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LOWER EXTREMITY REVIEW

March 23 / volume 15 / number 3

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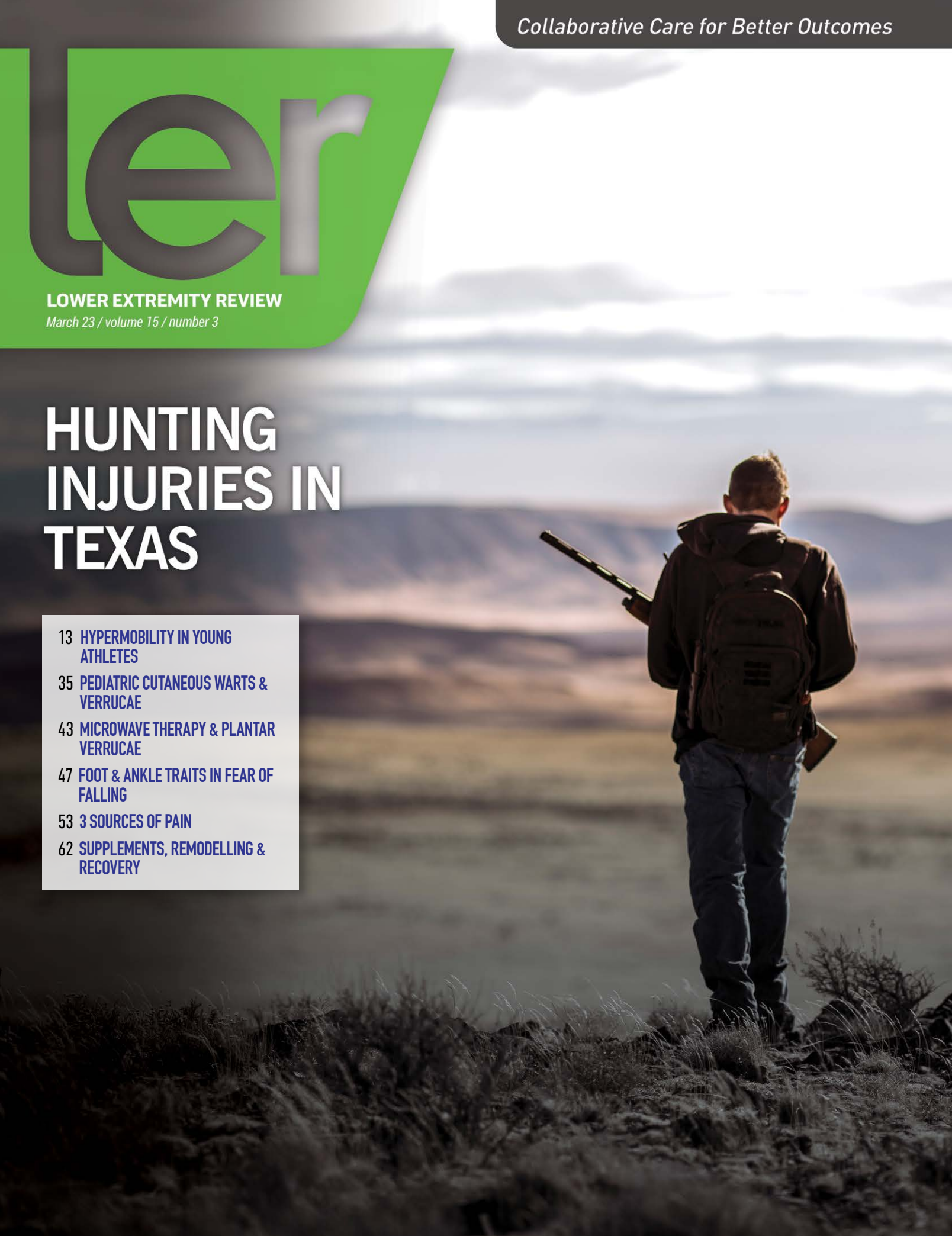

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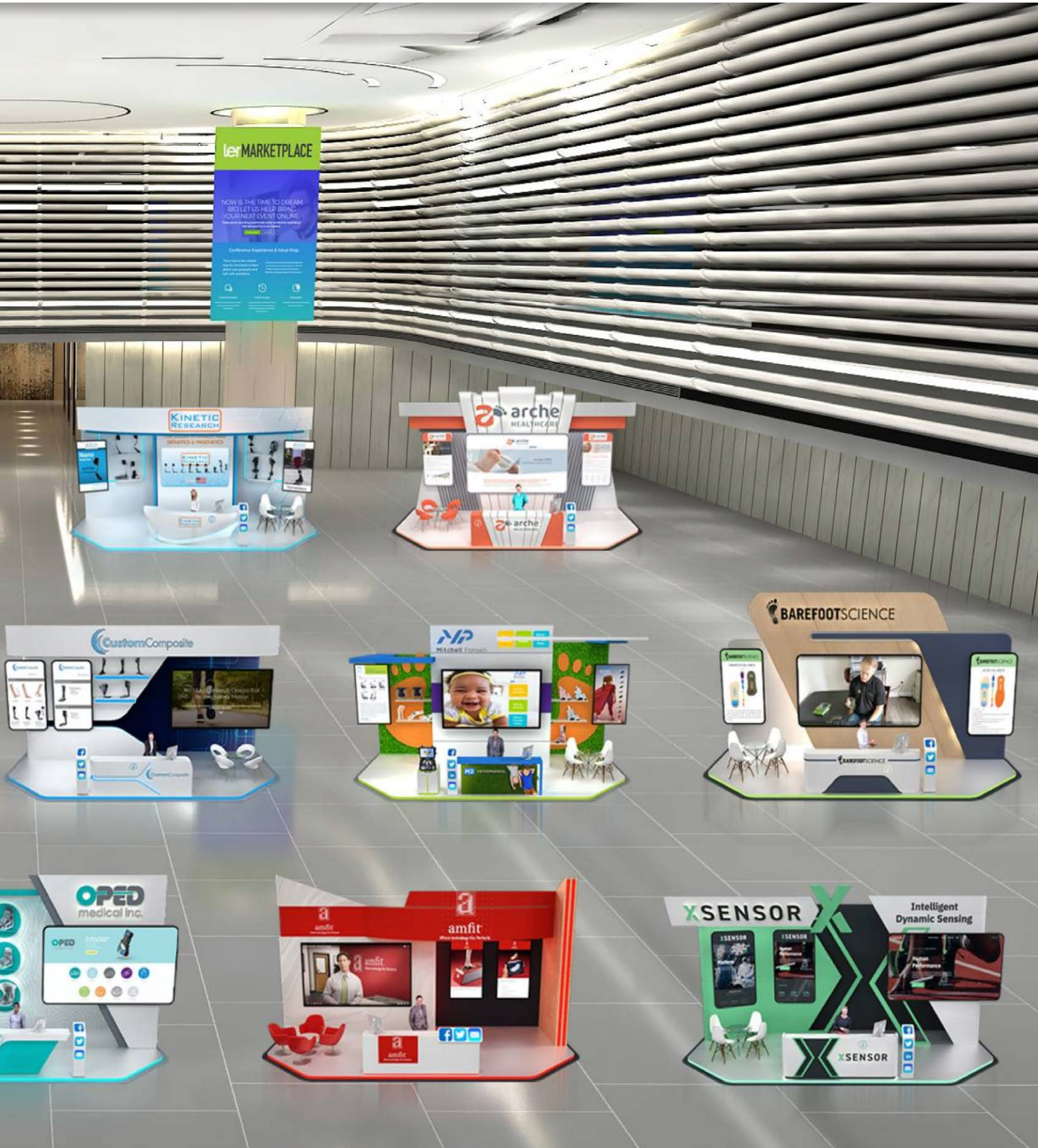

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contents

EDITORIAL OBSERVATIONS

EXPERT OPINION

NEW & NOTEWORTHY

AD INDEX

THE LAST WORD

COVER STORY

SHORTTAKES FROM THE LITERATURE

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BOOK EXCERPT

FEATURES

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LOWER EXTREMITY REVIEW

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Lower Extremity Review

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.

