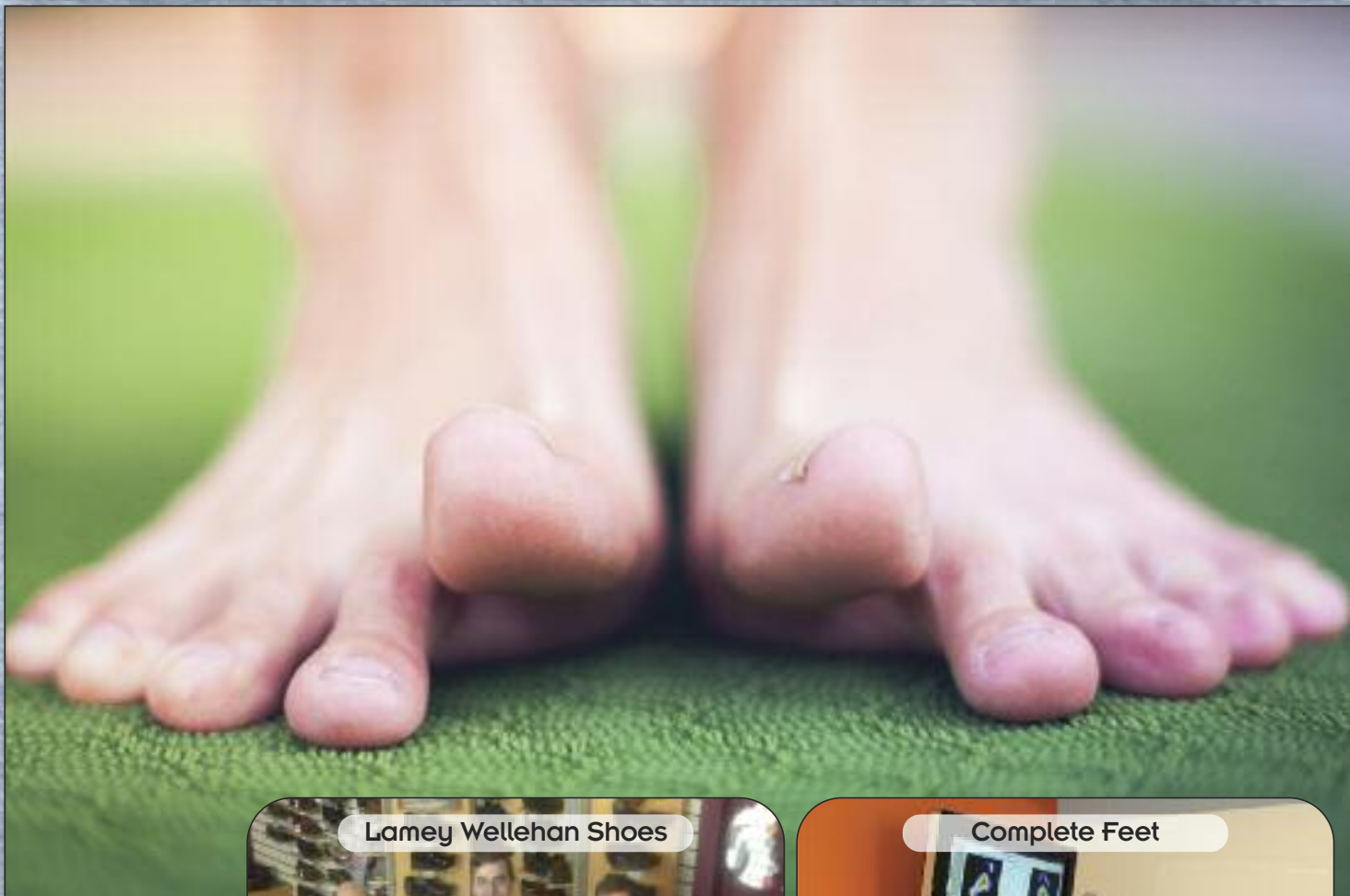


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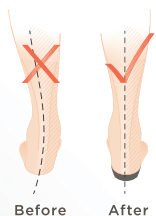
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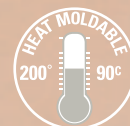
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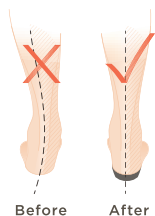
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By Shalmali Pal

21 Intricacies of metatarsal stress fracture treatment

A growing body of research on metatarsal stress fractures is helping lower extremity practitioners manage both the biomechanical and physiological effects of these frustrating injuries, as well as the expectations of patients who are eager to return to activity.

By Erin Boutwell

From the editor: Chasing change



One of the defining characteristics of the foot health world is that it's always changing.

The most obvious reason for this, of course, involves shoes. No other healthcare specialty has its own corresponding segment of the fashion industry, and no other patient population is as significantly influenced by fashion trends.

Foot health practitioners naturally develop a familiarity with mainstream footwear fashion, first by observing the

types of shoes patients wear when they first seek help, and then by hearing about the styles patients hope to wear again after treatment.

Therapeutic footwear has never been part of the fast fashion movement, but styles have evolved over time—Mary Janes, sandals, high-tops, boots, and even low-heeled pumps now meet government requirements for diabetic footwear—which has led to improved patient compliance along with increased sales.

But the changing nature of foot health goes beyond fashion trends. Other patient lifestyle choices that affect their feet also have evolved considerably over time.

Patients are living longer than in the past, but they're also more likely to be sedentary, overweight, and vitamin deficient. Those variables increase patients' risk of numerous conditions—including diabetes, peripheral vascular disease, plantar fasciitis, osteoarthritis, osteoporosis, and stress fractures—that can directly or indirectly involve the feet.

