for barefoot testing, which included a 5-minute acclimation period and walking along a walkway using a 2-step initiation protocol.



Ensemble average for the center of pressure velocity during stance phase for normal, planus and cavus feet.



Ensemble average for the center of pressure lateral–medial force index for normal, planus and cavus feet.

The cavus foot was found to have the slowest average and minimum COP velocity during terminal stance compared with the planus foot. However, on pre-swing, the cavus foot had the fastest maximum COP velocity (top figure). As for lateral-medial force index,

Continued on page 12

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the planus foot showed a lower range during terminal stance compared with the normal foot (bottom figure). These findings help us understand how foot posture impacts COP, especially in the propulsive phases of gait.

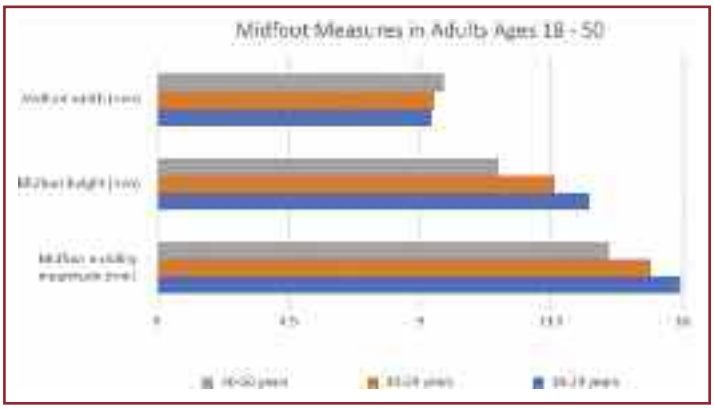
Source

Buldt AK, Forghany S, Landorf KB, et al. Centre of pressure characteristics in normal, planus and cavus feet. J Foot Ankle Res.2018 Feb 5;11:3. doi: 10.1186/s13047-018-0245-6. eCollection 2018.

Midfoot mobility and patellofemoral pain

Seeking to better understand foot mobility in adults with patellofemoral pain (PFP, or so-called runner's knee), Australian researchers studied almost 200 adults aged 18 to 50 years. Both weight-bearing and non-weight-bearing measures were used to calculate midfoot height mobility, midfoot width mobility, and foot mobility magnitude. Cluster analysis identified three distinct age groups: 18 to 29, 30 to 39, and 40 to 50. Midfoot height mobility differed across all three groups with moderate to large effect sizes, and, for those aged 40 to 50, when compared to those aged 18 to 29, foot mobility magnitude was significantly less (see figure).

These findings indicate that significant age-related changes in foot mobility are occurring earlier than previously recognized and pertain to foot mobility height moreso than foot mobility width. The authors speculate that, in an older population, the effectiveness of orthoses may be in their ability to better manage weight-bearing loads by redistributing plantar pressures, rather than in controlling motion.



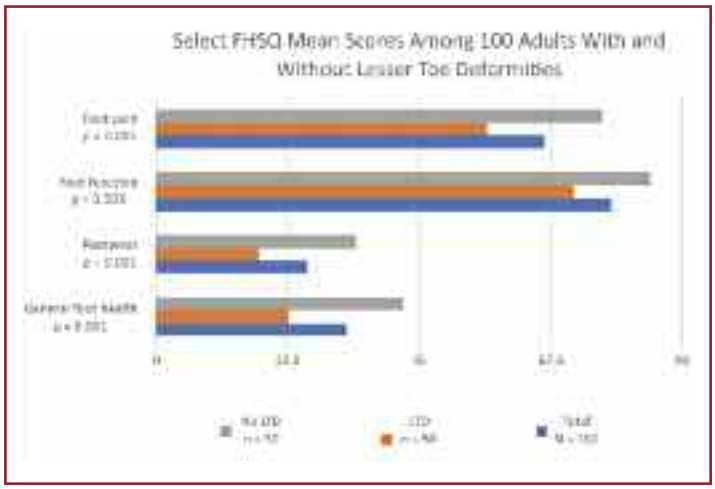
Source

Tan, JM, Crossley KM, Vicenzino B, Menz HB, et al. Age-related differences in foot mobility in individuals with patellofemoral pain. J Foot Ankle Res. 2018;11:5.

Foot pain, ill-fitted footwear increase risk of falls in elderly

Foot pain and poor-fitting footwear are among the well-known risk factors for falls among the elderly. Two new studies from Spain sought to quantify the significance of these issues in the elderly by looking at lesser toe deformities (LTD) in a general population, and footwear fit among those with Alzheimer's disease.

The first study included 100 older adults with a mean age of 74 years; 50 subjects had LTD and 50 were without foot problems. Ages ranged from 65 to 88 years and sociodemographic characteristics were comparable between the 2 groups. Participants first had each foot measured and examined by a qualified practitioner. Participants then completed the Foot Health Status Questionnaire (FHSQ), in which they self-reported foot health-related quality-of-life by answering questions about foot pain, foot function, footwear, and general foot health. Physical characteristics (eg, LTD including hammer toes, claw toes, and mallet toes) were used to assess pain and function; footwear evaluation was related to availability of shoes and comfort, and general foot health perception was based on patients' own assessments. Responses are detailed in the figure.



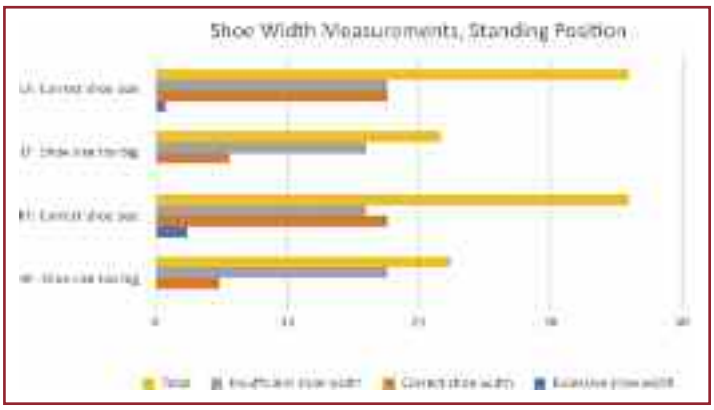
Scores for FHSQ range from 0 to 100, where 0 represents worst possible state of foot health, and 100 represents best possible state of foot health.

The authors attribute the significantly lower scores for those with LTD specifically to the deformities due to their influence on plantar pressure and postural disturbances, as well as their association with falls in the geriatric population. They note that helping patients maintain independence by maintaining functional capacity is critical for the overall health of the elderly. Given that 1 in 4 older adults is at risk of falls, and that more than 75% of those with foot problems are at increased risk, assessing foot health, in particular LTD, in this population at every visit can play a vital role in preserving patients' quality of life.

In the second study, researchers wanted to examine foot health in a community-dwelling population with Alzheimer's disease (AD), with specific attention to footwear. A progressive degenerative disorder, AD is associated with declines in memory and executive function which can affect communication skills; mobility challenges, including disturbances in equilibrium and limb coordination; sleep disturbances; frailty; and falls. There is currently no cure for AD, which affects mostly those over age 65. The public health challenge comes in the increasing frequency of this disorder in a population that is rapidly expanding and will continue to do so until 2050 given current projections.

Working with a Center of Excellence AD facility, 73 patients with diagnosed mild to moderate AD were recruited for the study; ages ranged from 65 to 95 years (guardian's consent was required for inclusion). Patients were evaluated using the Barthel Index for activities of daily living, and their feet were measured for length and width using a Brannock Device. Nearly 90% of patients reported

foot problems of some type. The foot examination found bunions (79%), nail or keratotic disorders (52%), hallux limitus (47%), hallux rigidus (19%), and deformed toes (12%). Further measurement showed that nearly 70% of patients were using different shoe sizes between the 2 feet and/or inadequate footwear.



Key among their measured findings was that only 30% of patients in this study had shoes that were of accurate width. With nearly 70% of this group of AD patients using shoes that were not fitted properly, thus putting themselves at higher risk for falls, the researchers identified a clear need for podiatric clinicians to regularly monitor the fit of shoes in their patients with AD, with special attention to width.

Sources

Lopez-Lopez D, Martinez-Vazquez M, Losa-Iglesias, ME, et al.. Foot health-related quality of life among elderly with and without lesser toe deformities: a case control study. Patient Prefer Adherence. 2018:12 251–255.

López-López D, Grela-Fariña M, Losa-Iglesias ME, et al. Clinical aspects of foot health in individuals with Alzheimer's disease. Int J Environ Res Public Health. 2018 Feb 7;15(2). pii: E286.

Reliability of FPI-6 in older adults warrants caution

Because it uses 6 items to quantify and classify foot pressure, the Foot Pressure Index-6 (FPI-6) is considered a more complete measure than many others. The FPI-6 has been validated for use with adults aged 18 to 57, where it can play a role in identifying risk factors for sports and training injuries. However, it has not been validated in older adults, where edema, bunions, and bone callosity are more common and may affect the findings, and where this tool can play a role in assessing fall risk.

A recent study in the journal Musculoskeletal Science and Practice sought to confirm the validity of each measure in the FPI-6 in healthy older adults over age 65 by comparing 2 examiners' ratings from 2 assessments over 2 weeks. While ratings for adults were substantially similar, ratings for older adults varied dramatically in this small, but healthy population. The examiners reported that age-related variations in foot structure made visualizing the underlying biomechanics difficult; as a result, the researchers urged caution when using the FBI-6 in older adults.

Source

Aquino MRC, Avelar BS, Silva PL, et al. Reliability of foot posture index individual and total scores for adults and older adults. Musculoskelet Sci Pract. 2018 Feb 6. pii: S2468-7812(18)30042-0. doi: 10.1016/

Neuromuscular training in high-risk female adolescent athletes

Noting that an up to 10-fold increased risk of injury has been demonstrated in female athletes compared with male athletes, particularly for anterior cruciate ligament (ACL) sprains, patellofemoral pain, and ankle injuries, researchers sought to evaluate the effects of a school-based neuromuscular training (NMT) program on sport-related injury incidence at the high school and middle school levels.

Focused on school-based basketball, volleyball, and soccer, a prospective randomized controlled clinical trial included 474 female athletes from a public school district in Kentucky. Of these athletes, 222 were middle-schoolers, and 252 were high-schoolers. Students could engage in more than 1 sport.

Players were cluster assigned to an NMT group or sham group. The sham group performed resisted running using elastic bands, while the NMT group performed exercises focused on the trunk and hip. From the first day of team practice until the first competition, teams performed the NMT training for 20 to 25 minutes, 3 times per week, and then a reduced-volume protocol of 10 to 15 minutes, twice a week through the competition season.

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The data indicate that an NMT program implemented at the middle school and high school levels prevented injury in female basketball and volleyball athletes over the athletic season, particularly knee injuries, and was most pronounced for knee injuries in middle school volleyball players. No difference was observed for ankle injuries between the NMT and sham groups either by level, or by sport.

The researchers further noted that the knee-injury reduction observed for middle school volleyball athletes was of particular interest, concluding that their data might suggest the importance of implementing injury-prevention strategies at younger ages to have the greatest effects on young female athletes.

Source

Foss KDB, Thomas S, Khoury JC,Myer GD, Hewett TE. A school-based neuromuscular training program and sport-related injury incidence: A prospective randomized controlled clinical trial. J Athl Train. 2018;53:20-28.

Continued on page 14

Continued from page 13

How might power training improve gait in older adults?