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Showcasing evidence and expertise across multiple medical disciplines to build, preserve, and restore function of the lower extremity from pediatrics to geriatrics.

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- Biomechanics matter
- Movement is essential
- Injury prevention is possible
- Diabetic foot ulcers can be prevented
- Collaborative care leads to better outcomes

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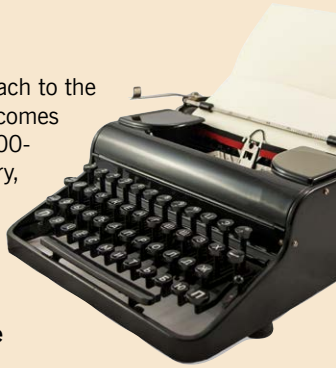

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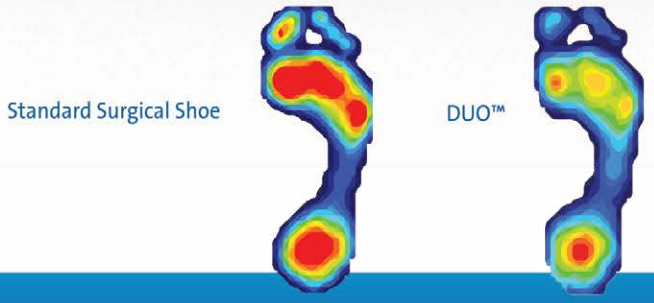

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Editorial **Observations**

What's In A Name? That Which We Call Workout Shoes, By Any Other Name Could Be Personal Protection Equipment…Could It Not?

By Janice T. Radak, Editor

As I stuffed the old water aerobic shoes into the recycle bag, I felt terrible pangs of sadness, like losing a friend who had endured a long journey with me. I'd been through a lot in those shoes.

I lost 40 pounds in those shoes.

I healed an injured back in those shoes.

I got off high blood pressure medicine in those shoes.

I was able to tolerate a 4th day at Disneyland in 90-degree heat in those shoes (granted I swapped out their insoles for a sturdier orthotic insole, but still…).

I made myriad new friends in those shoes who continue to support my water aerobic habit.

Those shoes supported my arches, kept the plantar surfaces of my feet from being rubbed raw by the pool floor, and with the help of an elastic plantar fascia sleeve, kept my left posterior tibial tendon from being shredded by the sesamoid on my left foot.

Those weren't just shoes, they were a mandatory part of my workout. They weren't just workout clothes…they were personal equipment. Personal protective equipment. PPE!

And that made me think about a Guest Perspective we ran 18 months back— "What If We Adopted PPE as a Mindset for Ankle Protection?" by the Australian inventor and designer, Craig J. Hubbard.[1] In that article, he argued that the taping methods used today for ankle injury prevention are basically the same as those that were in play when we landed a man on the moon—50 years ago! Yet we know far more today about the long-term cumulative costs of ankle injury and the subsequent post-traumatic ankle osteoarthritis (PTAOA).

Photography by Elizabeth Larson

As noted by the Ankle Consortium in their 2016 Consensus Statement,[2] while a single lateral ankle sprain (LAS) is often considered an innocuous injury that will heal on its own, "Unfortunately, the majority of patients with a history of LAS will sustain at least one additional sprain, with many developing physical and subjective functional limitations, with ongoing 'giving-way' in the affected ankle, resulting in the defined condition of chronic ankle instability."

The statement goes on to say: "Compounding the high percentage of the population that reports a history of LAS, is evidence of early onset PTAOA, along with decreases in physical activity levels and health-related quality of life. This illustrates that PTAOA is a degenerative health issue that is not exclusive to middle-aged and elderly populations. Furthermore, the financial impact of LAS is high, with billions spent annually on initial treatment and follow-up care. The negative consequence of LAS and chronic ankle instability are concerning, and improved efforts to address these conditions must be initiated."

Continued on page 11

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Continued from page 9

But Hubbard pointed out that "ankle safety in sports is not given the same media, research, or administrative attention, nor is it subjected to the same risk assessments, standards, and testing as traditional sports PPE, such as helmets, pads, mouth guards, or even the gloves staff use to prevent blood infections."

He went on to argue that the long-term effects of LAS have not garnered as much attention to date as concussion, yet LAS occurs far more often. As a result, he said, the absence of consistent safety standards and public awareness of the real costs of LAS allows the continued use of ankle tape as PPE for athletics across the spectrum.

But things may be shifting. In a January 2023 systematic review and meta-analysis (the most recent available at this writing), Wang et al[3] concluded that proprioceptive training is recommended for preventing LAS, especially for people with a history of lateral ankle sprain. Bracing, they argued, seems to have an ambiguous preventive effect and requires further investigation.

As we encourage more physical activity across the age spectrum, given the prevalence of ankle sprains, we should rightfully expect more ankle sprains. But will tape be an appropriate preventive for all populations? What about the waste factor—what to do with all that used tape? What about those with sensitive or fragile skin? What to do about adhesive-on-adhesive residue—will that provide enough support? What about the dreaded MARSI—medical adhesive-related skin injury? What about folks with arthritis whose flexibility prevents the reach needed to properly apply the tape? Are there alternatives in development?

What Hubbard was really arguing for is a mindset shift. Moving away from the notion of ankle sprain as a 1-off injury that just needs a band-aid. Just as we wouldn't ask someone with a partial foot amputation to simply stuff a sock in an old shoe, should we really ask athletes—or anyone who is being physically active regularly—to use a 50-year-old solution that current evidence doesn't truly support?

"What's in a name? That which we call a rose/ By any other name would smell as sweet."

As I recall from high school English, Juliet's line is meant to convey the idea that what's important is what a thing is…not what it is called.

Since parting with these shoes, I have a clearer idea of what their successors actually are…and what they actually do for me. They are indeed personal protective equipment *for me and my specific challenges.*

But one has to wonder,what is the most effective PPE for the long-term complications of LAS?

With apologies to Shakespeare...

Janice T. Radak is Editor of Lower Extremity Review.

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3. Wang F, Guan Y, Bamber Z, et al. Preventive interventions for lateral ankle sprains: A systematic review and meta-analysis. Clin Rehabil. 2023 May;37(5):585-602. doi: 10.1177/02692155221137640. Epub 2023 Jan 11. PMID: 36630892.