On the flip side, active patients—and more of these are now women, thanks to Title IX—are more likely to be tempted by trends involving barefoot or minimalist running and extreme forms of exercise such as ironman triathlons or high intensity training. And doing too much too soon is an excellent way to end up in a foot health practitioner's office.

Like fashions and lifestyle trends, foot health issues will continue to change over time. That's why we've launched *LER: Foot Health*. We'll keep you informed of the latest developments affecting the feet, which will help you provide your patients with the best possible care.

Jordana Bieze Foster, *Editor*



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Extra bodyweight enhances effects of high heels at knee

Lower heels, BMI may reduce OA risk

By Emily Delzell

Walking in shoes with heels higher than about 1.5 inches causes gait abnormalities that are amplified by extra bodyweight, according to recent research that found high-heeled walking creates significant changes in knee loading similar to those seen in knee osteoarthritis (OA).

Using a shoe that converts through a removable heel from a height of 3.8 cm (1.49 inches) to 8.3 cm (3.26 inches) and a standard half-inch-drop athletic shoe, investigators from Stanford University in California asked 14 healthy normal-weight women to complete 10-m marker-based gait trials in shoes of each height and under several conditions. These conditions included walking at their preferred speed with and without a weight vest equal to 20% of their bodyweight and walking slower than preferred and faster than preferred without the vest.

The investigators calculated measures of knee flexion angle and knee extension and adduction moments, normalizing external joint moments to percent bodyweight and shoe height. Weighted trials were normalized to percent bodyweight plus vest weight and shoe height.

Walking speed declined significantly with heel height, but wasn't affected by weight. At preferred walking speed, knee flexion angle at heel-strike and midstance increased with increasing heel height and weight. Maximum knee extension moment during loading response decreased with added weight; maximum knee extension moment during terminal stance decreased with heel height; and maximum adduction moments increased with heel height.

The investigators also found a threshold effect with heel height, noting a significant increase in maximum knee flexion moment for the higher heel compared with the control shoe and no significant change with the lower heel compared with the control.

"High heeled shoes cause a myriad of foot problems. What is less appreciated is that walking in high heels also changes

forces across the lower back, hips, knees, and ankles," said study lead author Constance R. Chu, MD, professor and vice chair of research in Stanford's Department of Orthopedic Surgery. "We measured the compensatory forces across the knee and found increases similar to what people with the most common forms of knee osteoarthritis have. The abnormal forces were eliminated by wearing [the control shoe] and nearly eliminated by wearing a 1.5-inch 'kitten' heel."

Chu and her colleagues didn't control for foot type, but she noted that foot deformities can magnify abnormal forces, not only across the foot, but also through the knee and other joints during gait.

The results support the concept of a threshold shoe heel height above which aberrant loading patterns at the knee are amplified.

"The larger knee adduction moment with increasing heel height is very interesting because increases in this value have been linked to progression of knee OA on the medial side," said Neil Cronin, PhD, a senior researcher at the Neuromuscular Research Centre at the University of Jyväskylä in Finland. "But we don't yet know how repeated use of high heels affects cartilage health. Determining what is actually happening to the structure of the tissues around the knee joint would take us a step closer to being able to really link high heel use with increased risk of OA."

Both Chu and Cronin said the findings emphasize that additional bodyweight is associated with changes in knee joint mechanics that are similar to those seen in knee OA.

"Overweight women who wear heels regularly could increase their risk of devel-



oping OA more so than people who are not overweight," said Cronin.


Chu and her colleagues noted in the paper, published in the *Journal of Orthopaedic Research* in March, that their data support the existence of a threshold heel height at which aberrant loading patterns are amplified.

"There is now a growing body of evidence to support this statement," said Cronin. "It may be that by simply wearing lower heels—about four centimeters, for example—a woman can significantly decrease her risk of various negative side effects. This could include OA, but also other symptoms such as leg and back pain, balance problems, and foot and toe deformities."

The Stanford group documented within-group variability among participants' movement patterns, finding increased maximum flexion knee flexion moment with the higher heel after correcting for speed.

"We observed a slower preferred gait when subjects walked in heels that reduced some aberrant loading patterns," said Chu.

This variability suggests that different women adapt to shoes in different ways, said Cronin, noting this study and others have had small sample sizes.

"We really need bigger studies to account for this [variability]," he said. 

Source:

Titchenal MR, Asay JL, Favre J, et al. Effects of high heel wear and increased weight on the knee during walking. *J Orthop Res* 2015;33(3):405-411.



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Foot orthoses for heel pain help improve walking activity

Study supports custom device use

By Barbara Boughton

In patients with plantar fasciitis, the pain relief associated with custom foot orthoses (CFOs) appears to result in increased walking activity, as well, according to a recently published clinical trial.

In the double-blinded randomized placebo-controlled trial, published in May by the *Journal of the American Podiatric Medical Association*, episodes of walking lasted significantly longer in patients who wore CFOs for three months than those who wore prefabricated foot orthoses (PFOs) or sham orthoses.

Study investigators randomized 77 patients who had plantar heel pain for less than a year into three treatment groups and assessed pain and function at baseline, one month, and three months. In a subset of 30 patients—10 per group—the assessed activity, balance, and gait.

At three months, patients who wore CFOs increased the duration of their walking episodes by 125% compared with baseline, while PFOs were associated with an increase of 22% and sham orthoses with an increase of just .2%. Patients who wore CFOs also outperformed the other two groups for duration of postural transitions at three months.