Building on previous data that tentatively supports the possibility that power training could induce changes in neuromuscular activation during level walking in older adults, researchers tested the effects of a 10-week program of lower extremity power training on gait velocity and neuromuscular activation of lower extremity muscles during level walking in healthy older adults. The researchers hypothesized that power training produces correlated improvements in gait velocity and increases in agonist activation, or decreases in antagonist coactivation.


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Study subjects were age 65 or older and were drawn from the Potsdam Gait Study. The lower extremity power-training program consisted of 30 sessions over 10 weeks designed to improve lower extremity power with a program of leg press, ankle press, knee extension, and knee flexion exercises, using bilateral movements, performing 3 sets of 6-10 repetitions at 40-60% of 3-repetition maximum.

Surface EMG activity was recorded from 5 muscles of the right leg. Data from 12 participants were included for the analysis of the power training intervention, and 13 from the control group. The researchers found that in addition to gains in maximal EMG amplitudes and isometric strength, older adults demonstrated elevated knee extensor activation and coactivation during early stance, and elevated plantarflexor activation during push-off. The data suggest that the power training-induced increases in agonist muscle activation underlay the increases in isometric muscle strength and gait velocity.

While noting that future studies should determine if power training increases hip muscle activation during gait, the researchers concluded that a 10-week power-training program improved agonist muscle activation during isometric actions and during walking, and that the power training-induced increases in agonist muscle activation may have a role in isometric strength and fast gait velocity.

Source

Beijersbergen, CMI, Granacher U, Gäbler M, et al. Power training-induced increases in muscle activation during gait in old adults. Med Sci Sports Exerc. 2017;49:2198-2025.

Effects of running-specific prostheses at varying speeds

Most previous studies on running mechanics in amputees have used prostheses originally designed for walking, and those that have looked at running mechanics using prostheses designed for running have focused on sprinting. Because submaximal-speed running is common in day-to-day and sporting activities, researchers sought to determine how lower extremity joint moments change throughout the gait cycle when running with running-specific prostheses (RSPs) under different speed constraints.


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Eight individuals with unilateral transtibial amputations and 8 control subjects with no amputations ran at 3 constant velocities. The researchers found that, compared with the intact limb, the prosthetic limb generated significantly greater peak ankle plantar flexion moments and smaller peak ankle varus, knee stance extension, knee swing flexion, knee internal rotation, hip stance flexion, hip swing flexion, hip swing extension, hip valgus, and hip external rotation moments. They observed that the intact limb had greater peak hip external rotation moments than control limbs, but all other peak moments were similar between these limbs. Increases in peak hip stance and knee swing flexion moments associated with speed were greater in the intact limb than the prosthetic.

The researchers concluded that the intact limb knee and hip joints generated greater peak moments than the prosthetic limb in all 3 planes of motion, suggesting a greater reliance on the intact limb during running. However, with the exception of hip internal rotation moments, the intact limb generated similar peak moment values to the control limbs, suggesting that the intact limb is not overloaded when individuals with lower extremity amputation run with RSPs. Only the hip peak stance flexion moment and knee swing flexion moment increases associated with speed were greater in the intact limb than the prosthetic limb, which they observe is likely a result of the greater joint accelerations and inertial properties in the intact limb. The researchers noted that research on potential functional differences between individuals with congenital vs traumatic amputations would be useful.

Source

Baum BS, Hobara H, Koh K, et al. Amputee locomotion: Joint moment adaptations to running speed using running-specific prostheses after unilateral transtibial amputation. Am J Phys Med Rehabil. 2018 Feb 5. doi: 10.1097/PHM.0000000000000905. [Epub ahead of print].

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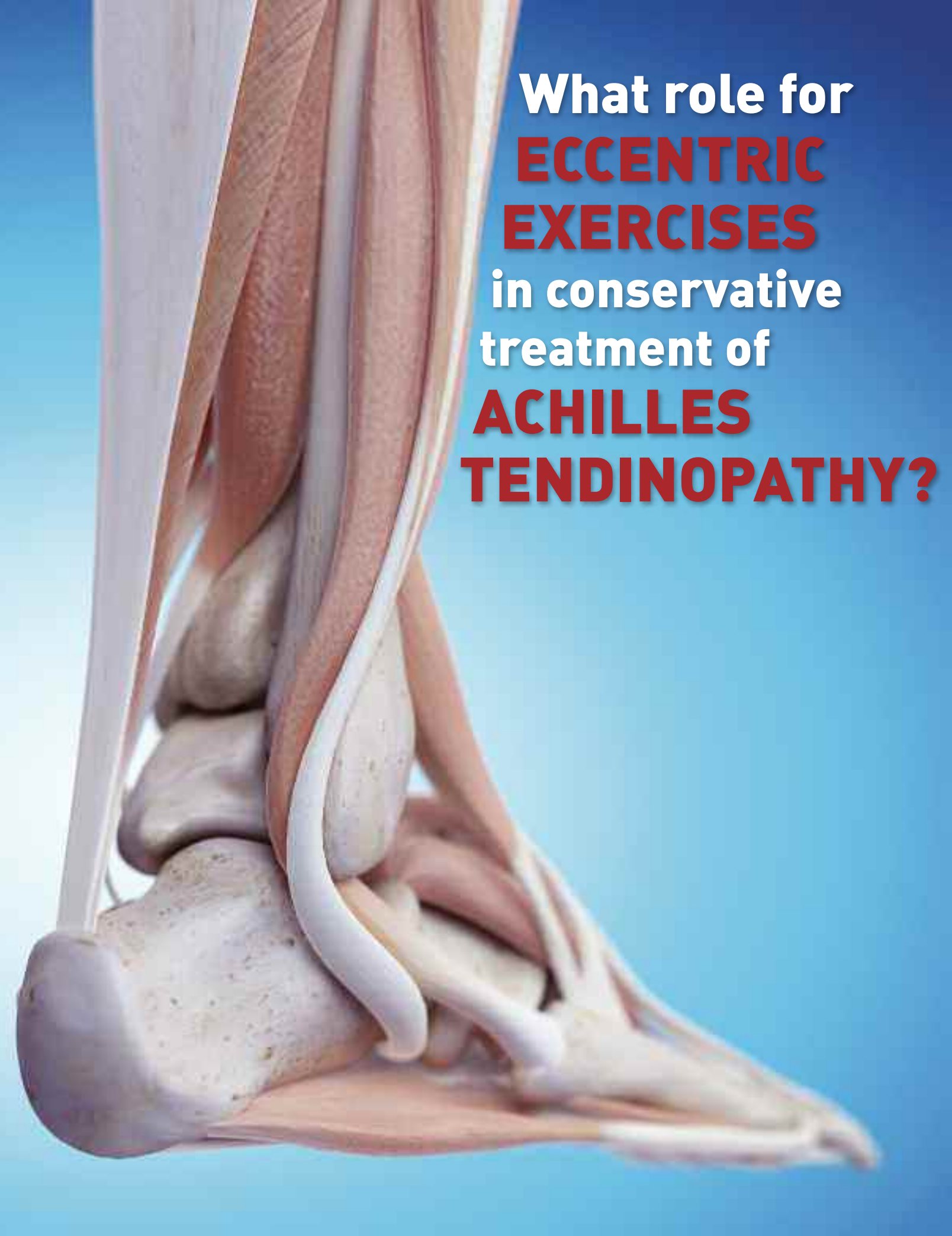

What role for ECCENTRIC EXERCISES in conservative treatment of ACHILLES TENDINOPATHY?

The authors seek answers to clinical questions regarding the optimal program of eccentric exercises: Does type of tendinopathy predict success? What modifications to exercise duration and repetitions make sense? What is the likelihood of long-term pain relief afforded by such a program of exercise?

By Jonathan L. Hook, DPM, MHA, and Curt Martini, DPM

Pain in the Achilles tendon is common among athletes, recreational exercisers, and inactive people alike. Achilles tendinopathy, a non-inflammatory cause of pain in this tendon, affects approximately 7% to 9% of runners but also affects participants in other sports and nonathletes.[1,2]

Maffulli and coworkers describe the clinical presentation of Achilles tendinopathy as a triad of pain, diffuse or localized swelling, and impaired performance of the Achilles tendon[3]; histologic examination of the Achilles tendon insertion demonstrates necrosis and mucoid degeneration, rather than inflammatory infiltrate.[4] This absence of an inflammatory component defines the condition as tendinopathy.

We further subclassify Achilles tendinopathy as midsubstance (also midportion) Achilles tendinopathy, insertional Achilles tendinopathy, and acute or chronic paratendinopathy.

Midsubstance Achilles tendinopathy represents approximately 55% to 65% of Achilles tendon injuries.[5] This type, which occurs 2 to 6 cm from the insertion of the Achilles tendon, has the classic presentation of pain, swelling, and impaired performance[6] owing to the region's zone of hypovascularity.

Insertional Achilles tendinopathy presents as pain and stiffness at the posterior aspect of the calcaneus[6] and accounts for approximately 20% to 25% of Achilles tendon injuries.[5]

Both acute and chronic paratendinopathy will have edema and hyperemia around the midportion of the tendon, while the pain of chronic paratendinopathy is exercise induced.[6]

A diagnosis of Achilles tendinopathy can be made clinically, based on pain with walking, running, or stairclimbing and physical examination findings that include pain on palpation to the Achilles tendon either proximal to or at the insertion; difficulty performing double heel raise; and decreased strength with plantar flexion typically due to guarding. Imaging studies with ultrasound and magnetic resonance imaging can confirm the diagnosis of Achilles tendinopathy, but imaging is not required to make the diagnosis.

Risk factors

Intrinsic risk factors for Achilles tendinopathy include age between 30 and 55 years, male sex, obesity, exercise-induced hyperthermia, presence of systemic disease (eg, diabetes mellitus, rheumatoid arthritis, Ehlers-Danlos syndrome), reduced tendon flexibility/ankle-joint range of motion, reduced blood supply, and prior injury to the area.[7] Other intrinsic factors include abnormal subtalar-joint range of motion, increased foot pronation, decreased ankle-plantar flexion strength, and abnormal tendon structure.[1] Extrinsic factors for Achilles tendinopathy tend to cause acute injury; these extrinsic factors include training errors, faulty equipment, improper shoes, overuse, surface on which the athlete is training, and use of quinolones or corticosteroids.[7]

An overview of treatments

Conservative treatment generally is recommended as the initial strategy, regardless of the type or etiology of the patient's Achilles tendinopathy. Several conservative modalities have better evidence than others to support their use, but we know of no high-quality head-to-head studies that compare the effectiveness of the various conservative treatment regimens described here. We review these modalities briefly to put in context the evidence regarding a program of eccentric exercise.