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Tackling Hypermobility and a Lack of Core Strength To Reduce Youth Sports Injuries

By Jay Blumberg, PT, DPT

Growing up playing sports, I would hear coaches call some kids "injury prone." Now that I have my doctorate in physical therapy and work as a youth sports physical therapist, I have a different perspective on what it means to be "injury prone." It is not just a coincidence, nor are the forces of the universe conspiring to end a child's potential professional sports career before it has a chance to start. Kids who are more susceptible to injury share similar physical characteristics, which I often see in the clinic. Usually, these injuries are the result of a lack of coordination and strength, but there is often an underlying reason for that. These youth athletes are hypermobile.

So what is hypermobility and how do you combat it?

Contrary to popular belief, being hypermobile does not mean that one is "double jointed." Hypermobility refers to laxity, or looseness, in the joints, allowing them to bend farther than average and, in many instances, farther than is safe for the structures of the joint. It is not unusual for most people to have laxity in some joints, but when kids have global joint hypermobility (consistent throughout the entire body), they are at much greater risk for injury.

Hypermobility is common in children: approximately 1 in every 3 is hypermobile. For the kids that step into my clinic with an injury, I would say that number is 2 out of 3. Why? Hypermobility has a genetic component, so it often runs in families.

Having increased movement in the joints isn't always a bad thing. In fact, it is beneficial in many sports, as long as you have the strength to control that extra motion. Most – if not all – high-level gymnasts are hypermobile. These athletes use their hypermobility to their advantage, putting their bodies into incredible physical

positions. The key here is adequate strength. When you are hypermobile, but don't have the strength to control the motion, the hypermobility becomes an instability in that joint, which leads to increased chance of injury.

The other one-third of my "injury prone" patients may not be hypermobile, but they still display poor motor control/coordination, decreased single limb stability, and/or muscle weakness. (And, to be fair, some may just have bad luck.) These other physical causes revolve around a lack of stability.

Being unstable, whether due to hypermobility or not, increases the risk for injury, especially injuries that include falling and things moving out of place, such as sprains, dislocations, and fractures. Impairments I see in most kids who are hypermobile include poor balance and stability, compensatory movements, generalized muscle weakness, and having a difficult time purposely engaging specific muscle groups. These impairments are typically the root cause of the injury that brought them into the clinic in the first place. I have seen far too many injuries in the clinic that stem from young patients having weak cores or not being able to engage these muscles properly.

Injuries and pain related to core weakness include:

- Balance- and stability-related injuries such as ankle sprains, knee injuries, and falls/fractures
- Low back pain and hamstring injuries
  - Both of these involve attachments to the pelvis, so if the core is not

Continued on page 15

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Continued from page 13

stabilizing the pelvis, these areas are required to work overtime and compensate for that decreased stability

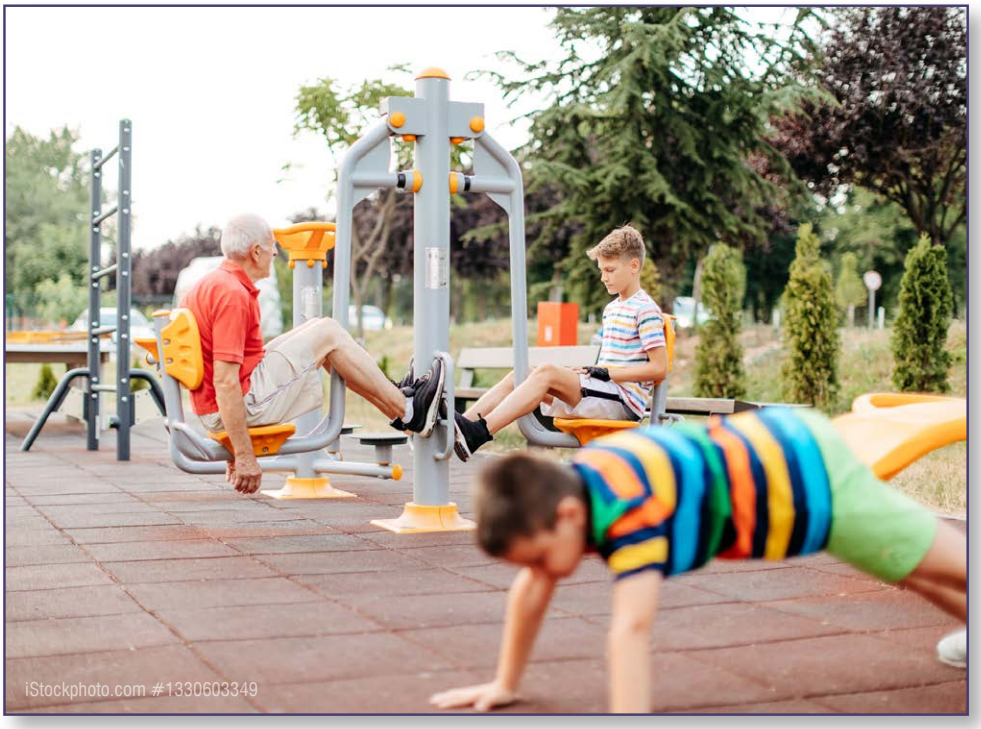
- Poor posture and postural-related impairments
  - This includes scapular and deep neck flexor weakness, along with pec and upper trap tightness. Having elevated shoulders is a compensation which could even cause headaches.

Creating Better Youth Athletes

Traditionally, strength training for kids has been synonymous with "play," and the idea is that as long as they are moving and exercising (in any capacity), kids will naturally build adequate strength. This, combined with their sport-specific training and physical education in school, has been the standard for youth exercise and fitness. Many parents will pay for youth sports training programs as well, which tend to focus on speed, agility, jumping, hand-eye coordination, and sport-specific drills. Physical Education in school primarily has students running, stretching, and playing sports with less training structure. These are all great things, but we are doing a big disservice to our young athletes if we aren't focusing on, or at least introducing, strength training early on. It is never too early to establish good fitness habits.

Core strengthening, in particular, is something we need to prioritize so that youth athletes can achieve the strength and stability required to prevent many sports-related injuries. An athlete's core is critical to healthy athleticism. The major muscles of the core include the rectus abdominis (whose tendinous intersections form the infamous "six pack"), transverse abdomins, diaphragm, multifidus, internal and external obliques, erector spinae, quadratus lumborum, psoas major and the glutes. These stabilizing muscle groups are very important for moving properly and protecting hypermobile joints.

According to Luo et al.,[1] "Core training optimizes the transfer and overall control of motion and force to the terminal segment within



athletic actions. Meanwhile, core training could increase stability and stiffness in the spine to reduce unrequired 'energy leaks' and torso movement during the exertion of external loads. This mechanism could help athletes achieve better skill performance. Therefore, this review suggests that core training should be considered integrated into athletes' daily training routines."