"The findings were an eye opener for us," said lead researcher James Wrobel, DPM, associate professor of internal medicine at the University of Michigan in Ann Arbor. "People who wore the custom foot orthoses were getting up and out of their chairs without the presence or prompting of a physical therapist."

Yet, improvement in self-reported morning pain and quality of life did not differ significantly between groups, suggesting that walking activity may be a more sensitive measure of the benefits of CFOs, Wrobel noted. The CFO and PFO groups also reported improvements in evening pain.

"They were obviously feeling better—but these improvements in symptoms may have been too subtle to be picked up by the scales used in the study," Wrobel said.

All patients were given the same athletic shoes and instructed to wear them throughout the day. Every patient received longitudinal and metatarsal padding to wear for one to two weeks before the orthoses arrived, and were told to ice and stretch regularly for three months. The fact that even the sham group experienced symptom improvement at three months suggests a potential benefit of athletic shoe use, stretching, ice, and the short-term use of padding—another unique finding of the study, Wrobel noted.

Walking activity may be a more sensitive measure of the benefit of custom foot orthoses than self reported pain or quality of life.

At three months, those in the CFO group were stretching significantly less than at baseline and compared with the other two groups, which could be an indication of symptom relief, Wrobel noted.

The study was specifically designed to address the limitations of previous randomized trials comparing CFOs and PFOs—including the lack of a sham or placebo group and a failure to use validated health measures, Wrobel noted. The researchers also strove to make the orthoses look as similar as possible.

The CFO was a full-length cast-based polypropylene orthosis modified to address deformity, patient weight, foot and ankle function, and foot type. The PFO was a full-length ethylene vinyl acetate (EVA) orthosis with a triplanar orthotic foot bed and a 15-mm heel cup. The sham device was a full-length 3-mm thick layer of EVA that was heated and then vacuum pressed onto a positive mold of the patient's foot. All devices had similar 3-mm neoprene top covers.




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"The study is a milestone in assessing the benefits of custom and prefabricated foot orthoses for plantar fasciitis heel pain," said Russell Volpe, DPM, professor in the department of pediatrics and orthopedics at the New York College of Podiatric Medicine/Foot Center of New York in New York City.

Volpe commended the study authors for their use of validated measures for pain and foot-related symptoms (primarily the Revised Foot Function Index and the 36-item Short Form Health Survey), and for including details of patients' biomechanical examinations and the orthotic prescription process. Perhaps most important was the considerable effort made to measure changes in patient function, he said.

"That's the real breakthrough in this study. The researchers showed custom foot orthoses can help patients be more active and participate more fully in activities of daily living," Volpe said.

He also pointed out the value of the study's finding regarding the benefit of using icing, stretching, and foot pads together.

"It reminds us that it's important to treat plantar fasciitis with a multidisciplinary approach," Volpe added. 

Barbara Boughton is a freelance writer based in the San Francisco Bay Area.

Source:

Wrobel JS, Fleischer A, Crews RT, et al. A randomized controlled trial of custom foot orthoses for the treatment of plantar heel pain: A return to spontaneous physical activity. J Am Podiatr Med Assoc 2015 May 5. 1Epub ahead of print

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The Apex Boss Runner is a biomechanically designed, straight lasted, motion control running shoe. The shoe features a molded external heel counter extended on the medial side for rearfoot stability, Carboplast footbridge for torsional stability, and a triple density, compression sculpted midsole to preserve balance between the body and ground reaction forces. The adjustable Lockdown Heel Strap tightens for patients with narrow heels and spreads out to accommodate AFOs. The 5/16" removable depth in two layers and spacious anatomical toe box allow for biomechanical efficiency and fitting flexibility.

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Ped Lite Valerie

Ped Lite's newest women's casual shoe, the Valerie, offers a fashion-forward interpretation of the typical diabetic shoe. Available in black with an all-leather upper, the Valerie looks like a slip-on shoe but has a Medicare-approved adjustable closure that makes it functional as well as stylish. With the same comfort and affordability as the rest of Ped Lite's line of women's footwear, the Valerie offers as much style as any shoe on the market. All Ped Lite women's shoes are available in half sizes from 6 to 11 and in three widths.

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Dr. Comfort Ruk and Riley

Dr. Comfort is proud to feature two new fashionable shoes that allow customers to feel great: the Ruk and the Riley. The Ruk is a classic dress style shoe for men that is versatile enough to pair with jeans or trousers. It comes with a suede upper material in a rust color or full-grain oiled leather in brown, in sizes 7.5-14. The Riley is a comfortable yet stylish casual shoe for women in sizes 5.5-11. It features a soft, washable fabric upper available in black, white, or midnight. The Riley's breathable fabric helps keep feet cool and dry while the padded tongue provides a comfortable fit. Both styles come in three widths.

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Arcopédico USA debuts three new colors—grey, camel, and purple—this summer for the top-selling Leina collection of sporty Mary Jane walking slides. Featuring a wide, nonrestrictive form and a stay-on elastic band for a secure fit, these shoes are ideal for misshapen feet. The Lytech upper material offers bidirectional elasticity, easing pressure on the foot and adjusting with every step. Arcopédico's twin-arch support sole allows for an even distribution of body weight over the entire plantar surface of the foot, and a removable cushioned insole facilitates the use of custom orthotic devices.

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Lamey Wellehan Shoes:

Investing in expertise pays off for 101-year-old company

By Nancy Shohet West




our fitting and pedorthic skills as more people come in with foot problems and back problems,” Stowell said. “We don’t make medical diagnoses, but we can certainly try to find the best solution for each customer’s needs.”