Initial treatment may include a combination of rest, pain medication, stretching, strength training, heel lift, footwear change, and correction of malalignment.[8] Custom foot orthoses to control rearfoot motion have minimal effect when used as the only treatment modality[9,10]; taping and use of heel lifts also have limited evidence of efficacy.[1] Stretching exercises may be helpful for patients who have limited dorsiflexion at the ankle joint.[1]

Platelet-rich plasma also has been used recently, but compelling evidence to support its use is lacking. Corticosteroids are associated with an increased risk of tendon rupture and have minimal effect on Achilles tendinopathy.[11] Use of extracorporeal shock-wave therapy

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(ESWT) as monotherapy and in combination with other modalities has, however, recently been shown to benefit patients.[12]

Surgery is typically reserved for patients whose symptoms do not resolve with 3 to 6 months of conservative treatment; choice of procedure depends on both the amount of tendon involved and location of tendinopathy. Open surgery with debridement of adhesions and nonviable tendon may be effective for midsubstance tendinopathy; Rolf and Movin reported improvement in symptoms in 86% of patients after undergoing surgical debridement, with a complication rate of 13%.[13]

Augmentation is the procedure of choice in cases that require more than 50% debridement. Options include the use of the flexor hallucis longus tendon, owing to its good power; it is also an in-phase transfer and has a similar line of pull to the Achilles tendon.[14] Researchers reported improvement in American Orthopaedic Foot & Ankle Society ankle-hindfoot scale from 41.7 to 90.1 following flexor hallucis longus tendon transfer performed on 29 tendons.[15] Although the patient undergoing this procedure will lose plantar flexion at the hallux interphalangeal joint, it typically has no effect on gait and requires no modification of activity. The proximity of the flexor hallucis longus muscle belly to the hypovascular zone of the Achilles tendon allows for increased vascularity and postoperative healing. Tendons less commonly used for augmentation are the flexor digitorum longus, peroneus longus, peroneus brevis, and posterior tibialis tendon.[14]

Surgical treatment options for insertional Achilles tendinopathy include debridement and augmentation procedures described for midsubstance tendinopathy, along with resection of retrocalcaneal exostosis and removal of the retrocalcaneal bursa.[16]

Do eccentric exercises work?

A program of eccentric exercise for treatment of Achilles tendinopathy was first described by Alfredson and coworkers in 1998.[17] A control group (n=15) underwent classical treatment and surgery, while an experimental group (n=15) was assigned to an exercise program performed twice daily (180 repetitions/day) every day for 12 weeks. Patients began with the ankle in plantar-flexed position and lowered the heel in relation to the forefoot, which eccentrically loaded the gastrocnemius and soleus muscle complex. The unaffected limb was then used to return to the start position to prevent concentric loading (Figure 1). Once pain had improved, patients would perform the same exercise with weight added.

Patients who underwent the exercise program had significant improvement in pain (visual analogue scale [VAS]) and strength of the affected tendons, and no statistically significant difference in outcomes was found between patients in the experimental-exercise group compared with those in the surgical group.

A multicenter study that compared short-term results of eccentric- vs concentric-exercise–training programs for treatment of chronic midsubstance Achilles tendinopathy found that 82% of patients undergoing an eccentric-exercise program were able to return to their preinjury activity level, compared with 36% of patients who underwent a concentric-exercise program.[18] Although only 22 patients were included in each study group, the results suggest a significant difference between the 2 treatment programs for chronic midsubstance Achilles tendinopathy.

The mechanism by which an eccentric-exercise program exerts an effect on Achilles tendinopathy remains poorly understood, although 1 study demonstrated increased type 1 collagen associated with an eccentric-exercise program in diseased tendons. This finding supports the observation that diseased tendons are caused by chronic overuse that exceeds the repair capabilities of tissue and that an eccentric-exercise program allows for increased production of type 1 collagen that may assist the diseased tendon to achieve homeostasis.[19]

Figure 1. Eccentric exercise for Achilles tendinopathy. With the ankle in plantar-flexed position (a), the heel of the affected limb is lowered in relation to the forefoot, which eccentrically loads the gastrocnemius and soleus muscle complex (b). To prevent concentric loading, the unaffected limb is used to return to the start position (c). After improvement following a regimen with the straight-leg exercise, the patient may then perform the exercise with the knee of the affected leg bent (d, e).

From Munteanu S, Landorf K, Menz H, et al. Efficacy of customised foot orthoses in the treatment of Achilles tendinopathy: study protocol for a randomised trial. J Foot Ankle Res. 2009; 2:27. https:// commons.wikimedia.org/ wiki/File:Efficacy-of-customised-foot-orthoses-in-the-treatment-of-Achilles-tendinopathy-study-protocol-for-a-1757-1146-2-27-S4.ogv.

Other proposed mechanisms include[20]:

- Structural tendon adaptation
- Tendon-length change
- Neurovascular ingrowth
- Neurochemical alterations
- Fluid movement
- Neuromuscular adaptations

Studies provide insight on modifications

Stevens and Tan sought to evaluate the effect of modifying the number of repetitions in the Alfredson eccentric-exercise program, with 28 patients in 2 groups: 1 performing the daily regimen of 180 repetitions (n=15) and the other group performing the exercises as tolerated (n=13). At 6 weeks, researchers noted significant improvement in Victorian Institute of Sports Assessment-Achilles (VISA-A)

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questionnaire for both groups and in VAS pain scores for patients in the do-as-tolerated group.[21] This study, however lacked sufficient follow-up to compare rates of recurrence between the do-as-tolerated and the 180 repetitions/day groups.

Another study sought to examine additional modifications to the Alfredson eccentric-exercise program: 6 weeks' duration versus 12 weeks and stretches maintained for at least 15 seconds, compared with 10 seconds.[22] The study included 190 patients: 168 with midsubstance Achilles tendinopathy and 22 with insertional Achilles tendinopathy. Researchers found that 86% of patients with midsubstance Achilles tendinopathy and 80% of those with insertional Achilles tendinopathy reported significant relief from pain.

The long run?

How durable are the effects of an eccentric-exercise regimen for Achilles tendinopathy? A randomized controlled study compared an eccentric-exercise group of 22 patients with a control group (n=18) who performed both concentric and eccentric exercises at a lower load than the experimental group, to determine effectiveness of the 12-week program at 1 year. Patients were evaluated at intervals of 6 weeks, 3 months, 6 months, and 1 year after initiating treatment.[23]

No significant difference between the 2 groups was found at any of the evaluations, although significant overall improvement was noted in the eccentric-exercise group. This cohort of patients had better outcomes with respect to plantar flexion, reduced pain on palpation, asymptomatic periods, and reduced tendon swelling. In addition, more patients in the eccentric-exercise group felt they had fully recovered and had returned to regular activity levels. [23]

Although the effectiveness of the eccentric-exercise program was demonstrated at 1 year, it did not suggest longer-term benefit. For this, van der Plas and coworkers evaluated 70 tendons from 58 patients that had undergone the Alfredson eccentric-exercise program 5 years prior. Using the VISA-A questionnaire and pain status, the researchers determined that 58 tendons had an improvement in their VISA-A score from 49.2 to 83.6 after initial treatment and 83.4 at the 5-year mark. The researchers reported that 39% of patients were pain free and 48% had mild pain for which they received alternative treatments.[24] Thus, while supporting the use of Alfredson's eccentric-exercise program for pain relief and as a good initial treatment modality, the study results demonstrated that approximately half of patients who undergo the treatment regimen will require further treatment with an additional modality or may continue to experience pain long term.

Evidence suggests that eccentric exercises may be more beneficial when used in combination with other modalities, specifically ESWT. Rompe and coworkers assigned 68 patients equally into 2 groups: 1 received only eccentric exercises, and the other group received eccentric-exercise program and ESWT.[25] At 4 months, 56% of patients in the eccentric-exercise–only group had significant improvement in symptoms, and 82% of patients in the combination therapy group with ESWT had significant improvement in symptoms.

Of benefit to all types, equally?

Does an eccentric-exercise program benefit 1 type of Achilles tendinopathy more so than another type? Of 101 cases of midsubstance chronic Achilles tendinopathy treated with an eccentric-exercise program, 89% of tendons had significant improvement, with patients reporting satisfactory results and return to preinjury activity levels. In this same study, the authors also examined the protocol's effectiveness on insertional Achilles tendinopathy. In this cohort, only 32% had an improvement in VAS pain score and were satisfied with treatment.[26] This disparity between improvement for midsubstance compared with insertional Achilles tendinopathy is likely due to compression of the retrocalcaneal bursa. During the ankle dorsiflexion phase of the eccentric-exercise program, the bursa is pressed against the anterior surface of the Achilles tendon, resulting in increased tension at the insertion point.

Following the results of this study, Jonsson and coworkers sought to determine whether modifying the eccentric-exercise training program to prevent loading into dorsiflexion could better help patients who had insertional Achilles tendinopathy.[27] To accomplish this, patients performed the exercises on the floor, rather than on a step. The researchers reported that 67% of patients in the modified-exercise group had less pain compared with 32% of subjects reporting improvement after undergoing the original eccentric-exercise program.

Additional research has demonstrated that eccentric exercises do not have the same effect for insertional Achilles tendinopathy compared with midsubstance Achilles tendinopathy. Kedia and coworkers conducted a single-blinded, randomized, controlled trial to determine whether the addition of eccentric exercises to a conventional training program significantly reduced pain.[28] Their finding? A program consisting of gastrocnemius, soleus, and hamstring stretching; ice massage on the Achilles tendon; heel lift; and night splints was as effective for insertional Achilles tendinopathy with or without a program of eccentric exercises.

In the clinic

The cause of the patient's tendinopathy and its clinical presentation will inform management, which may include addressing any extrinsic factors causing pain, such as reducing the amount of training, modifying footwear or recommending a change in the training surface. Intrinsic modifications include use of custom orthoses to modify rearfoot alignment, improving range of motion at the ankle joint, strengthening the Achilles tendon, and controlling any systemic disease.

Strong evidence supports the use of an eccentric-exercise program, particularly for midsubstance Achilles tendinopathy, and greater efficacy may be realized when used in conjunction with another treatment modality, such as ESWT. Insertional Achilles

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tendinopathy, however, does not respond as well to eccentric exercises as does the midsubstance type. In these cases, the exercises must be modified to eliminate the dorsiflexion-loading phase, which will, in turn, relieve compression—and tension of the retrocalcaneal bursa—on the insertion of the Achilles tendon.

Alternatively, eccentric exercises can be used in conjunction with a stretching and strengthening program with regular icing for pain relief. There has also been improvement to insertional Achilles tendinopathy when combining the modified heel-drop exercise with other types of therapy such as ESWT.

The continually demonstrated effectiveness of an eccentric-exercise program for Achilles tendinopathy, taken together with its low cost and low risk to the patient, position it high among first-line treatments for Achilles tendinopathy.

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The effect of footwear on the management of pain caused by disorders of the knee joint

Clinical studies have demonstrated that properly fitted footwear may alleviate knee pain resulting from osteoarthritis or other joint disease processes, while the wrong shoe can exacerbate the condition. How can practitioners help patients with knee pain make the distinction?

By Keith Loria

Footwear plays an integral role in force distribution on the lower extremities, and choosing appropriate footwear is one of many strategies people can use to manage knee pain caused by joint disorders. When footwear is properly fit, force and stress can be shifted away from weaker parts of the knee, and the leg stabilized. This may lead to a significantly better quality of life for patients with knee problems, such as osteoarthritis (OA) and patellofemoral pain syndrome.

"The wrong footwear can contribute to the development of painful knees and exacerbation of arthritis in the knee joint," said Justin Price, MA, corrective exercise specialist in San Diego, CA. Price recommends investigating force distribution, stability in the lower extremities, reduction of load, and patient comfort when evaluating the various types of footwear.