Focusing on core strength and motor control for my "injury prone" athletes is a key strategy to improve their overall athletic performance. Seeing firsthand the under-utilization of core strengthening in kids and teens was one of the reasons I recently published a children's book titled: *Corey and Abby Go to the Gym: A Fun and Motivating Fitness Adventure Book for Kids*. The book contains a core workout that I regularly do with my patients between the ages of 6 and 17. And it's not just a good workout for kids; it's a fun and challenging workout for the entire family. Most books in the Amazon categories of "Exercise & Fitness for Children" and "Children's Fitness Books" are about yoga and meditation. It's time we stop seeing "strength training" as only appropriate for adults. Today, youth athletes are playing sports at higher skill levels. Let's give them the best shot to not only succeed but stay injury free. Let's establish good fitness habits as early as possible, showing kids that exercise and fitness is fun, working hard is fun, getting a strong core is fun, and not being "injury prone" is definitely fun. ler

Jay Blumberg is a doctor of physical therapy and has been working for the past 9 years as a youth sports physical therapist at Rady Children's Hospital in San Diego, California. He has given numerous talks to various youth soccer and baseball clubs, created injury prevention programs for both professional and youth sports teams, and regularly hosts sports medicine talks at local high schools. He is the creator and author of Corey and Abby Go to the Gym*, which can be found on Amazon at https://a.co/d/eN59ios and at his website coreyandabby.com*

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PATIENTS REPORT BENEFITS, CONCERNS OVER THERAPEUTIC CANNABIS USE

As medical use of cannabis becomes more common in the treatment of chronic pain, these researchers wanted to better understand the patient perspective of this therapy.

Based on semi-structured interviews with 13 chronic pain patients at a hospital-based clinic in Ontario, Canada, patients reported reduced pain, improved functionality, and less risk of harms associated with opioids.

Harms identified by patients included grogginess and coughing, and wide variability in personal experience. Patients also cited stigma and costs as important barriers to the use of cannabis.

The authors conclude that clinicians who prescribe medical cannabis would benefit from evidence-based guidance for addressing these patient concerns. ler

Source: *AminiLari M, Kithulegoda N, Strachan P, et al. Benefits and concerns regarding use of cannabis for therapeutic purposes among people living with chronic pain: a qualitative research study. Pain Med. 2022;11(23):1828–1836. doi.org/10.1093/pm/pnac085.*

CANNABIS-IMPAIRED DRIVING

Researchers from McGill University and Lady Davis Institute for Medical Research in Montreal, Canada, took on the task of examining the ethical considerations physicians face when patients admit to cannabis-impaired driving. As of October 2018, dried forms of cannabis became legal in Canada for adults age 18 and older, and edibles and concentrates followed in October 2019. This widespread use of cannabis is thought to be one cause of the recent increase in motor vehicle accidents in the country. The research team undertook an ethical analysis in the form of a critical interpretive review. Their synthesis of the available evidence came up with 3 take-home points:

For patients who report driving frequently and using cannabis, the frequency of use, dosage, form of cannabis, tolerance levels, and withdrawal symptoms should be discussed, while informing the patient of the risks, harms, and legal consequences associated with cannabis-impaired driving.

The practitioner's primary responsibility in the cannabis-impaired driving context is to provide care to patients who drive and consume cannabis, which may include referring patients to mental health care to manage addictive or problematic behaviors associated with cannabis use.

Practitioners may have a duty to report cannabis-impaired driving

to legal authorities (such as law enforcement) when the user engages in harmful behavior to themselves or others. ler

Source: *Huerne K, Ells C, Grad R, Filion KB, Eisenberg MJ. Cannabis-Impaired driving: ethical considerations for the primary care practitioner. Ann Med. 2023 Dec;55(1):24-33. doi: 10.1080/07853890.2022.2151716.*

Continued on page 19

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Continued from page 17

METFORMIN & SEX DIFFERENCES IN NEUROPATHIC PAIN

As a widely prescribed anti-diabetic drug, metformin (MTF) has been receiving novel attention for its analgesic potential. In the study of the complex etiology of neuropathic pain (NeP), male and female individuals exhibit quite different responses characterized by higher pain sensitivity and greater NeP incidence in women. This "gender gap" in our knowledge of sex differences in pain processing strongly limits the sex-oriented treatment of patients suffering from NeP. Besides, the current investigation of the analgesic potential of metformin has not addressed the "gender gap" problem. Hence, this study focuses on metformin and sex-dependent analgesia in a murine model of NeP induced by chronic

Tweet of the Month The Impact of Diabetes on Tendon Health

Arun Samuel Jaykumar @arun_jaykumar · Dec 1, 2022

Effects of long term elevation in serum glucose levels in Diabetic people are well documented. IT's affliction on multiple systems is clear. However our understanding of it's effects on tendon health has improved over the last decade. Here are some salient points in this regard.

Diabetes (DM) on tendon health

Lui 2016, Ranger 2016, Kwan 2020, Nichols 2019, Zakaria 2014, Singh 2014

Run #33

Prevalence of diabetes in UK is nearly 5 million (> 7%). In the US > 23 million (10% of the population).
850,000 people are living with Type 2DM (T2DM) in UK but are yet to be diagnosed.
90% of people with DM have T2DM.

Apart from its effects on Cardiovascular system & Immune system T2DM also affects MSK system (↑ #s and Tendinopathy incidence).

Prevalence of Tendinopathy in diabetes is >3 times greater than in non-diabetic people. People with DM are also at an increased risk of tendon rupture.

Elevated levels of HBA1c (indicator of long term serum glucose control) increases risk of tendon injury (even in prediabetic range).

DM causes structural changes in tendons even before symptoms seem to manifest.

Advanced glycation end products (AGEs) (i.e.) non enzymatic glycation of proteins (collagen in this instance) may play a role in pathogenesis.

AGEs induces apoptosis, pro-inflammatory changes, tissue stiffness, calcification, micro & macrovascular complications.

Increased collagen cross-linking caused by AGEs creates its stiffness & brittleness.

DM seems to predispose people to tendinopathy. A gradual progression of load (e.g. longer rest periods between exercise sessions) in people with DM seems essential in preventing the onset of tendinopathy.
Similarly, when treating diabetic people with tendinopathy, emphasis on good DM control seems of paramount importance to aid improvement & hence a collaborative effort between medical & AHPs seems necessary.

1 3 19

Continued on page 21

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Continued from page 19

constriction injury of the sciatic nerve. These authors investigated sexual dimorphism in signaling pathways involved by 7 days of MTF administration, such as changes in AMP-activated protein kinase and the positive regulation of autophagy machinery, discovering that MTF affected in a sexually dimorphic manner the immunological and inflammatory response to nerve lesion. These effects were complemented by morphological and adaptive changes occurring after peripheral nerve injury.