Stowell points to colleague Chris Stanley, CPed, director of pedorthic education for the stores, as leading the charge when it comes to integrating a genuine and educated understanding of pedorthics into the sale process. Under the mentorship of current business owner Jim Wellehan, Stanley, who is on the board of

to be more educated about the foot issues that we can be expected to handle on the sales floor: things like plantar fasciitis, tendonitis, or shoe needs following foot surgery. We’ve also used our increased understanding of biomechanics to grow our running shoe department.”

Stowell noted that the business is riding the wave of two trends: an aging population and a greater interest in fitness and physical activity. The combination of the two factors means Lamey Wellehan’s loyal customers need more help when it comes to taking care of their feet and ankles, whether the result of a new habit of walking several miles a day or problems that frequently develop in older adults, such as diabetes and edema.

The sales staff is known for going the extra mile—literally—to help a client: If a customer has physical difficulties getting to a store, the company will send a sales associate out to see them, whether in their home, a retirement facility, or a hospital.

“It may not be the most efficient process, but some of our customers don’t have anyone else who will do that for them,” Stowell said. “That kind of service, plus the fact that we have committed, knowledgeable, and attentive sales staff in every store, is what brings people back. Those qualities are not easy to find in the big-box retail world.” 

Nancy Shohet West is a freelance writer in the Boston area.

Many foot care professionals would probably confess to a love-hate relationship with the footwear industry. At times, it may feel like the manufacturers of tottering stiletto heels and poorly supported platform shoes are the bane of one’s existence when it comes to helping people walk or run more comfortably. And customers’ desire to look stylish far too often wins out over awareness of the short-term and long-term health problems the wrong footwear can invoke.

But Lamey Wellehan Shoes, based in Augusta, ME, may be one exception. With its emphasis on employing certified pedorthists and putting those knowledgeable professionals in front of customers rather than generically trained sales staff or footwear fashion mavens, the 101-year-old company, which has six storefronts throughout Maine, is showing a genuine commitment to foot health.

“We sell footwear, cradle to grave, for little children all the way up to the oldest seniors,” said Don Stowell, the company’s operations manager. “We provide options in every category: dress shoes, work shoes, sneakers, sandals.”

The company has always put a premium on customer service, but over the past decade or so, its leaders have had a slight change in vision as far as what that means.

“We’ve been working hard at improving



directors of the Pedorthic Footcare Association, has helped to increase the level of medical expertise within the company, through both external and internal training.

“Over the years, Jim felt that the skill and knowledge of the sales staff had eroded somewhat, so we decided to send a couple of associates to a pedorthic pre-certification program,” Stanley recalled. “They had a great time learning about feet and footwear and fitting, and it made them better retailers. Now we send a number of associates every year for pedorthic certification, and we’ve also designed an internal curriculum that we call our retail pedorthic specialist program. The goal is for all of us



Do you know of a store or clinic we should profile?

Complete Feet:

Pedorthist's new venture emphasizes the customer experience

By Catherine M. Koettters | Photos by Michael Moore

Michael Duvdevani, CPed, thinks of his newest store, Complete Feet, as a carefully thought-out step in the right direction.

After several years owning and operating a comfort shoe store, The Shoe Inn, out of the lobby of his clinic, Pedorthic Care, Duvdevani understood that if he wanted to serve more customers he needed to provide them not just with comfortable shoes and foot orthoses, but also a comfortable experience. The space that houses Pedorthic Care and The Shoe Inn, in an office building just outside Birmingham, AL, looks like a clinic, and the tandem businesses rely primarily on professional referrals.

"I wanted to create a retail environment and have the ability to make custom orthotics on site, but not in a clinical type of setting like we have at Pedorthic Care," he explained.

Location was key. Complete Feet opened March 1 in downtown Homewood, a Birmingham suburb that is seven miles from Duvdevani's clinic on a street lined with stores and restaurants and near several medical centers.

"We have people who walk in because they've parked in front of us, or they're just

passing by after shopping two doors down or getting their hair cut next door," said Amy Reese, store manager.

Duvdevani turned a 2600-square-foot former curtain shop into a space designed to be welcoming and fashionable to both casual shoe customers and patients. Individual displays sit at eye level, and the main color scheme in the store is orange. A hallway leads to the clinic, which maintains the same look as the retail store.

"It feels fresh, fun, modern, not rigid," Duvdevani said.


Because Complete Feet's customers range from runners to medical patients, the store offers a wider selection of footwear than The Shoe Inn. Duvdevani carefully researches each brand he brings in, with the goal of selling comfort shoes that are well-designed and built to last, fit comfortably, and can be modified as needed. Complete

including the fabrication and alteration of custom foot orthoses, shoe modifications, rocker soles, and relasting. Many orthotic adjustments can be made in minutes.

As the name suggests, Complete Feet aims to offer everything an individual needs for better foot health, including creams, socks, toe spacers, heel lifts, and off-the-shelf ankle braces and insoles.

As of June, the store was selling more than 100 pairs of shoes a week on average. Duvdevani uses radio and newspaper advertising, direct mail, and participation in local events to help get the word out. A Kia Soul wrapped with Complete Feet's logo rides around town piquing interest. To strengthen pedorthic referrals, a sales representative creates and maintains relationships with local physicians.

Duvdevani, who says he designed Complete Feet as a franchise opportunity, hopes to open two new Complete Feet stores in the next couple of years, and turn the space where Pedorthic Care and The Shoe Inn currently reside into a third.

"The emphasis is to grow this company on a national level, to turn it into a national brand," he says. "People look for something like this. I can't tell you how many people come in and say, 'Oh my God. This is great. We've never had anything like this.' That's what we're trying to create." 

Catherine Koettters is a freelance writer in the Los Angeles area.