The problem with heels

Shoes with a standing surface not parallel to the floor due to an elevated heel, such as dress shoes, running shoes, and boots, tip the body's center of mass forward, causing the entire body to compensate in order to avoid falling. People who wear high-heeled shoes may stand or walk with their knees constantly bent to stay upright, Price said. Over time, the sustained knee flexion may lead to inflammation, pain, and additional musculoskeletal imbalances. In addition, an elevated heel may cause an anterior pelvic tilt, where the pelvis rotates forward, tilting up at the back and down at the front and resulting in excessive lumbar lordosis and compensatory shifts up the spine to the head.

Kade Paterson, MSD, post-doctoral research fellow, in the Department of Physiotherapy at the University of Melbourne, Australia, said it's now well known that shoes with higher heels increase load within the tibiofemoral and patellofemoral joints, contributing to knee pain. "Many standard athletic shoes have a heel height of 30 mm or more [higher than an inch], which can increase knee load

> A key message is to individualize treatment. This involves thoughtful attention to foot type and type of knee compartment affected.

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by more than 15%," he said. Shoes that have a lower heel height and pitch and are more flexible reduce load in these joints.

Moreover, according to Price, almost all fashion-focused footwear is problematic for the knees because it is typically designed to narrow toward the front. This narrowing of the foot width with associated compression of the toes decreases the base of support, again causing the entire body to compensate in order to remain upright.

Gregorio Caban, DPM, Doral, FL, a reconstructive foot-and-ankle surgeon, noted he often sees referred patients with knee conditions, many of whom have received a diagnosis of patellofemoral pain syndrome (PFS). "My role [in these cases] is to identify a possible deformity in the foot that is contributing to the knee condition," he said. He treats PFS with proper foot gear and orthotics based on the patient's foot type.

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Findings from recent studies

Although comfort and fit are very important, as an uncomfortable shoe either won't be worn or will actually cause foot pain, it is equally important to replace shoes frequently. "In one of our recent clinical trials," noted Paterson, "we asked participants to bring in their most commonly worn pairs of shoes and found most were very old and well worn, with an average self-reported age of 3.4 years and estimated 5240 hours of wear."[1] Avoiding foot pain is beneficial, said Paterson. "[Foot pain] exacerbates existing knee pain in people who already have knee OA."

Jared M. Newman, MD, Department of Orthopaedic Surgery, SUNY Downstate Medical & Rehabilitation Medicine Center, Brooklyn, NY, and fellow researchers reviewed the

current literature on the use of various types of footwear worn by patients who suffer from knee pain, by specifically evaluating knee OA and patellofemoral pain and the effect that different footwear had on patient symptoms.[2]

Newman and his colleagues found that various footwear modalities were beneficial but that the results among studies were conflicting and warranted further investigation. The authors also discovered, however, that there were several positive outcomes that could be used as a foundation for further study. For example, the review revealed that the use of wedged insoles with and without subtalar and ankle joint straps can potentially diminish symptoms by diverting forces away from the medial position of the knee, reducing joint space narrowing and subsequent pain and improving function.[2]

Similarly, the use of specialized footwear, such as minimalist shoes—flexible, flat shoes without raised heels—was shown to reduce pain and knee adduction moment, and therefore load on the knee joint. Reduction in joint load has been theorized to minimize the progression of knee OA and pain. Studies have demonstrated that these shoes can decrease patellofemoral pain by reducing the stress of the patellofemoral joint, Newman said.

One size does not fit all

In another study, David Hunter, MBBS, MSc, M SpMed, PhD, FRACP, Florence and Cope Chair of Rheumatology and professor of medicine at the University of Sydney and the Royal North Shore Hospital, Sydney, Australia, and coworkers


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looked at the role of footwear in predisposing to exacerbations of knee pain in persons with knee osteoarthritis.[3] The study found that people who had little support in their shoes, particularly in high-heeled footwear, were more likely to have exacerbations of knee pain. The study found that proper footwear appears to be important both in preventing a person from developing pain and in controlling its severity, Hunter said. Repeated physical activity over a long duration can compound the damage and resultant pain, Hunter said. "I think the key message is to individualize treatment. This involves thoughtful attention to foot type and type of knee compartment affected rather than using a 1-size-fits-all approach."

Paterson recently led a study comparing the biomechanical effects of flat, flexible shoes to more stable supportive shoes, based on 5 key criteria--heel thickness, shoe pitch, motion control properties, sole rigidity, and shoe mass. Study participants walked in 3 shoe styles from each category, for a total of 6 shoe styles in all.[4] Use of flat, flexible shoes resulted in significantly lower knee joint loads compared with stable supportive shoes. The authors reported that their results were generalizable to other shoe brands and models that meet the 5 criteria. In addition, the criteria are readily measurable in the clinic, thus clinicians are provided with a rough guide to choosing shoes that reduce knee load, potentially reducing pain.

In another study conducted by Paterson et al, people with moderate or severe radiographic knee OA (grades 3 and 4, based on the Kellgren-Lawrence [KL] X-ray grading scale) had greater improvement in knee pain while wearing an unloading shoe compared with a conventional walking shoe. Conversely, patients with mild radiographic disease (KL grade 2) had no clinical benefit with the unloading shoe, and in fact, responded more favorably to conventional

walking shoes.[5]

"The reductions in symptoms in people with moderate and severe radiographic disease were achieved via a reduction in the knee adduction moment (a surrogate measure of internal medial knee joint loading)," Patterson said, "confirming this as the mechanism through which the unloading shoes achieved their clinical effects." He added, "This is the first evidence of a potential subgroup of knee OA patients that are more likely to respond to biomechanical interventions designed to reduce knee joint loading, such as unloading shoes."

Tips for choosing the correct shoe

Andy Gerken, MD, foot and ankle specialist with Hoag Orthopedic Institute, Newport Beach, CA, noted that athletic shoes are the easiest to work with in terms of foot function when trying to reduce pain. "A rigid insole to prevent bending stresses that exacerbate midfoot and forefoot arthritis is helpful," he said. For runners, particularly older runners (older than 35 years), he recommends a running shoe that takes shock while allowing normal running kinematics and gait.

Kevin D. Plancher, MD, MPH, clinical professor of orthopaedics at Albert Einstein College of Medicine in Bronx, NY, said running is an important sport and 1 shoe does not fit all, especially when considering differences between men and women runners. Women's running shoes tend to have a narrower heel and a wider forefoot, with greater flexibility, he said, with the front of the shoe offering a wider toe box, so the toes are not squeezed. "They are lighter in weight with deeper grooves. If your foot gets flat and the arch collapses, it puts pressure on the inside of your knee. We have to put something in the sneaker or create a good platform to take pressure off."

Minimalist shoes have been tested in various contexts for knee OA and appear to have an important role in reducing loading through the medial compartment in people that have medial tibiofemoral OA. However, Hunter said, it's been difficult to translate that into clinically important outcomes such as pain and function. "People should be willing to spend a lot of time trying on different shoes in order to discover the pair that works best," he said. This is particularly true for people with pre-existing foot problems or who are overweight or obese. "They should be careful not to use flimsy, stylistic shoes that look good but can result in problems later."

Keith Lorria is a freelance medical writer.

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Function meets fashion in modern therapeutic devices

Unattractive therapeutic devices do not benefit patients if they won't wear them. Leading practitioners discuss how, over the past decade, manufacturers have made significant strides in turning the solely functional into the truly fabulous.

By Jill R. Dorson

You probably think that "fashionable therapeutic device" is an oxymoron. After all, the extra depth needed for a good diabetic shoe is sure to ruin the elegant line of high heels. And there's nothing good looking about medical-grade compression stockings. When talking about orthotic and prosthetic devices, well, the goal is to walk, not look good, right?

Some practitioners would take issue with the idea that a person can't both feel good and look good, or that fashion and therapeutic devices are mutually exclusive. Sure, it's tough to make that clunky brace look cool, but physicians, academics, and pedorthists are trying.

The intersection of fashion, form, and function

"Most people are not aware of more stylish options," said Peter Morcom CPed[C], president of the Pedorthic Association of Canada and manager of a footwear and orthotics venue in Vancouver, BC. "There is [an] overarching fear of this large, clunky orthopedic shoe." Today, however, most patients don't require that type of footwear.

Not only are shoe companies and custom shoe manufacturers offering a wider range of therapeutic devices, Morcom added, but the materials and methods of fabrication have also improved over the past 5 or 10 years. The result is that fashion, form, and function are becoming better integrated.

More options, it turns out, also means better options. Roy H. Lidtke, DPM, CPed, FACFAOM, of the Department of Physical Science and Rehab at St. Luke's Hospital in Cedar Rapids, IA, and an assistant professor of internal medicine, at Rush University Medical Center in Chicago, is at the forefront of bringing fashion to diabetic footwear. Lidtke's research demonstrated a 200% reduction in forefoot pressure when women wore a modified—and stylish—heeled shoe.[1] The study enrolled only 10 women, and none with foot deformities, but Lidtke said the results were compelling.

He and his team conducted the study because of the natural skepticism around high-heeled shoes for the diabetic population. "It just doesn't make biomechanic sense. But I like a good challenge,

> Making shoes, stockings, and other devices more fashionable isn't just about looking good. It's about patient adherence.

YOU'RE NOT STILL USING A TYPEWRITER

So, why use a 2D scanner?

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Image courtesy of Cascade DAFO

so we looked at what parts of the shoe we could modify." The researchers found the forefoot pressure could be decreased, even in those subjects with diabetes.

The shoe, a modified patent-leather, Mary Jane style, was tested against a more standard heeled shoe. The modifications included an elevated midsole, a metatarsal bar, anterior rock, and several cut-out areas. The result was a comfortable shoe that provided a more dressed-up, high-heeled option for those women who wear diabetic shoes.

Aesthetic improvements in the past 10 years

There is little research on the aesthetics of therapeutic devices, but practitioners say they've seen an improvement in everything from diabetic shoes to compression stockings to orthotic and prosthetic devices in the past decade.

Making shoes, stockings, and other devices more fashionable isn't just about looking good. It's about patient adherence. In fact, studies[2,3] have shown that many patients wear their prescribed footwear less than 60% of the time during daylight hours. Practitioners admit the onus is on them to talk with patients about what footwear is available, why they should use it, and

Continued on page 36

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the consequences – which vary widely – of not adhering. That conversation often begins with the first office visit.

"I'm very aware that people want to look nice," said Milwaukee-based Alex Kor, DPM, MS, immediate past president of the American Academy of Podiatric Sports Medicine. "For women who favor a 3-inch heel and a narrow toe box, I suggest a 1 ½-inch heel and a wider toe box. I try to give them an idea of what to look for. They need to be satisfied and have less pain and be happy when they look down at their feet."

Although Lidtke embraced the challenge of creating a more stylish diabetic high-heeled shoe, Morcom said that overall, therapeutic shoes are better looking and more comfortable now because the materials are better, softer, and more functional. In fact, Morcom pointed to several running shoe companies that incorporate a stiff front rocker, which according to a 2017 study,[4] alleviates stress on the forefoot and can create subtle changes in gait. Morcom said that feature used to be exclusive to specialty shoes but now can be found in some off-the-shelf running shoes and dress shoes, which allows patients to get relief at lower cost and without "clunkiness."

Compression stockings have not caught up

Advances in style have not necessarily made their way into other therapeutic aids. For example, medical-grade compression stockings still look like, well, medical-grade compression stockings worn with shorts or skirts that expose the legs. Practitioners say that lighter and more advanced materials have made the stockings more comfortable and less likely to bunch up and create discomfort, but few advances have been made in terms of fashion.