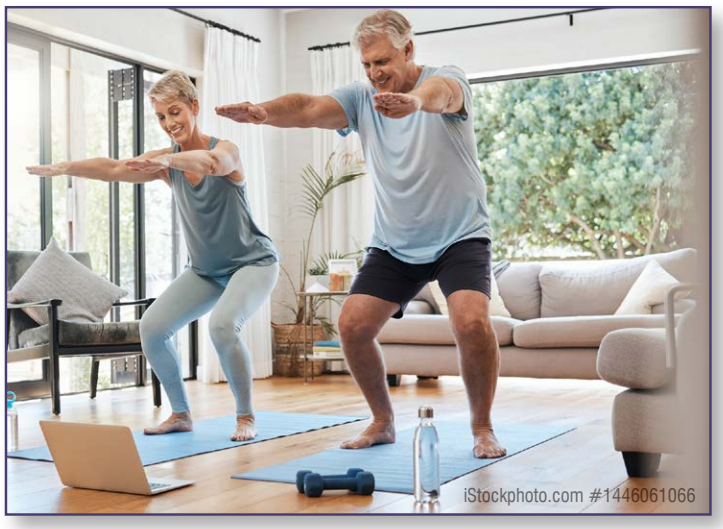
In their discussion, the authors note: The clinical interest in MTF-based therapy has been recently expanded to include several neurological disorders, mainly because of the parallel between some neuropathological mechanisms recognized in both type 1 and type 2 diabetes and neurodegenerative diseases such as Alzheimer's disease. Indeed, energy dysfunction, failure in AMPK activation and disinhibition of mTORC1 signaling are mechanisms accountable for the deficit in protein translation underlying neurodegeneration as well as for the relationship between stimulation of autophagy machinery, MTF treatment, and relief from NeP. The sex-dependent assessment of MTF-induced AMPK phosphorylation revealed a lack of AMPK activation in female mice, while at Day 3, after CCI, the authors found the highest degree of AMPK activation in male animals, which was still higher at Day 7. Hence, such potential insensitivity to MTF-induced AMP phosphorylation in female mice may help to understand the absence of long-lasting functional recovery after peripheral nerve injury in female animals. Essentially, while in male mice, MTF treatment induces an early AMPK activation (as also reported with other autophagy inducers), in females showing a hyperactivated AMPK signaling, the MTF seems to induce a paradoxical effect, decreasing both AMPK and SIRT1 phosphorylation.

Altogether these data can contribute to explaining a number of potential mechanisms responsible for the complete recovery from NeP found in male mice, as opposed to the failure of long-lasting recovery in female animals. ler

Source: *De Angelis F, Vacca V, Tofanicchio J, et al. Sex differences in neuropathy: the paradigmatic case of metformin. Int J Mol Sci. 2022;23(23):14503. doi: 10.3390/ijms232314503.*

AEROBIC, RESISTANCE EXERCISE SHOWN TO FIGHT ATHEROSCLEROSIS

Carotid atherosclerosis is the leading cause of ischemic stroke. Carotid intima–media thickness (cIMT) is a validated surrogate marker of atherosclerosis that is independently associated with the risk for cardiovascular disease. It's presence in the general population has been well documented, with one study showing that among nearly 15,000 participants, mean cIMT was 0.74 (0.11) mm, with almost 40% having cIMT >1 mm and documentable early atherosclerotic lesions. Lifestyle modification may be key to treating subclinical atherosclerosis as it affects vascular and endothelial function. However, recent studies on the effect of exercise on cIMT have yielded conflicting results. These researchers undertook a systematic



review and meta-analysis to summarize the current evidence regarding the effects of exercise on cIMT in adults and determine the impact of the 3 characteristics of exercise (duration, intensity, and type) on cIMT.

Their review included 26 studies with 1370 participants. Compared with control participants, those who engaged in exercise showed a decline in cIMT (weighted mean difference [WMD] −0.02; 95% Confidence Interval [CI], −0.03 to −0.01; I2 = 90.1%). Participants who engaged in aerobic (WMD −0.02; 95% CI, −0.04 to −0.01; I2 = 52.7%) or resistance (WMD −0.01; 95% CI, −0.02 to −0.00; I2 = 38.5%) exercise showed lower cIMT compared with control participants. An exercise duration of >6 months was associated with a 0.02 mm reduction in cIMT. In participants with low cIMT at baseline (<0.7 mm), exercise alone was not associated with a change in cIMT (WMD −0.01; 95% CI, −0.03 to 0.00; I2 = 93.9%).

The authors' findings suggest that aerobic exercise with a minimum duration of 6 months was associated with reduced cIMT in adults. Aerobic exercise is associated with a greater decline in cIMT than other forms of exercise. The authors also called for large, multicenter, randomized controlled trials to establish optimal exercise protocols for improving the pathological process of atherosclerosis. ler

Source: *Wang Y, Wu H, Sun J, et al. Effect of exercise on carotid artery intima-media thickness in adults: a systematic review and meta-analysis. J Phys Act Health. 2022;19(12):855-867. doi: 10.1123/jpah.2022-0372.*

IMAGING STRATEGY ENHANCES LIPEDEMA TREATMENT

A unique collaboration between imaging science, vascular medicine, and rehabilitation at Vanderbilt University Medical Center (VUMC) is transforming the diagnosis and treatment of lipedema, a debilitating, abnormal deposition of fatty tissue that afflicts an estimated 17 million women in the United States.

Continued on page 22

Continued from page 21

Lipedema, often mistaken for obesity, does not respond to diet or exercise. In women, the accumulation of fat occurs mainly in the legs, causing them "a lot of pain and difficulty with their daily activities," said Aaron Aday, MD, MSc, assistant professor of medicine. Although it is a true condition, many women have trouble finding a diagnosis.

About 7 years ago, Rachelle Crescenzi, PhD, decided to do something about it. As a postdoctoral fellow in the Department of Radiology and Radiological Sciences at VUMC, she began to apply imaging techniques to improve diagnosis. Lipedema "had been characterized in the 1940s, but people were relying on external measurements, which made it a very difficult diagnosis," said Crescenzi, now an assistant professor in the department. With imaging, "we can look inside the body and show that this really is different from obesity."

Lipedema is a disorder of the lymphatic system, which plays a major role in removing excess water (edema) from body tissues. Too much fluid in the heart, for example, can lead to heart failure. Sodium (salt) plays a major role in regulating blood pressure and fluid volume. It is also a magnetic molecule and, as such, can be tracked by MRI.

With funding from the Lipedema Foundation, Crescenzi and colleagues developed an MRI strategy to quantify sodium content and fatty subcutaneous adipose tissue (SAT) throughout the body. They found that sodium and SAT volumes were significantly elevated in patients' legs, but not arms, compared to women without lipedema.

In 2021 Crescenzi received the first R01 (independent investigator grant) ever awarded for lipedema research by the National Institutes of Health. Supported by the 5-year, $2.5 million grant, titled "Visualizing vascular mechanisms of lipedema," Crescenzi established the Sodium Adipose and Lymphatics Translational (SALT) Lab, which is evaluating various treatments and diagnostic modalities.

In particular, the researchers are looking at conservative physical therapy to relieve patients' lipedema-related leg pain, weakness, and excess fluid, improve mobility and optimize their home self-management program.

The manual techniques used in therapy include manual lymphatic drainage massage, myofascial and soft tissue releases to relax contracted muscles and surrounding connective tissues, along with use of graded negative pressure to expand and stretch tissue — all of which can improve lymphatic circulation.

This is where Paula Donahue, PT, DPT, MBA, comes in. Donahue, a Certified Lymphedema Therapist by the Lymphology Association of North America (CLT-LANA), is an assistant professor in the Department of Physical Medicine and Rehabilitation.

Working with Crescenzi's team, they have shown that pain relief and improved function experienced by women with early lipedema after physical therapy correlated with a reduction of tissue sodium in the skin

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Continued from page 23

and SAT as measured by sodium and water MRI.

This proof-of-principle study, published in Lymphatic Research and Biology, showed that hands-on manual massage techniques not only helped patients feel better, but acted directly on the source of their pain. One of the patients "was dealing with pain which was unexplained, and her doctor didn't know what to do," Donahue said. With physical therapy, "her pain basically went down to zero and very quickly for her … For these individuals, it was very effective in changing their quality of life."