Feet carries shoes by Naot (Duvdevani's best seller), Wolky, Taos, Mephisto, New Balance, iRunner, and Dr. Comfort. Plans are under way to bring in two additional brands soon.

Despite the shift to a more retail-focused model, Complete Feet still gives individualized attention to each person who walks through the door.

"We measure and fit everybody every time they come in," Duvdevani said. "We don't just hand them shoes."

And, if a customer needs more than just stylish, comfortable shoes, Complete Feet performs a thorough evaluation and provides a wide range of pedorthic services,



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Improving compliance with diabetic footwear

Convincing patients with diabetes to wear their prescribed footwear presents a challenge, but experts agree that encouraging patient compliance requires lower extremity clinicians to look beyond the disease and gain insight into the person being treated.

By Shalmali Pal

Genomes, epigenomes, pharmacogenomics—these are just some of the industry buzzwords today, as practitioners look to personalize medicine. A recent viewpoint column in *JAMA Internal Medicine*¹ introduced another “ome”—the personome—and defined it as the “influence of the unique circumstances of the person.”

“Individuals are not only distinguished by their biological variability; they also differ greatly in terms of how disease affects their lives,” wrote Roy C. Ziegelstein, MD, a cardiologist at Johns Hopkins University School of Medicine in Baltimore, MD. “People have different personalities, resilience, and resources that influence how they will adapt to illness...”

Many lower extremity practitioners are familiar with the concept of individualized healthcare, particularly if they treat patients with diabetes. After all, what could be more personal than helping a patient choose a pair of custom-molded, prescription footwear that will become part of their daily lives?

But getting patients to comply with prescribed footwear presents a challenge. Studies have shown that footwear adherence is less than optimal among these patients. A 2014 study noted that, among 153 Dutch patients with diabetes presenting at a foot clinic, footwear use was low to moderate, with patients wearing the shoes for less than 60% of their daytime hours.²

Another study evaluated the thinking behind patient noncompliance, noting that those at risk for diabetic ulcerations often based their decision on the immediate risks and benefits of wearing the shoes. In other words, the threat of a future ulceration may not be enough to ensure compliance.³

LER: Foot Health checked in with practitioners to see how they handle this dilemma in real-world settings. They all agreed that encouraging patient compliance requires clinicians to look beyond the disease or disorder, and gain insight into the person being treated.

The time to talk

Complaints about aesthetics are common among patients who refuse to wear their prescribed footwear routinely. While experts agree

Patients may abandon their prescribed therapeutic footwear the minute they are home, either for cultural reasons or because they think the home is a safe environment.

diabetic footwear designs have improved over time, the shoes are still not likely to wind up in the pages of fashion magazines.

But Rob Sobel, CPed, cautioned against making assumptions about a patient's fashion concerns based on gender. Sobel, the president of the Podiatric Footcare Association and owner of Sobel Orthotics & Shoes in New Platz, NY, has found that aesthetic concerns are fairly equal between men and women, but that women may ultimately be more pragmatic.

"A big difference between men and women is that women are more likely to say, 'OK, I have this issue, and this what I need to do to deal with.' Men are not necessarily as willing to deal with the problem," he explained. "They are often in denial and have the attitude of, 'Those shoes are fine for other people, but I'm tougher than that. I'm bigger than this disease.'"

When faced with either form of noncompliance, Sobel suggests practitioners take time to talk to patients about their concerns.

"Maybe the patient's focus is really on aesthetics and style," Sobel said. "Let's say she is determined to get a Mary Jane-style dress shoe, but that may not be appropriate because the shoe exposes too much of the foot, so she needs a shoe with more coverage. I'll take the time to explain why I'm not inclined to give them the Mary Jane, instead of saying no without explanation."

And, he said, don't expect instant results.

"Patients are being asked to make some major changes to their lives because of this disease and, as practitioners, we have to accept that compliance may not be instantaneous," Sobel said. "Just taking the time to hear them out can be useful."

Robert P. Thompson, CPed, agreed that men, and men aged 50

years and younger in particular, can be resistant to wearing prescribed footwear because of a sense of invincibility. Thompson is a retired podiatrist based in Birmingham, AL. He now serves as the executive director of the Institute for Preventive Foot Health.

While in practice, Thompson's strategy was to refocus the patients' attention on the comfort level of the shoes.

"I'd strongly encourage them just to try the shoes on, and once I'd get them into the footwear, they were always struck by the shoes' comfort level," he said. "Then we could shift the discussion to comfort rather than looks."

Another driver of noncompliance is lifestyle, although the lack of adherence may not be intentional. For instance, a patient may wear the prescribed footwear outside the house, but abandon the shoes the minute they are home. The issue may be cultural—"outside" shoes are not worn indoors—or simply because patients assume the home is a safe environment.

A Dutch study found that, among patients with diabetic neuropathy and a recently healed plantar foot ulcer, adherence to custom-made footwear was particularly insufficient at home, where patients' walking activity was greatest.⁴

Study author Sicco Bus, PhD, senior investigator and head of the Human Performance Laboratory at the Academic Medical Center in Amsterdam, said noncompliance at home did not mean the patients were consciously willing to risk reulceration. It's more likely that patients lacked awareness about the risk of reinjury.

Interventions to improve at-home adherence could include a pair of indoor offloading shoes based on the last of the outdoor prescribed footwear, Bus said. Depending on the status of their foot health and risk of injury, Sobel said he might recommend anything

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over the situation, rather than feeling that the shoes are being thrust upon him or her.

"That doesn't mean there isn't a fight to get them to comply, but I don't want to insult someone's intelligence by making threats," Sobel said.