Compression stockings used to improve peripheral circulation for patients with any of a number of conditions, including diabetes and peripheral vascular disease, may also be used temporarily to help prevent blood clots after a surgical procedure.

A January 2018 web search of medical-grade stockings turned up many stylish options for when the leg is not exposed—patterned knee-high stockings for men and women and pantyhose and tights for women. But when a patient's leg is exposed, as is often the case

Image courtesy of Sigvaris.

in warm weather, the options are few. Regardless of whether a patient's leg is exposed, weather can have a big effect on the comfort of—and therefore desire to wear—the socks, stockings, or other therapeutic device.

Kor noted that efforts to make medical-grade stockings more aesthetically pleasing may not be worth it. "I don't think I've ever had a patient tell me that they don't like compression socks because of the color. …Thickness and ease of application play a role, and

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Image courtesy of Anodyne.

Image courtesy of Ped Lite.

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Image courtesy of KnitRite.

some of the newer synthetic materials can be thinner and more comfortable and provide the right compression." Kor's experience is backed up by research and thoughts from other practitioners. Sizing can be tricky, and if patients aren't fitted properly, they may experience pain and not wear the stockings.

For in-shoe inserts, functionality rules

Orthotic and prosthetic devices are another area where aesthetics are changing, although both Kor and Morcom noted that the stylishness of an in-shoe orthotic is not a major concern. "On the orthotic side of things, we make a business-casual insert that matches the inside of the shoe," Morcom said. "There are better products being made, and they are more attractive." One insert manufacturer offers 60 to 70 different materials from which to choose.

Kor feels that before taking aesthetics into account, podiatrists must make sure to consider what types of shoes patients will be wearing with orthotics or other therapeutic devices. He said he hears more often from women than men that their orthotics don't fit their shoes and, in turn, that the patients don't wear them. Once fit is correct, aesthetics can come into play.

Kids like keeping it cool

Practitioners believe making the look of the device "cool" is particularly relevant for kids. "I've seen orthopedic shoes with flashing lights," Kor said. "There are lots of things you can do with them." Kid-colored options for ankle-foot orthoses (AFOs) and prosthetics are available, but some young patients may not want to draw attention to their therapeutic device.

Although making a device colorful might seem like a good idea, adding color to the plastic of an AFO can shorten the life of the device. Decals, such as the logo of a favorite sports team, a superhero, or a piece of artwork, applied to the exterior of the device don't degrade the material.

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Although adding color or artwork to devices may seem appealing for children, it is not always the case. Cora Miller, RN, has seen first-hand how hard it can be to get a child to embrace a brace. Her son, Miles, now 6, was born with clubfeet and wore Ponseti braces 23 hours a day for 3 months when he was 1 year old, and at night for more than a year. Over the past 5 years, Miles has endured not only braces but also serial casting, and from December 2017 to January 2018, he wore casts on both legs following Achilles tendon–lengthening surgery.

"He should have worn the braces longer," Miller said, "but he hated [them]." Miles, however, was able to choose candy-stripe colors for his recent set of casts, which he debuted at Christmas. "For the braces, there wasn't too much we could do with them."

Aesthetics continue to make strides

Although the aesthetics of therapeutic devices may still be a work in

progress, practitioners say that making patients aware of available options is critical. The internet can be used to get this information to patients and presents another avenue for professionals to share that information. "There's not a day that goes past that I'm not with a patient at the computer, that I am not showing a patient a picture," said Kor.

That said, while the internet facilitates the sharing of information, Lidtke reminds patients to be aware that not everything on the internet is "good" information. "I do use technology and the internet," Lidtke said. "But I do think that 'Dr. Google' can give you some bad information. I generally try to use it in the office and give patients specific websites to look at."

Ultimately, whether practitioners can improve the fit and look of a medical device through technology or cutting-edge materials, the end result must be a device that the patient will wear. "People need to have more fashionable options [for therapeutic devices] because people are only going to use them if they fit into their lifestyle," Morcom said. "It's important for us to look at what our patient does every day and make sure [what we prescribe] works for them." ler

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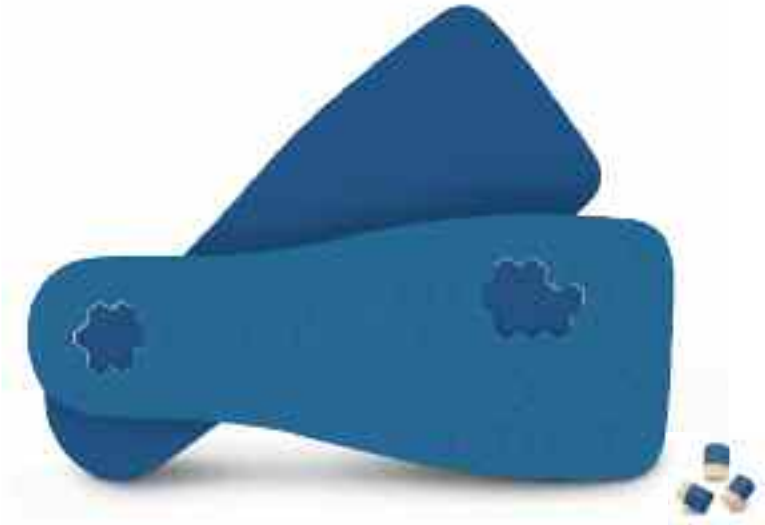

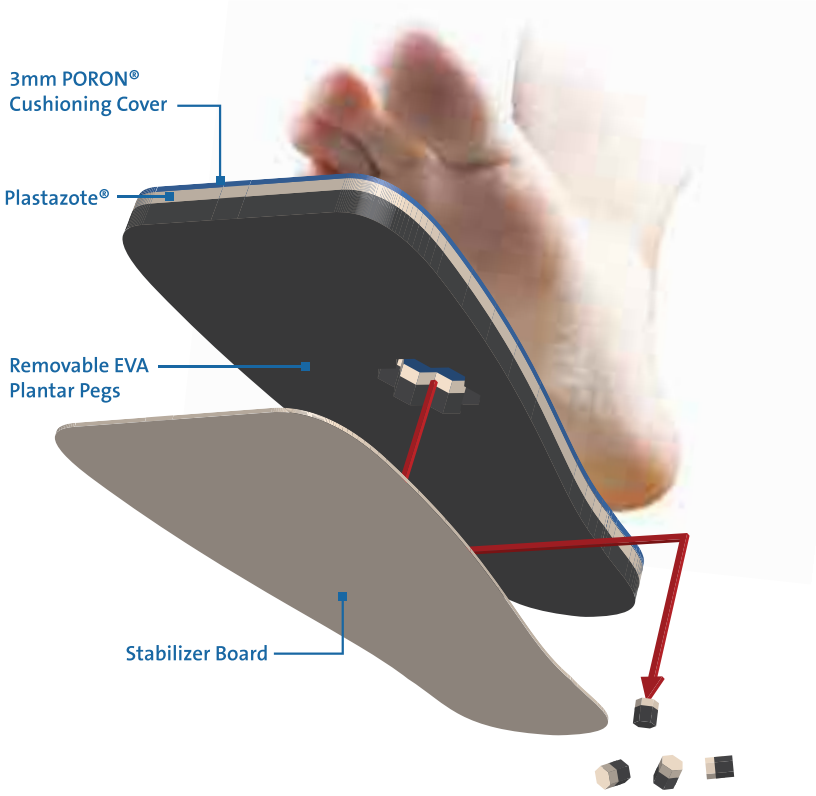

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Is it the foot—or the footwear? Considerations for protecting a diabetic foot

In diabetes, assessing the mechanical properties of the patient's soft tissues *and* the properties of footwear and orthoses comes before drafting a management plan.

By Nachiappan Chockalingam, PhD

Prescription footwear and foot orthotics are standard interventions for any type of diabetic foot disease. We lack knowledge, however, on how to select appropriate materials for footwear and orthotics for our patients who have diabetes; generally, cushioning materials with which these devices are constructed are selected based on the clinician's experience and on anecdotal evidence. In this article, I look at promising advances being made by researchers in developing quantitative evidence to inform the management of diabetic foot disease.

Limited tools to address major sequelae of diabetes

The complications of diabetes include a range of foot pathologies:

- neuropathy
- ulcers, as a result of injury and trauma
- musculoskeletal problems, leading to shape deformities
- neuropathic osteoarthropathy, a degenerative disorder of the joints within the foot.

Typically, people with diabetes who have neuropathy are susceptible to injury and mechanical trauma; because of the loss of sensation, they might not notice resulting damage to soft tissues for a long time.

Many people who have diabetic neuropathy also have peripheral artery disease; compromised circulation in the lower extremity impairs their ability to fight infection and puts them at higher risk of foot ulcers. Previous reports suggest that the lifetime incidence of foot ulcer in diabetes can be as high as 25%.[1] Ulcers tend to lead to infection and, in some cases, to amputation.

Although several clinical management and prevention modalities—eg, regulation of the blood glucose level, a structured screening process, patient education, and footwear and/or orthotics—have been described, there is a paucity of information on the effectiveness of such measures.

We don't know a lot about how to select appropriate materials for footwear and orthotics to protect the feet of our patients with diabetes. New research might give us the tools to make good decisions and achieve better outcomes.

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Understanding tissue mechanics through laboratory modeling

Given the multifactorial nature of diabetic foot ulcer, there is a clear need to understand the tissue mechanics of this complication, with an eye to developing effective clinical management tools using footwear or orthotics. An earlier study,[2] while outlining the importance and the mechanical behavior of the heel pad within the foot during walking, attempted to quantify the stress–strain relationship in this structure—a relationship that is paramount to understanding mechanical characteristics of the tissues in question.

A later study[3] then utilized an ultrasound-based indentation device to estimate the energies that were input into, and returned from, the heel pad. A nonlinear visco-elastic model used within this study helped to quantify the elastic and viscous model components; this quantification correlated significantly with maximum strain. This kind of information is essential to develop computational models, which will lead to a better understanding of structures within the foot.

Finite element modeling is a computational tool used in engineering and the physical sciences to understand and predict structural behavior. This tool has been used to understand the biomechanics of the foot, its internal structures, and supportive devices such as footwear and orthotics, but the true contribution of finite element modeling to our understanding specific clinical conditions and the development of clinical management schemes remains questionable.

A principal reason for this gap in knowledge—between the laboratory and the clinic—is that the finite element method is used mainly within the research environment, not at the point of delivery of clinical assessment and management. There is a clear need for clinically applicable finite-element models that will not only help researchers develop novel diagnostic techniques but also pave the way for novel methods of treatment planning and optimization.

An overview of the modeling techniques employed within the field of foot biomechanics was provided by Behforootan and colleagues,[4] who lament the lack of an integrated modeling system that could be used directly in a clinical scenario. Their report outlines the key challenges related to acquisition of 1) accurate data to create the necessary geometry and 2) information on patient-specific material properties with which to run models.

To address some of these needs, Chatzistergos and co-workers[5] developed a clinically viable, noninvasive method of assessing the mechanical properties of the heel pad. Their study, in addition to validating the method they proposed, investigated the effect of nonlinear mechanical behavior of the heel pad on its ability to distribute loads uniformly during foot contact.

The results of Chatzistergos's work highlighted the fact that the function of the heel pad is influenced by 1) its overall deformability and 2) the nonlinear nature of its mechanical behavior. If deformability is constant, changes in heel-pad biomechanics—leading to mechanical behavior that is more nonlinear, so to speak, in nature—can compromise the ability of the heel pad to distribute plantar loading in a uniform manner, thus making it more prone to overloading and trauma. The technique developed within this study was validated against in vivo data, and proved to be able to assess the visco-hyperelastic behavior of the heel pad accurately.