"It wasn't thought that you could compress out any of the pathologic tissue in lipedema, that it was just fat," Crescenzi added. "But it really is fat and edema. We think sodium is a marker of inflammation … and it reduces after therapy."

MRI is expensive, so Crescenzi and her colleagues are testing whether a lower-cost diagnostic method, ultrasound, is as effective in quantifying the extent of abnormal salt and SAT accumulation.

They have also developed a technique called magnetic resonance lymph angiography to better understand the hallmark features of lipedema. "We think the vascular system is just overloaded with a lot of edema, and it shows up on angiography," Crescenzi said.

"We're at the infancy of understanding this disease," said Aday, co-author with Crescenzia and Donahue of the paper on the angiography technique published in the *Journal of Magnetic Resonance Imaging*. "We don't have a good mechanistic understanding of this."

The hope is that identifying what causes lipedema will lead to better ways to treat or prevent it. "We're in a position to develop a national resource for lipedema," said Crescenzi, who presented the group's latest findings last October at the American Vein and Lymphatic Society's Annual Congress in New Orleans.

Sources: *Donahue PMC, Crescenzi R, Petersen KJ, et al. Physical therapy in women with early stage lipedema: potential impact of multimodal manual therapy, compression, exercise, and education interventions. Lymphat Res Biol. 2022;20(4):382-390. doi: 10.1089/lrb.2021.0039.*

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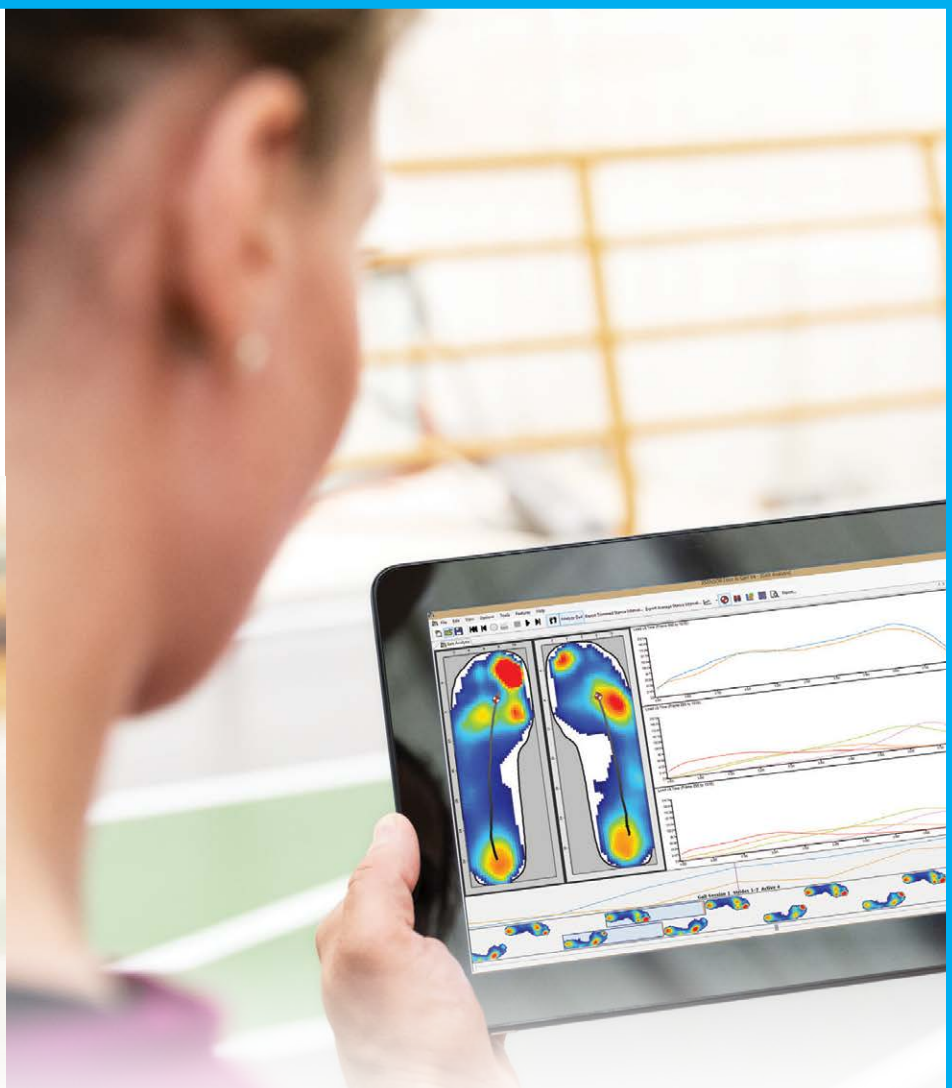

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Lower Extremity Injuries Due to Hunting Incidents Involving Firearms and Other Weapons in Texas

By Mathias B. Forrester, BS

Background: Hunting is a popular activity in the United States. However, injuries due to firearms and other weapons may occur while hunting. The objective of this study was to characterize lower extremity injuries due to firearms and other weapons while hunting in Texas.

Methods: Cases were all lower extremity injuries included in the 2002-2021 Texas Hunting Accident Reports produced by the Texas Parks and Wildlife Department (TPWD). These reports provide information on all hunting incidents (accidents) resulting from a discharge of a firearm or bow while hunting which causes the injury or death of any person(s) that are reported to TPWD Game Wardens.

Results: There were 170 persons with lower extremity injuries from hunting incidents involving firearms and other weapons, out of 542 total persons injured (and 424 persons where the body part injured was mentioned). There were 11.8% lower extremity injuries during February-April, 4.7% during May-July, 34.1% during August-October, and 49.4% during November-January. The injury was self-inflicted in 61.2% of the cases. Of the 133 records that mentioned the exact part(s) of the lower extremity that were injured, 72.9% mentioned the lower leg, ankle, foot, or toe. The weapon involved in the incident was 42.4% shotgun, 38.8% rifle, 17.1% handgun, and 1.8% bow.

Conclusions: Lower extremity injuries due to hunting incidents involving firearms and other weapons accounted for 40% of all such injuries. The injuries were seasonal, with almost half of the injuries reported during November-January. Most of the injuries were self-inflicted and the majority involved the leg below the knee.