Crystal Holmes, DPM, CWS, an assistant professor in the department of internal medicine at the University of Michigan in Ann Arbor, takes a similar tack. Typically she discusses the risks of not complying with prescribed footwear and lets patients make an educated decision. But if she still meets with resistance—especially when it comes to fashion concerns—Holmes will be blunter.

"I have to be candid with them: 'Is the look of this shoe worth your lower extremity? Is it worth having an amputation? If the answer to that is yes, then please continue to do what you are doing. If the answer is no, then you need to make some modifications,'" she said.

Thompson said he had no qualms about sharing "horror stories" of patients whose lax foot care had serious consequences, or conveying what he called "violent numbers," such as the finding that more than half of patients with diabetes who underwent a first amputation had a second one within five years.⁶

"I would make it a point to show them those kinds of scary, violent numbers. I would make it clear to them what the consequences could be if they chose not to protect and care for their feet. I wouldn't sugar-coat that," he said.

An education

A trial done in Iran reported that patients with diabetes who underwent training on foot care, whether in a group setting or as individuals, had an increase in foot care self-efficacy, such as daily foot inspection, cli-

nician visits, and, of course, using the right footwear.⁷

But, like the use of data, practitioners' approaches to patient education differ.

Holmes said hers starts with the patient's specific foot issues.

"Whenever I talk to patients about diabetic shoes, I try to educate them first on what their particular pathology is," she said. "I think that is very important. If I have a patient who has diabetes, neuropathy, vascular disease, foot deformity, and a history of ulcerations, that conversation is going to be a lot different than one with a diabetic patient who has neuropathy and bunions but has never had an ulceration."

Grogg advocates a whole-body approach. For example, a health education program that she and other healthcare providers conducted at an Air Force base was designed to show attendees that other health problems can stem from anomalies or stressors in the feet. While the attendees of this program were not exclusively patients with diabetes, the same approach is feasible, she said.

"Patients with diabetes are sometimes very focused on the disease itself; it's almost a full-time job for them in terms of management, taking medications, going to see doctors, etc.," Grogg said. "They may lose sight of the big picture and how changes they make in one area—diabetic footwear, new diet, increased activity—can be meaningful on a greater level."

Sobel emphasized that practitioners must work together.

"Podiatrists, pedorthists, primary care physicians—we've got to work as a team. Don't assume the other practitioner will take care of educating the patient," he said. "It's important for everyone to have essentially the same message to get that patient on board with treatment."

A discussion of patient education wouldn't be complete without technology and social media. Patients can now download apps that

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will guide them through a daily foot check, maintain a database of changes in foot health, and look up medical terminology. An app to track diabetic footwear compliance doesn't yet exist, but could be a logical next step. And connecting with others online to discuss diabetic footwear and related issues could be another avenue to compliance, Thompson said.

To that end, practitioners may want to keep up with blogs or Facebook pages that their patients are using.

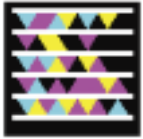
"Don't discount the possibility that a discussion on a Facebook page could lead your patient to make the right decision about her footwear," Thompson said. "Sometimes patients respond more openly to other people who are in the same situation they are."

Patient usage of personal technology and social media to learn about diabetic footwear issues will depend on a number of factors—age, access to smartphones, and how tech savvy the patients are. But figuring out how an app or a social media site works may be an opportunity for older patients to connect with grandchildren or other young people in their lives, Grogg suggested.

Age alone is not necessarily a barrier to using gadgets, Thompson said.

"My mom is ninety-two," he said, "and she just got her first iPad!" 

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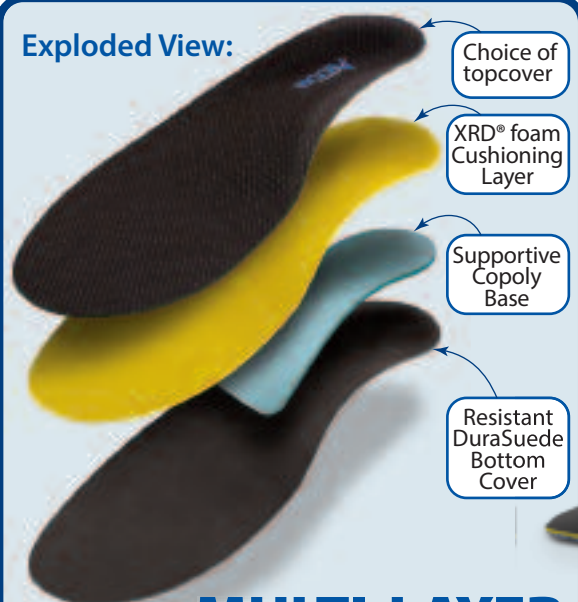
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Intricacies of metatarsal stress fracture treatment

A growing body of research on metatarsal stress fractures is helping lower extremity practitioners manage both the biomechanical and physiological effects of these frustrating injuries, as well as the expectations of patients who are eager to return to activity.

By Erin Boutwell

Emilie Reas, 30, an avid runner from San Diego, was finishing an 11-mile run when she felt an “achy tension” in the dorsal surface of her right foot, followed by numbness radiating down her second toe.

“The next day ... I could not walk without an intense, deep, throbbing pain,” she said.

A series of x-rays indicated a stress fracture of her second metatarsal.

Metatarsal stress fractures often plague athletes like Reas, removing them from competition and relegating them to the bench for weeks and even months at a time. And even researchers who have studied metatarsal stress fractures extensively don’t completely understand them.