Although specialist prescription footwear and orthoses are used widely by people with diabetes to redistribute pressure, there is a dearth of information on the optimum cushioning properties of this equipment. Another set of studies attempted to develop a numerical, subject-specific method that can be used to investigate the cushioning properties of different insole materials.[6,7] The reported procedures involved generation of 2-dimensional, subject-specific finite element models of the heel pad, based on ultrasound indentation. These models are used to inverse-engineer the material properties of the heel pad and simulate contact between plantar soft tissue and a flat insole.

After this modeling procedure was validated, the researchers utilized it to investigate the importance of measuring plantar soft-tissue stiffness, thickness, and loading for proper selection of insole material. The results indicated that heel-pad stiffness and thickness influence plantar pressure but not optimum insole properties.

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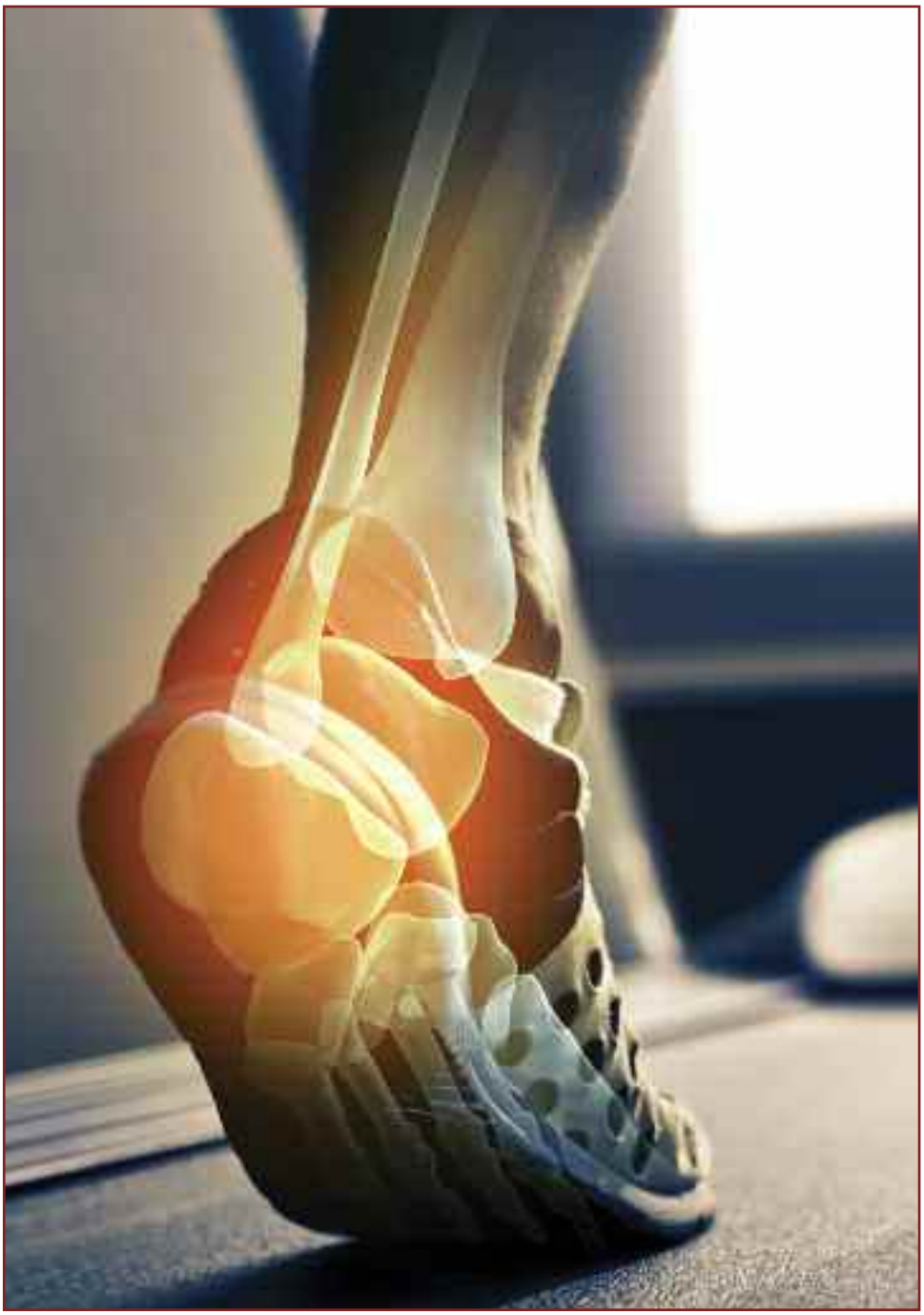
On the other hand, loading appears to significantly influence optimum insole material properties. The results of this study highlight the fact that the parameters that affect the loading of plantar soft tissues, such as body mass and level of physical activity, should be carefully considered during selection of insole material.

Although body mass and physical activity are important, one needs to understand the correlation between mechanical properties of the heel pad of people with diabetes and the clinical parameters that are normally used to monitor their health and risk of ulceration.[8,9] Another investigation that attempted to address this matter used the same ultrasound-based indentation device to measure the thickness and stiffness of patients' heel pads. [5] The investigators correlated the results of this mechanical testing with clinical assessment measures, including the ankle–brachial index and the vibration perception threshold.

The study found that people who have diabetes and elevated levels of triglycerides and fasting blood glucose are more likely to have stiffer heel pads. Increased stiffness could limit the ability of tissues to evenly distribute loads, making them more vulnerable to trauma and ulceration. This study was the first to identify a link between the biochemical profile of people with diabetes and the mechanical properties of their plantar soft tissues; subsequent studies,[2] by other groups, verified these results.



Naemi and colleagues,[10] after establishing the mechanical parameters of the heel pad, investigated whether assessment of the mechanical properties of plantar soft tissue can increase the accuracy of predicting diabetic foot ulceration. The study employed ultrasound elastography to investigate plantar soft-tissue stiffness and thickness along with other clinical parameters in 40 patients with diabetic neuropathy but without foot ulcers. At 1-year follow-up, 7 patients had developed foot ulceration.

Using a predictive model, the results indicated that patients with higher plantar soft-tissue thickness and lower stiffness in the area of the first metatarsal bone had an increased risk of ulceration. When investigators added the plantar soft-tissue stiffness and thickness to the model, results improved in terms of specificity (by 3%), sensitivity (by 14%), predictive value (5%) and strength of prognosis (1%).

The study makes it clear that the mechanical properties of plantar soft tissue can be used to improve the predictability of ulceration in patients with a moderate-to-high risk of ulceration. Understanding tissue behavior undoubtedly helps clinical management and development of new prognostic and diagnostic tools and interventions. But one needs to be pragmatic: How, then, can we apply this knowledge to improve available interventions and, thus, avoid foot ulceration.

Optimizing cushioning materials, patient by patient

A recent study[6] investigated the biomechanical properties of a set of cushioning materials to establish the basis for patient-specific material optimization. This is an important departure from current empirical evidence—a new direction that will substantially help the existing prescription process. The study used bespoke cushioning materials, which exhibited similar mechanical behavior but were of varying stiffness. In

addition to performing mechanical testing, researchers asked participants to walk on these materials to test their ability to reduce pressure.

Overall, results showed a reduction in plantar pressure by optimization of the stiffness of the cushioning materials. In addition, researchers correlated optimum stiffness and body mass for individual subjects. This is the first study to provide quantitative data to support the importance of stiffness optimization in cushioning materials and sets the stage for development of methods to inform optimum material selection in the clinic.

Progress toward better outcomes

The studies reviewed in this article are a step towards developing quantitative evidence to inform the clinical management of dia-

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betic foot disease—from the development of screening guidelines to evidence-based prognostic and diagnostic tools. In addition, the reports discussed here that looked at bespoke materials and their biomechanical properties help pave the way for patient-specific interventions in diabetic foot care.

For example, one might need different materials for a given patient's right foot and left foot, depending on his (her) biomechanics and level and type of physical activity; findings of current studies are that materials for walking might need to be stiffer than materials for standing. Development of quantitative evidence will give clinicians a clear idea of a given patient's needs, rather than depending on experience and empirical evidence provided by peers.

To sum up: Clinicians and patients should think about both the mechanical properties of soft tissues and the properties of footwear/orthoses before planning or choosing any clinical management plan.

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Disclosures: The author receives research funding from the European Commission, the executive unit of the European Union.

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The effect of sensory stimulation on movement accuracy

The author explores the sensory aspects of the foot, and footwear, on patient movement accuracy, joint stabilization, and perception of pain. An integrative approach to the dynamics of human movement is discussed.

By Emily Splichal, DPM

Dynamic movement involves a relationship between gravity and the ground, creating impact forces that provide our bodies with the energy to move. Our relationship with gravity is the foundation of performance, and of pathology. A patient with a complaint of pain while walking often has had a breakdown in this relationship with impact forces, causing an insufficient loading response and inability to harness potential energy from gravity.

Our relationship to gravity begins with the human foot.[1] The perception of the ground is instrumental in enabling us to move easily in diverse natural environments. Humans have adapted to stepping on to, off of, or moving over, soft, irregular, or slippery surfaces in a manner that minimizes metabolic cost, reduces impact forces, and stabilizes the vertical center of mass.[1] As Nigg and colleagues have stated, the perception of these forces must be accurate to effectively harness the power of potential energy.[2]

And yet, advances in footwear, orthoses, and surfaces interfere with this natural process of perception, creating delayed, inaccurate, and insufficient loading responses. The result? Chronic overuse, impact-related injuries such as plantar fasciitis, Achilles tendinitis, stress fractures, and shin splints.

We practitioners must better understand the demands of dynamic movement as it relates to sensory stimulation. We begin with gravity and ground reaction forces, the stimuli that drive locomotion, which begins with foot contact.

Innervation of the plantar foot

The glabrous skin on the plantar foot houses unique haptic, or touch, receptors that are critical to how the brain perceives movement. Like the palm of the hand, the plantar foot contains a dense innervation of cutaneous receptors that convey a spatial image of stimuli, providing the ability to discriminate spatial details of surfaces and objects. High innervation densities translate to more afferent fibers and larger representations in the motor cortex.[3] The foot is 1 of several areas of the body most sensitive to sensory stimulation.

Four distinct haptic receptors or mechanoreceptors innervate the glabrous skin of the human foot; slow-adapting type 1 (SA1), slow-adapting type 2 (SA2), fast-adapting type 1 (FA1), and fast-

> The enhanced plantar stimulation afforded by minimal footwear designs may translate to improved overall foot function.

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adapting type 2 (FA2).[3]

- **SA1 receptors** perceive 2-point discrimination with a spatial acuity of 1 mm, and interpret whether a surface is smooth or rough, which translates into stabilization during walking.
- **SA2 receptors** respond to skin stretch, which, when stimulated, downregulate the sympathetic nervous system.
- **FA1 receptors** respond to low-frequency vibration, or flutter.
- **FA2 receptors** respond to high-frequency vibration.