Hunting is a popular activity in the United States (US). In 2020, over 15 million hunting licenses were sold in the US, with approximately 4.6% of the US population issued a hunting license that year.[1] However, injuries due to firearms and other weapons may occur while hunting. Research using data from the Inter-University Consortium for Political and Social Research Firearm Injury Surveillance Study 1993-2008 found that hunting accounted for 2% of all firearm injuries.[2] Several studies of firearm injuries managed at rural Midwestern trauma centers reported that approximately 25% of the injuries were related to hunting.[3,4]

Hunting injuries due to firearms and other weapons can involve any part of the body, including the lower extremity.[2,5] The objective of this study was to describe lower extremity injuries due to hunting incidents involving firearms and other weapons in Texas. Texas had the highest number (n=1,120,620) of hunting licenses issued by any state in 2020, representing 7.9% of all hunting licenses issued in the US that year.[1]

Methods

Data for this study were obtained from the Texas Parks and Wildlife Department (TPWD, https://tpwd.texas.gov/). The TPWD collects detailed reports of all hunting-related fatal and non-fatal incidents. The TPWD defines a hunting incident (accident) as resulting from a discharge of a firearm or bow while hunting which causes the injury or death of any person(s) that are reported to TPWD Game Wardens.[6] If a hunting-related incident is reported to a Game Warden, the Game Warden submits a report of the incident to the TPWD Hunter Education Program. These individual reports are compiled in annual Texas Hunting Accident Reports.[6]

The TPWD Texas Hunting Accident Reports for 2002-2021 are available in pdf format at the following website: https://tpwd.texas.gov/education/hunter-education/accidents

The reports contain both aggregate and incident-specific data. For example, in the Texas Hunting Accident Report 2021, aggregate data are provided first. These aggregate data include the annual number of fatal, non-fatal, and total

Continued on page 28

Continued from page 27

accidents during 1966-2021. Next, for the most recent five years (2017-2021), the report provides the annual number of accidents by shooter's age, shooter's equipment, "additional facts," main contributing factors (hunter judgment, skill/aptitude, safety, other), and animal hunted. Then the report provides incident-specific information on all fatal accidents, non-fatal incidents, non-forearm/bow hunting related incidents, and non-hunting/firearm related incidents. The information provided for each incident are the date, county, shooter's age and gender, firearm, animal hunted, self-inflicted (yes, no), hunter education (shooter) (yes, no), comments (brief narrative of the incident), and prevention (a statement on how to prevent incidents such as the one being described).[6] A given incident may involve more than one victim or more than one shooter.

The data are publicly available and de-identified. Therefore, this study was exempt from institutional review board (IRB) approval.

Cases were all lower extremity injuries included in the 2002-2021 Texas Hunting Accident Reports. Since the reports do not have a data field specifically for the body part that was involved in the injury, the Comments field for each incident was reviewed for any mention that a lower extremity was involved. An incident may involve injury to more than one body part. The Comments field did not always mention the body part involved, so the cases included in the study are a subset of all such incidents in the reports.

The variables examined were affected lower extremity body part, year and month of the incident, shooter's age and sex, whether the incident was fatal, whether the injury was self-inflicted, the type of firearm involved, and the type of animal being hunted. The distribution of cases was determined for these variables.

Results

During 2002-2021, there were 170 persons with lower extremity injuries due to hunting incidents involving firearms and other weapons, representing 31.4% of the 542 total persons injured (whether the injured body part was mentioned) or 40.1% of the 424 persons injured where the body part injured was mentioned. The body part injured was 52 (30.6%) foot, 31 (18.2%) lower leg, 31 (18.2%) upper leg, 10 (5.9%) knee, 9 (5.3%) ankle, 9 (5.3%) toe, and 38 (22.4%) leg (exact part not otherwise specified). (A person can have an injury to more than one part of the lower extremity.) Of the 133 records where the exact part(s) of the lower extremity that were injured was mentioned (one record mentioned the leg and the knee), 97 (72.9%) mentioned the lower leg, ankle, foot, or toe.

There were 53 (31.2%) persons with lower extremity injuries during 2002-2006, 40 (23.5%) during 2007-2011, 38 (22.4%) during 2012-2016, and 39 (22.9%) during 2017-2021. The annual number of lower extremity injuries ranged between 2 in 2011 and 2021 and 14 in 2006. By season, there were 20 (11.8%) persons with lower extremity injuries during February-April, 8 (4.7%) during May-July, 58 (34.1%) during August-October, and 84 (49.4%) during November-January.

Of the 167 cases with a reported shooter's age, 14 (8.4%) were 7-12

years, 40 (24.0%) 13-19 years, 35 (21.0%) 20-29 years, 23 (13.8%) 30-39 years, 25 (15.0%) 40-49 years, 13 (7.8%) 50-59 years, 13 (7.8%) 60-69 years, and 4 (2.4%) 70-75 years; the mean age was 32 years (range 7-75 years). Of the 169 cases with a reported shooter's sex, 165 (97.6%) were male and 4 (2.4%) female. Three (1.8%) persons died. The injury was self-inflicted in 104 (61.2%) of the cases. The weapon involved in the incident was 72 (42.4%) shotgun, 66 (38.8%) rifle, 29 (17.1%) handgun, and 3 (1.8%) bow. The most frequently hunted animals were hog/feral hog (n=42, 24.7%), dove (n=39, 22.9%), deer (excluding explicitly stated exotic deer) (n=28, 16.5%), rabbit (n=13, 7.6%), waterfowl/ducks/geese (n=10, 5.9%), and quail (n=8, 4.7%).

Discussion

This study examined lower extremity injuries due to hunting incidents involving firearms and other weapons in Texas. Such information is important because lower extremity injuries accounted for 40% of all hunting incidents involving firearms and other weapons where the location of the injury was mentioned.

There were 170 lower extremity injuries due to hunting incidents involving firearms and other weapons in Texas during 2002-2021 or an average of 8.5 such injuries per year. Considering that over 1 million hunting licenses were issued in Texas in 2020 alone, this suggests that lower extremity injuries due to hunting incidents involving firearms and other weapons are relatively uncommon in the state.

The number of lower extremity injuries due to hunting incidents involving firearms and other weapons was highest during 2002-2006 then declined during 2007-2011 and remained relatively stable during the final two 5-year periods. In comparison, the total number of injuries due to hunting incidents involving firearms and other weapons was 178 during 2002-2006, 134 during 2007-2011, 130 during 2012-2016, and 100 during 2017-2021 – a decline over each 5-year period. This difference might be due to reports being more likely to mention the injured body part during the latter parts of the study period. In fact, the portion of records that mentioned the injured body part was 66% (n=118) during 2002-2006, 84% (n=112) during 2007-2011, 79% (n=103) during 2012-2016, and 91% (n=91) during 2017-2021.

Lower extremity injuries due to hunting incidents involving firearms and other weapons in Texas were seasonal, with almost half of the injuries occurring during November-January and 5% during May-July. Although hunting seasons in Texas vary by geographic area and animal, general hunting season is November-January.[7]

Of those cases where the specific injured part of the lower extremity was identified, 73% mentioned a body part below the knee. The majority of injuries in the study were self-inflicted. Self-inflicted wounds where the injured person was holding the firearm or other weapon, particularly those involving long-barreled firearms such as shotguns and rifles, might be more likely to result in injuries to the lower leg than the upper leg. Of the 97 injuries involving the leg below the knee, 75 (77%) were self-inflicted.