“Stress fractures, they’re an interesting animal—especially in the foot—because there’s not a great understanding yet of who gets them or why,” said Robin Queen, PhD, FACSM, director of the Michael W. Krzyzewski Human Performance Lab and assistant professor of orthopaedic surgery at Duke University Medical Center in Durham, NC.

The foot-ankle complex is a highly complicated system, and so many variables are involved in the mechanism of stress fractures that it may be impossible to separate the individual contributions. Nor are all metatarsal bones alike—the first metatarsal is large, strong, mobile, and less frequently injured than the lesser metatarsals. By comparison, the fifth metatarsal is susceptible to bending moments applied from plantar loads, and may be characterized by poor healing and an inadequate blood supply.¹

The patient populations affected by metatarsal stress fractures also are somewhat varied. Athletes and military personnel may be at increased risk for stress fractures due to their high levels of physical activity. However, metatarsal stress fractures can occur in anybody, especially when caused by a traumatic event.¹

While the type and etiology of metatarsal stress fractures vary, some common risk factors and elements exist. In a 2009 *LER* article

Footwear design, and cleat placement in particular, have been shown to affect plantar loading, potentially increasing the risk of metatarsal stress fracture.

that focused chiefly on fifth metatarsal fractures, Queen and co-author James Nunley, MD, described these risk factors, including type of activity, gender, foot posture, and shoe/surface characteristics.²

Since then, research by Queen and other researchers has continued to explore the mechanisms underlying metatarsal stress fractures and how to prevent their development. The results of these studies, along with current clinical opinion, highlight some important areas for future consideration.

Footwear

Any time athletes start demonstrating symptoms of an overuse injury, inappropriate footwear is a potential culprit. Indeed, footwear design has been shown to affect plantar loading patterns, influencing the forces within the metatarsals.² This is a particularly relevant issue as the popularity of barefoot or minimalist running grows in the US.

A 2015 study concluded that peak pressures under the forefoot were increased when wearing a minimalist shoe compared with a typical running shoe, and hypothesized that this increased forefoot loading may be associated with stress fracture risk.³ These results substantiate an earlier case study in which two minimalist runners developed metatarsal fractures.⁴ In both publications, the authors suggested that foot strike patterns may need to be altered to address the potential biomechanical risks of barefoot running.

Comparisons have also been made between running shoes and bladed cleats during a jump landing, demonstrating higher forefoot loads in the cleated condition.⁵ Specifically, cleat placement for athletes who participate in field sports may play an important role in plantar pressure patterns.⁶ Differences in loading patterns between male and female athletes have also advanced the idea of gender-specific footwear.⁶

Queen indicated that more cushioning in the shoe itself may be beneficial, but expressed doubt that athletes would use such shoes.

"In soccer... they like to feel that ground; they want that proprioceptive feedback," she said. "You're walking a fine line between what the athlete wants from a performance perspective and ... what may prevent the injury."

Orthotic devices

Orthotic devices are also a commonly used method of managing loads within the foot, but they may need to serve multiple functions, including support and shock absorption. Because a metatarsal stress fracture is damage caused by repetitive impact loading, providing shock absorption with a shoe insert or orthotic device seems an intuitive solution. However, the results of scientific investigations have not demonstrated consistent improvement with orthotic devices.⁷ Studies of military populations have found no reduction in the incidence of metatarsal stress fractures in participants assigned to a shock-absorbing insole compared with the standard-issue insole in either the Israel military⁸ or Royal Marine trainees in the UK,⁹ although a reduced incidence of femoral⁸ and tibial⁹ stress fractures associated with the shock-absorbing insoles was reported.

An orthosis also can be used to support the foot structure and limit movement. This type of support may be necessary because of the dynamic nature of the mechanical structure of the foot. Research has demonstrated that peak pressure increased under the metatarsal heads after runners completed a marathon, and this

pressure increase was attributed to local muscle fatigue associated with a modified rollover process and increased pronation.^{10,11} Dieter Rosenbaum, PhD, director of the gait lab at the University of Münster in Germany and coauthor of both fatigue studies, added that an orthotic intervention may be warranted "as a preventive measure to just support the foot ... when it gets tired after prolonged loading."

One type of supportive orthotic device is a rigid carbon fiber shoe insert, designed to restrict movement of the foot structures. This insert has been tested as a possible way to mitigate forces on the metatarsals during cutting movements, but no reduction in loading beneath the metatarsals was found with the rigid insert.¹²

Studies have not demonstrated consistent improvement in metatarsal loading with orthotic devices, but clinicians say orthoses can be effective in specific patients.

Harvey Johnson, CO, of Hillsborough, NC, uses custom foot orthoses—and, in some cases, custom fracture braces^{13,14}—to treat metatarsal stress fractures in elite athletes. Over the past 27 years, he has successfully treated stress fractures in more than 300 elite athletes with fracture bracing, and an additional 1000 cases of stress fractures in professional and collegiate athletes with custom foot orthoses, he said.

Johnson builds full-length foot orthoses to treat metatarsal stress fractures using multiple density EVAs (ethylene vinyl acetates) and other materials, fabricating the devices individually in his lab.

"Pain is my ally when fitting and evaluating orthoses. I have to see an immediate and significant improvement in pain during the fitting to know I have built an effective device," he said.

Clinical consensus on orthotic use

The research results on orthotic devices do not present a compelling case for their use. Nevertheless, orthotic intervention may be warranted in specific cases. Joshua J. Mann, DPM, practitioner at the Ankle & Foot Centers of Georgia in Jonesboro, said he would consider an orthotic intervention when he detects biomechanical problems during a clinical exam or observational gait analysis.

"There can be added stress distally on the metatarsal neck/shaft regions with increased ground reaction force," Mann said. "These increased forces can be caused by an abnormal metatarsal parabola, cavus foot type, or ankle equinus."