Kennedy and coworkers reported that 70% of the 104 mechanoceptors on the plantar foot are fast-adapting and sensitive to vibration, which conveys the amount of force with which the foot is contacting the ground, which helps maintain dynamic balance while walking.[4] Robbins and colleagues reported that peak sensitivity of the mechanoceptors in the feet occurs at age 40 years; by age 70 years, the plantar receptors require twice the stimulation to create the same response. A decline in mechanoceptor density has been demonstrated at 69, 27, and 8 per mm at ages 3, 32, and 83 years, respectively.[5]

It is these plantar mechanooceptors that are critical to the perception of impact forces during dynamic movement. Although the sensory stimuli created by ground reaction forces is complex--including pain, skin stretch, heat and vibration--much focus has been on the vibrational stimuli created with each foot contact.[2,5] FA1 and FA2 mechanoceptors of the plantar foot are used to perceive both low- and high-frequency vibration, which in turn creates an accurate loading response.[3]

Stimulation of these fast-adapting mechanoceptors creates a stiffening response in the soft tissue structures that reduces vibrational forces to 50% in 15-70 ms and to 5% within 60-300 ms. In the time taken for amplitude to reduce to 5%, typically no more than 2 oscillations occurred in the vibration.[5]

Muscle tuning theory

This stiffening response--the muscle tuning theory--is based on the concept that an accurate perception of impact forces creates an accurate stiffening response in myofascial tissue, thus allowing the storage of potential energy. The adult takes an average 5,000-8,000 steps each day; with each foot strike, 1-1.5 x body weight in ground reaction forces enter the foot at a rate of <50 ms.[6] With regard to movement accuracy, not only must the degree of impact be accounted for, but also the rate. Rate of loading is defined as the peak vertical force divided by time to reach the peak vertical force.[6]

To put this 50-ms impact rate into perspective, fast twitch muscle fibers contract in 70 ms, meaning that impact forces enter the body faster than our muscles can react to them. Many patients who experience impact-related injuries demonstrate delayed reaction to impact, which often can be attributed to the inability of muscles to react fast enough to the stimuli of impact forces.

So, what is the solution?

Research has demonstrated that to effectively load impact forces, our loading response must be initiated before the foot contacts the ground; this is the pre-activation loading response.[2] The limiting factor to pre-activation loading response is our perception of impact forces. Certain footwear, smooth insoles, injury, and disease can cause a delay in the perception of impact forces.

Robbins refers to this inaccurate perception of impact forces as a perceptual illusion, and has demonstrated that it can result in chronically increased impact forces that cannot be sufficiently damped by the neuromuscular system.[5]

The effect of footwear on movement accuracy

Common footwear sole materials, such as those used in many walking and running shoes, filter out mechani-

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cal stimuli that assist in precisely judging plantar load and orientation of the plantar surface with respect to the leg.[5] It has also been demonstrated that as midsole thickness increases and hardness decreases, balance and stability during ambulation decrease.[7] This instability may result from the altered perception of vibrational forces; we use impact forces not only to know how hard we strike the ground, but also to maintain dynamic balance.

Footwear innovation today trends toward a minimally cushioned shoe as a means to optimize movement accuracy. The enhanced plantar stimulation afforded by minimal footwear can translate to improved overall foot function. Chen and colleagues demonstrated that habitual shod runners who transitioned to minimalist shoes developed a significant increase in leg and foot-muscle volume.[8] Safely transitioning to minimalist toe shoes was associated with a greater increase in intrinsic foot-muscle size compared with a control group wearing traditional running shoes.[9]

In addition to footwear outsole design influencing plantar sensory stimulation, insole design also has been shown to either positively or negatively influence the perception of sensory stimulation during dynamic movement. Waddington and coworkers demonstrated that movement discrimination scores in soccer players were significantly worse when wearing football cleats and socks, compared with barefoot data collected at the same time.[10] The substitution of textured insoles for conventional smooth insoles in the football cleats was found to restore movement discrimination to those achieved barefoot. The addition of rigid irregularities to flat, fairly rigid insoles has been shown to reduce vertical ground reaction forces to mimic barefoot conditions.[7] It was determined that the vertical deformations of textured insoles anchor the epidermis in the horizontal plane which causes shear distortion, providing stimulus to the plantar foot.


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Clinical applications of movement accuracy

A deficit in movement accuracy must be considered in patients who complain of pain on ambulation.

This movement accuracy relies on the anticipation of sensory stimulation from gravity and ground reaction forces, followed by how quickly and efficiently those forces can be damped, stored, and elastically released. A delay—or illusion in perception by the plantar foot—puts the patient in a reactive state, which slows the patient's ability to dissipate ground reaction forces. This reactive state can increase not only the risk of impact-related injury, but also forces and stress to joints of the feet, knees, and lower back.

Why might a patient be in a reactive state? As described earlier, footwear is one cause, but medically-associated alterations in movement accuracy must also be considered. A patient may develop decreased plantar sensitivity from a disease such as diabetes mellitus, Parkinson's disease, and multiple sclerosis. These patients may benefit from the use of textured insoles or minimal footwear.

Our goal for our patients is better move-

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ment. Because movement is driven by sensory stimulation, the question for some of our patients may be how we can help the patient better perceive sensory stimulation of movement.

Dr Splichal is a podiatrist in private practice.

Disclosure: The author is founder of the Evidence Based Fitness Academy; creator of the Barefoot Training Specialist, BarefootRx and BARE Workout Certifications; and has a relationship with Naboso Barefoot Technology.


iStockphotocom 874310040

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ad index

INDUSTRY SNAPSHOT

Noteworthy products, association news, and market updates

Pediatric Orthopedic treatments: "Choosing Wisely"

The American Academy of Pediatrics (AAP) has added several recommendations to limit the use of certain imaging, ultrasound, and orthotics in special circumstances in children. The list, which has been added to the broader American Board of Internal Medicine (ABIM) Choosing Wisely® campaign, was developed in partnership between the AAP Section on Orthopaedics and the Pediatric Orthopaedic Society of North America. The groups recommend that clinicians who care for children refrain from ordering the following tests and interventions:

- Screening hip ultrasound to rule out developmental hip dysplasia or developmental hip dislocation in an infant who has no risk factors and has a clinically stable hip examination
- Radiographs, bracing, or surgery for a child younger than 8 years with simple intoeing gait
- Custom orthotics or shoe inserts for a child with asymptomatic or minimally symptomatic flat feet
- Advanced imaging studies such as magnetic resonance imaging or computed tomography for musculoskeletal conditions in a child until all appropriate clinical, laboratory, and plain radiographic examinations have been completed
- Follow-up radiographs for buckle or torus fractures that are no longer painful or tender.

The American Board of Internal Medicine Choosing Wisely® campaign is designed to promote conversations between clinicians and patients by helping patients choose care that is evidence based, does not duplicate tests or procedures already received, is free from harm, and truly necessary. More than 80 specialty society partners have contributed to the list of approximately 540 recommendations.

For more information, visit www.choosingwisely.org.

RFPs for O&P research grants

The American Orthotic & Prosthetic Association (AOPA) is accepting proposals for separate research grants for clinical research on lower-limb related issues. The proposal submission deadline is April 30.

Four grants, in amounts of up to $60,000-$75,000 will be awarded by AOPA, together with partners among O&P manufacturers, patient care companies, and other entities committed to an evidence-driven future for O&P.

Topics under these grants include:

- Orthotic treatment for stroke patients
- Osteoarthritis of the knee
- Back bracing
- Orthotic treatment for plagiocephaly in children

AOPA also is accepting applications for pilot grants for up to $15,000-$30,000 for a number of O&P topics, in partnership with the Center for O&P Learning & Evidence-Based Practice (COPL). Multiple grants will be funded. Among the topics are quality of life metrics related to orthotic management, and the effect of OA knee brace use on community activity. Individual RFPs are available at www.aopanet.org.

Skived Metatarsal and Longitudinal Arch Pads

Aetna Foot Products has introduced Skived Metatarsal and Longitudinal Arch Pads, used to transfer or distribute weight from problem areas, minimizing pain and discomfort, while providing proper alignment, support, and cushioning. Skiving the pads removes material from the edges, providing a tapered edge which allows for better contouring and a more comfortable fit around prominences for improved patient comfort and care. Arch pads come in 2 sizes and offer stability while supporting the user's arch. Metatarsal pads come in one standard size. The pads are available in high-quality 70% wool/30% rayon blend orthopedic felt backed with medical-grade, acrylic, water-based adhesive.

Aetna Foot Products
800/390-3668
Atenafootproducts.com

Data Gathering Performance Treadmills

AMTI has introduced 2 new treadmill models: a fixed-tilt and an inclinable, capable of a 25% gradient. Both models have 2 independent 8800N-capacity force platforms, and a newly-designed frame engineered to achieve the highest possible natural frequency. According AMTI, the Mobius treadmills are capable of the most accurate gait data in the industry. The treadmills are appropriate for biomechanical studies, including running. The high-frequency structure was conceptualized to provide industry leading data quality. Belts have improved wear resistance. Both models come fully equipped with removable handrails and plug-and-play USB-enabled signal conditioners that integrate with all major motion capture and EMG software.

AMTI (Advanced Mechanical Technology, Inc.)
617/926-6700
amti.biz

AACPT Pledges $90K to Foundation for Physical Therapy

The Academy of Acute Care Physical Therapy (AACPT) pledged more than $90,000 to the Foundation for Physical Therapy to support 2 research grants related to acute care physical therapy.

"The Foundation's new major gift opportunities provide individuals and organizations the ability to quickly fund impactful research," said Foundation President, Edelle Field-Fote, PT, PhD, FAPTA. "We are excited to partner with the AACPT to offer the Foundation's first research grants in this vital area of physical therapy."

The first $40,000 acute care research grant in the 2018 funding cycle will be awarded to an emerging investigator seeking

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to advance the practice of acute care physical therapy. The Foundation will accept applications through August 2, 2018.

Grant eligibility includes only studies in which the interventions are provided by physical therapists, or selected components of the interventions are provided by physical therapist assistants under the direction and supervision of physical therapists.

For more information, visit https://foundation4pt.org.

Cadence Low Volume Insole

Cadence insoles introduces a thin, low-volume design that provides semi-rigid support, a wider forefoot, and unique comfort zone in the heel. The proprietary foam used in the insole construction has a low compression set and provides full-length, total-contact, shock-absorbing comfort. The unique combination of support and comfort can be customized with the addition of a wedge, post, or lift. Cadence fills the need for a semi-rigid orthotic with greater shock-absorbing comfort in the heel and forefoot. Cadence insoles were designed using feedback and outcomes from thousands of patients with various pain syndromes of the foot, knee, and hip. The Cadence Low Volume is available from participating doctors' offices and retailers.

Cadence Insoles
805/458-0567
cadenceinsoles.com

Ottobock Kenovo knee joint under FDA recall

The U.S Food and Drug Administration (FDA) issued a Class 2 device recall of the Ottobock Kenovo prosthetic knee joint, model 3C60=ST and model 3C60.

According to the notice, Ottobock discovered that the pylon may break if the device is used longer than 1.45 million cycles –or approximately 2.3 years of heavy use -- and the pylon clamp is tightened in excess of labeled torque specifications. Pylon breakage may cause the patient to fall. In the United States and in Canada, a 3-year service interval is required—compared to a 2-year mandatory service interval for the rest of the world—thus, only devices in the United States and Canada are affected by this recall.