"Custom orthotics can be expensive for a patient, but I do think they are beneficial for the right patient," Mann said. "With that being said, you would be amazed at how many patients train in worn-out shoes, and would benefit from just wearing proper footwear."

An orthotic device can help or hurt, said Selene Parekh, MD, MBA, a partner at the North Carolina Orthopaedic Clinic in Durham, NC and associate professor of orthopaedic surgery at Duke University.

"I have patients who have flat feet but are asymptomatic ... they see somebody, they get put into an orthotic that overloads their lateral column, and now they start having stress fractures," Parekh said.

Queen urged caution in the incorporation of orthotic devices in the treatment of patients with stress fractures.

"It's very, very difficult to understand exactly what we've done

when we start to put ... the orthotics in," she said. "We are obviously unloading a given area, but then what's the long-term implication of using an orthotic and then allowing them to return to sports? Are they really ready or not?"

Johnson maintains that orthotic intervention in patients with metatarsal stress fractures can be effective if done correctly.

"Foot orthotic management requires methodical attention to detail, including biomechanical evaluation of the foot/ankle complex in the unweighted prone position as well as functional weight bearing, and selective use of materials, design, and fabrication techniques," he said. "Additionally, there are numerous techniques and modifications I incorporate into the foot orthotic that reduces weight bearing on the offending metatarsal head and reduction of torsion to the metatarsal shaft."

Preconditioning

Whether an athlete is starting a new barefoot running program or gearing up for a season of collegiate sports competition, experts agreed that preconditioning is critical to the prevention of metatarsal stress fractures.

"Typically, patients have increased their activity level too quickly, or have added a higher impact exercise [eg, sprint intervals] that their body is not used to," Mann said of his metatarsal stress fracture patients.

Michael Orendurff, PhD, director of the biomechanics laboratory at Orthocare Innovations in Seattle, WA, explained that the rationale behind a preconditioning program involves the time lag between an increase in bone loading and an increase in new bone formation.

"Wolff's Law [if there's more stress, there's more bone] has a really big time lag, and so six to eight weeks into the [new loading] paradigm, you're finally starting to lay down new bone. Metatarsal fractures happen a lot about six to eight weeks into the beginning of some new training cycle," Orendurff said.

Citing a study that found kids who played ball sports had a reduced incidence of stress fractures in their adult lives compared those who did not report playing soccer or basketball in their youth,¹⁵ Orendurff also emphasized that childhood ball sports may be an important aspect of conditioning.

"Play-based loading and activity is really incredibly important for kids to have. [They] end up dosing [themselves] with just the right amount of stress," he said.

In addition to a gradual build-up in physical activity, Parekh suggested that blood testing for vitamin D deficiency may be an appropriate preventive measure. Vitamin D has been associated with promoting bone mineral density, although vitamin D intake has not been conclusively tied to a reduction in stress fracture risk.¹⁶

"I think that, in general, all athletes as part of their preseason medical evaluation should probably start getting vitamin D [testing] done. Vitamin D levels are so critical for bone health," he said.

Better measurement of loads

In discussions with experts on metatarsal stress fractures, a recurring theme was the need for more accessible and more precise data. Queen indicated that imaging techniques, in addition to the current standard of plantar pressure measurements, may be useful to get a better understanding of the loads placed on the metatarsal bones.

Load sensors that athletes or patients can wear to determine

the mechanical demands of an activity may also be useful, Orendurff said. Such sensors are commercially available and have been used to evaluate loading in Australian Rules football players¹⁷ and other professional athletes.

But Orendurff also noted that low-technology methods—or simple math—can be effective as well.

"You can think about it a little bit: 'Am I doing twenty percent more acceleration this week than I did last week? I'm at risk.' If you do that for eight weeks in a row, you're overloaded," he said.

Orendurff emphasized the importance of adequately conditioning the bone structure prior to intensive activity.

"Do it better in the preseason," he said. "We cannot rescue you by giving you an orthotic halfway through."

Vitamin D

Potential physiological factors affecting stress fracture risk span a wide range, including bone density, nutrition, and hormone levels,¹ and even within these systems, substantial overlap exists. For example, the aforementioned low vitamin D levels can result from a nutritional deficit but be detrimental to bone quality.

Interestingly, Parekh noted, many patients who present with stress fractures are not necessarily vitamin D deficient, which has been defined as a blood concentration of greater than 20 ng/mL, or even vitamin D insufficient, defined as a blood concentration of 20 to 29 ng/mL.¹⁸

"What we're finding is it really has to be above fifty nanograms per milliliter before you see the pain get better," Parekh added. "So even though their bloodwork may be 'normal' because it's in the thirties or forties, that's not good enough. It needs to be fifty and above, anecdotally."


A global perspective

Clearly, the management of metatarsal stress fractures is multifaceted, with many avenues yet to be explored. Clinicians are responsible for simultaneously managing both biomechanical and physiological effects, as well as handling the expectations of their patients.

Mann stressed the importance of educating patients regarding their injuries.

"Once patients understand the reasons they are developing a stress fracture, we can then work together to overcome the issue," he said. "Proper training, quality footwear, and orthotics to address their biomechanical issues, and nutrition are all important factors that must be considered."

Outside the clinic, researchers are also acknowledging the importance of expanding studies beyond a single area of focus.

"There needs to be a merging of worlds ... crossing that bridge between what we understand from a biomechanics and a load perspective to what's actually happening within the body with regards to the physiology of bone remodeling," Queen said. 

Erin Boutwell is a freelance writer based in Chicago.



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