Dorsal Hybrid Night Splint

Advantage by Elite Orthopaedics introduces the Dorsal Hybrid Night Splint, indicated for plantar fasciitis and Achilles tendonitis. The shell design with articulating hinge allows functionality with full range adjustability. The splint is designed with plush padding for comfort, and features an adjustable tension strap, which keeps the foot elevated at an adjustable angle, allowing for different tension relief for pain. The unit fits either right or left foot.

Elite Orthopaedics
800/284-1688
elite-ortho.com/product-p/t595.htm

Grant to study TBI-related lower extremity deficits

Kessler Foundation researchers Kiran Karunakaran, PhD, and Karen Nolan, PhD, have received a $35,000 grant from New Jersey Health Foundation to study the cortical changes in children and young adults with lower extremity motor deficits caused by traumatic brain injury (TBI).

Walking in robotic exoskeletons has been recognized as an effective method for rehabilitation compared with conventional physical therapy for lower limbs due to the device's ability to assist the user in performing goal-oriented, repetitive movements. The neural mechanism involved in this recovery due to training is still not completely understood. This pilot study will explore the clinical, functional, and neurophysiological effectiveness of robotic exoskeleton–assisted gait therapy for children and young adults with TBI.

"Our hope is that understanding the cortical (brain) activity changes after injury and during recovery will provide us with information to better understand the neural mechanism of learning or recovery and thus help in improving the design and effectiveness of rehabilitation therapy," said Karunakaran, a postdoctoral fellow in Human Performance and Engineering Research at Kessler Foundation.

Desksurfer Balance Activity Platform

The new Desksurfer from Medical Fitness Solutions is a patent-pending balance platform providing clinicians with an adjustable stability balance training device, with 360 degrees of rotation and 20 degrees of ankle plantar and dorsiflexion that can be achieved with complete control of patient challenge. Stability is adjusted via a simple hand pump with gauge, or bicycle pump, and eliminates the need for multiple stability and balance aids. Rigidity can be varied from 0-15 PSI, a range that accommodates patients who require a stable platform to highly functioning athletic users.

Medical Fitness Solutions
800/831-7665
medicalfitsolutions.com

ETFMx Multi-Frequency Electronic Tuning Fork

O'Brien Medical introduces the ETFMx multi-frequency electronic tuning fork. Building on the success of the ETF128, clinicians can now test sensation with the 3 most used frequencies in medicine, 64, 128 and 256 Hz. The ETFMx is used for diagnosing and tracking diabetic peripheral neuropathy, entrapment neuropathy, carpal tunnel, radiculopathy, and fall risk. It has also proven useful for sensation assessment in patients undergoing surgical nerve decompression. The multi-frequency instrument saves time and money by essentially integrating 3 tuning forks in 1. The Mx is available through the company website and selected distribution partners.

O'Brien Medical
207/290-0719
obimed.com

WPI researchers developing App to track and analyze chronic wounds

Researchers at Worcester Polytechnic Institute (WPI) have received a 4-year, $1.6 million National Institutes of Health grant to develop a smart phone app that will allow patients and their caregivers to track and assess chronic wounds, including diabetic wounds to the feet and legs, and arterial, venous, and pressure ulcers. This has implications for decreasing medical costs and identifying complications before they lead to hospitalizations and amputations.

Patients or their caregivers will be able to use the app to photograph a chronic wound, and algorithms built into the app will measure wound assessment metrics, including size, depth, and color, which indicate how the wound healing is progressing, and will compare the readings over time to determine if the wound is shrinking or expanding, and other changes that could indicate a complication. The app will also compute a healing score that tells the patient whether the wound is getting better, is unchanged, or is worsening. Finally, the app will suggest that the patient stay the course, consult a wound specialist for treatment advice, or seek immediate care.

The project is based on an app developed by Emmanuel Agu, PhD, associate professor of computer science and coordinator of WPI's Mobile Graphics Research Group, and his research team to help people with diabetes track and manage their weight and blood sugar levels, and also photograph and assess the status of any chronic foot ulcers. Agu will build on the wound assessment component of the original app. *Editor's note: This story was adapted from materials provided by WPI.*

GlideWear Midfoot Protection Sock for Charcot Foot

Tamarack Habilitation Technologies has expanded its GlideWear foot protection sock line with the addition of the Midfoot Protection Sock. Designed to protect the plantar surface of the midfoot, which is at greater risk for ulceration in people with Charcot arthropathy, the sock incorporates SmartKnit's moisture-wicking technology, seamless toe, and non-binding top that can accommodate edema. The sock features a patented, low-friction GlideWear zone around the plantar surface of the midfoot to protect the area from the friction and shear that contribute to diabetic foot ulcers, blisters, and calluses. The GlideWear Midfoot Protection Sock is indicated for use with orthotic walking boots, diabetic shoes, custom orthotics, and standard footwear.

GlideWear by Tamarack Habilitation Technologies
763-795-0057
glidewear.com

EHI acquires My Foot Doctor; seeks private equity backing

Atlanta-based Extremity Healthcare Inc. (EHI) has acquired My Foot Doctor, with locations in Cleveland, Lenoir City, and Athens, Tennessee. The acquisition was made through EHI's clinical division in Tennessee, Advanced Foot Care. My Foot Doctor's founder Barry Schulman, DPM, FACFAS, and Claire Bello, DPM, join the Advanced Footcare and EHI teams. Terms of the transaction were not disclosed.

ToePro Exercise Platform

HumanLocomotion.org offers the new ToePro Exercise Platform for strengthening specific small muscles of the foot and ankle to improve balance, increase arch height, enhance jump performance, and increase gait velocity. Because the toe and arch muscles provide stability during the pushoff phase while walking, jumping, and running, weakness in these muscles may lead to plantar fasciitis, stress fractures, bunions, and Achilles tendinitis. Older adults have toe strength declines of more than 35%, and the resultant toe weakness correlates with an increased risk of fall. Most foot strengthening protocols work the toe and arch muscles in a midline or downward position, which is not how these muscles are actually used – not the ToePro Platform.

Human Locomotion/Dr.Tom Michaud
617/969-2225
humanlocomotion.org

Slippers for Diabetics

Patients with diabetes know that something as simple as stubbing one's toe or stepping on a random item can lead to a serious foot complication. Anodyne's new slippers are designed with the diabetic end-user in mind, to protect and accommodate the feet. Described by the company as "extremely comfortable", the new slippers feature a premium suede upper, soft faux-shearling lining, and a removable supportive foam footbed. The footwear is manufactured with a durable outsole, making them appropriate to wear indoors or outdoors. A protective toe box and heel counter are included in the design. Multiple sizes are available.

Anodyne
844/637-4637
anodyneshoes.com

Open Sandals Accommodate Orthotics

Cabo Comfort Sandals specializes in open sandal, thong, and slider styles that allow the wearer to use their own orthotic inserts. The new sandals feature a pocket in the sole to fit the user's orthotics. The patented sandals feature leather uppers and polyurethane soles, and were invented by a frustrated orthotic user who could not wear open sandals because memory foam designs did not give the support and comfort he sought, and did not accommodate his orthotics. The new Cabo Comfort Sandals are designed to accept all brands of orthotics. Orthotic inserts with small heels are also accommodated with a removable insole heel pad.

Cabo Comfort Sandals
604/802-8195
cabocomfortsandals.com

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Amputee Repair Kit

Wearers of prosthetic devices need to maintain the device, as well as the residual limb. This maintenance includes adjusting or tightening the prosthetic limb to ensure more comfort and safety, as well as caring for the skin the prosthetic goes on. Sergius Industries has developed the Amputee Repair Kit (ARK) to provide all the necessary items an amputee needs to care for prosthetic and residual limbs. The kit comes in three configurations: Home, Vehicle, and Travel. Kits include such items as a 3-way Hex 4/5/6 mm, Adapt-Skin 50, quick-dry towels, baby powder, multitool with light, blister care kit, tape, hydrocortisone cream, antibacterial wipes, 4-inch crescent wretch, bandage shears, tegaderm dressing, alcohol prep pads, HealthyLimb skin protectant, isopropyl alcohol, prosthetic cleanser, travel power strip, and 10 x M8 x 12 mm cup set screws.

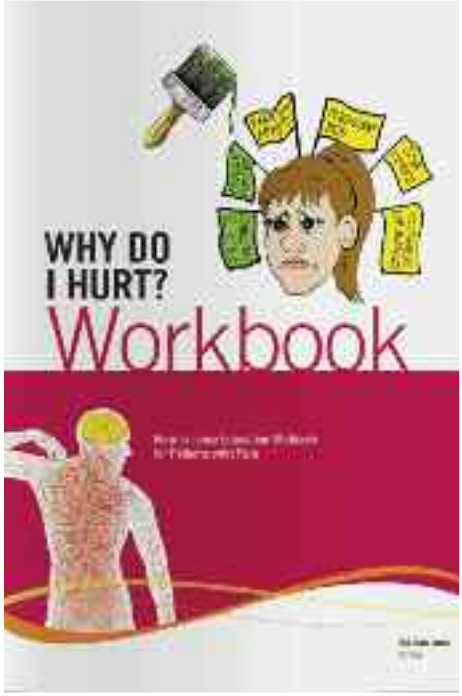
Sergius Industries
888/526-9353
Sergiusllc.com

Comfort Scan Mobile app

The Comfort Scan Mobile app by Dr. Comfort gives the practitioner's office the cutting-edge technology to order custom orthotics for patients in minutes. With the use of an iPad and Occipital camera, the new app captures a three-dimensional image of the patient's foot. This allows the practitioner to order custom-made products. Further, the app allows the practitioner to order non-custom-made products as well. The app is compact, offers a fast turnaround time, and is on a stable operating system. The Comfort Scan Mobile app is available for download at the App store.

Dr. Comfort
800/556-5572
drcomfort.com

Chronic Pain Workbook



OPTP has published a new educational resource for chronic pain patients. The Why Do I Hurt? Workbook by Adriaan Louw, PT, PhD is now available for purchase exclusively through OPTP. The neuroscience workbook allows patients to not only better understand their pain and how it works in the body, but also track and record it through active participation, and reflect on their personal pain journey. Patients write in the workbook to monitor their pain experiences and learn how to treat their condition. The interactive exercises and hands-on tasks help them understand why they hurt and how they can lessen their pain. The content is based on clinical scientific research and centers around 4 key strategies for recovery.

OPTP
888/819-0121
optp.com

AAOP headquarters move to Bethesda

The American Academy of Orthotists and Prosthetists has relocated its headquarters from Washington DC to Bethesda, Maryland, effective March 1. The address is 7910 Woodmont Avenue, Suite 760, Bethesda, MD 20814. Telephone and fax numbers remain unchanged.

Red Dot Patterned Compression Knee Highs

Therafirm, a Knit-Rite Inc. brand, has released an addition to the Ease Microfiber line of compression hosiery. Ease Microfiber Red Dot Patterned Knee Highs are black with a fashionable red dot pattern woven in. They are available in two compression levels – mild (15-20 mm Hg), and moderate (20-30 mm Hg). Like other Ease Microfiber hosiery products, the new patterned knee highs are made with high-stretch microfiber yarns making them easier to put on than other higher compression garments. Ease Microfiber garments have several other features that contribute to the ultimate in comfort, including a reinforced toe and heel for durability; a smooth and comfortable toe seam to eliminate irritation at the toe; and soft, comfortable, non-restrictive top band to help garments stay in place all day. Yarns used to make Ease Microfiber garments are super soft, in addition to the high-stretch capabilities.

Therafirm (A Knit-Rite Inc. brand)
800/821-3094
therafirm.com

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