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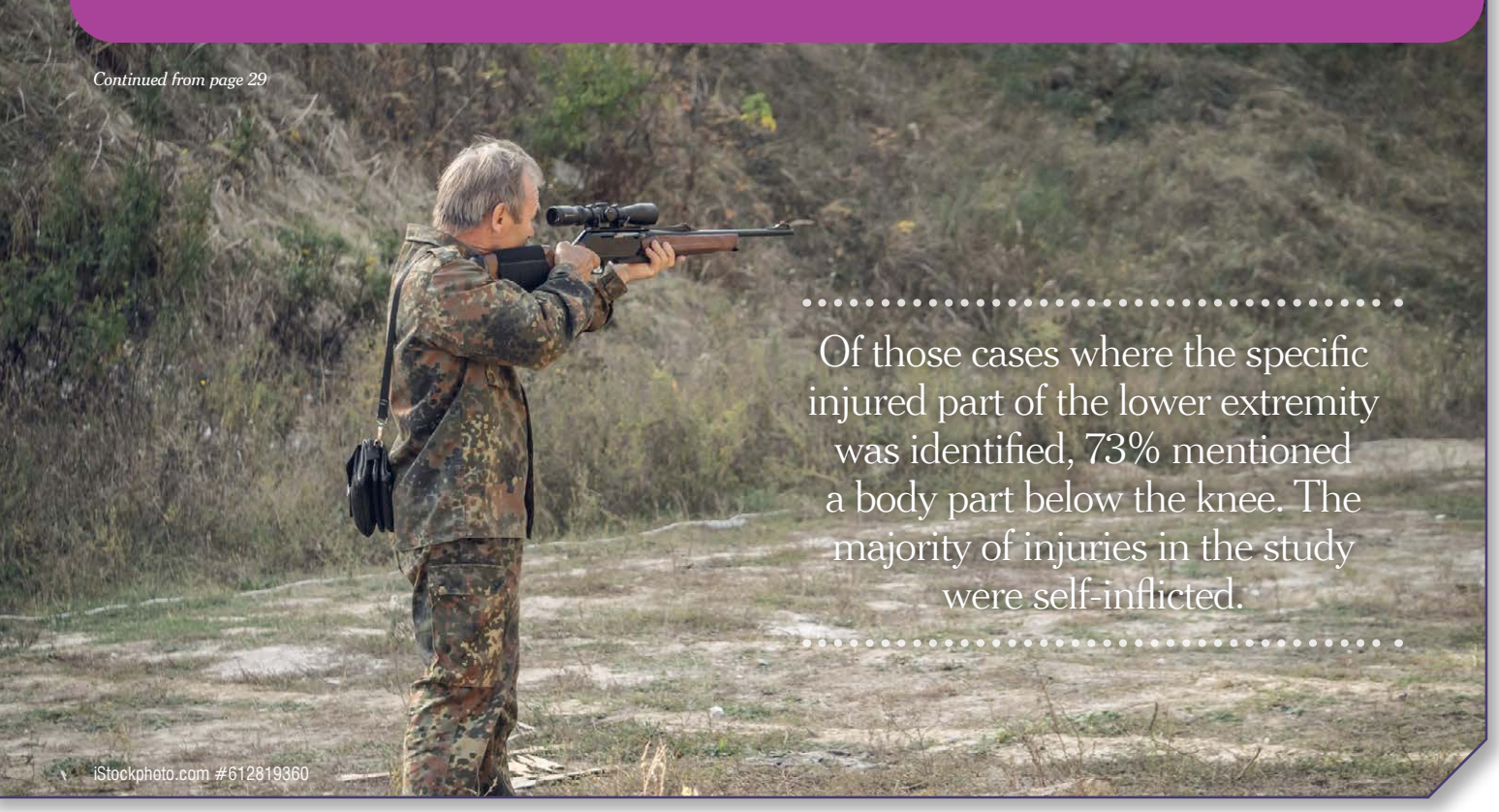

> Of those cases where the specific injured part of the lower extremity was identified, 73% mentioned a body part below the knee. The majority of injuries in the study were self-inflicted.

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Injuries due to hunting incidents involving firearms and other weapons can be prevented.

The Texas Hunting Accident Reports at https://tpwd.texas.gov/education/hunter-education/accidents provide tips on how to prevent such hunter-related incidents. One way to prevent such incidents is through hunter education. In Texas, hunter education has been mandatory since 1988.[6] Examples of ways to prevent hunting incidents include:

- always point the muzzle in a safe direction
- maintain a safe zone of fire
- communicate with hunting companions
- always know where others are positioned, and
- identify the target clearly.

This study is subject to limitations. The study used data from a single state, Texas. The pattern of lower extremity injuries due to hunting incidents involving firearms and other weapons may differ in other states. The Texas Hunting Accident Reports only included those incidents reported to TPWD Game Wardens. If an incident was not reported to a Game Warden, it would not be included in the Texas Hunting Accident Report. The individual records did not always mention the body part(s) that were affected, so the cases included in the study would be a subset of all such incidents. The reports only included demographic information for the shooter; if the injury was not self-inflicted, then demographic information on the person who was injured was not available. Finally, details of the type of injury and management and outcome of the injury (aside from fatality) were not included in the reports.

In conclusion, lower extremity injuries due to hunting incidents involving firearms and other weapons accounted for 40% of all such injuries. The injuries were seasonal, with almost half of the injuries reported during November-January. Most of the injuries were self-inflicted and the majority involved the leg below the knee. ler

Mathias B. Forrester, BS, is an independent researcher in Austin, Texas. Now retired, he previously performed public health research for various university and government programs for 38 years.

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SPEAKERS

John Cozzarelli
DPM, DABPS, FACFAS

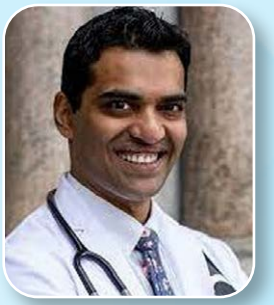
James M. DeJesus
DPM, FACFAS

Jeff R. Peterson
MD

Abdul Abdellatif
MD

Demi Turner
DPM

Nicholas Francis Cozzarelli
BS



Anuj Shah
MD

Mark E. Spier
DPM, DABFAS

Frederick Day III
DPM, DABFAS, FACFAS

Richard Dubin
Founder & CEO, LER Magazine, lerEXPO

AGENDA

- **Hyperuricemia – The New Marker for Metabolic Syndrome**
  - May 20, 2023, 09:00 AM – 10:00 AM
  - John Cozzarelli, DPM, DABPS, FACFAS
- **Gout – Is It Really Just a Flare Disease?**
  - May 20, 2023, 10:00 AM – 11:00 AM
  - John Cozzarelli, DPM, DABPS, FACFAS
- **Current Pharmaceutical Treatment of Gout**
  - May 20, 2023, 11:00 AM – 12:00 PM
  - James M. DeJesus, DPM, FACFAS
- **Lunch and Learn: Krystexxa (Pegloticase) with methotrexate : Changing the course of uncontrolled gout**
  - May 20, 2023, 12:00 PM – 12:45 PM
  - Jeff R. Peterson, MD
- **Point-of-Care Ultrasound Imaging (POCUS) Utilized in the Diagnosis and Treatment of Gout**
  - May 20, 2023, 12:45 PM – 01:30 PM
  - Demi Turner, DPM
- **The Impact of Gout on the Orthopedic Surgery Patient**
  - May 20, 2023, 01:30 PM – 02:00 PM
  - Nicholas Francis Cozzarelli, BS
- **Nephrology and Uric Acid**
  - May 20, 2023, 02:00 PM – 02:45 PM
  - Abdul Abdellatif, MD
- **Uric Acid and Cardiovascular Disease: An Update From Molecular Mechanism to Clinical Perspective**
  - May 20, 2023, 02:45 PM – 03:40 PM
  - Anuj Shah, MD
- **Infusing's Not Confusing**
  - May 20, 2023, 03:40 PM – 04:00 PM
  - Mark E. Spier, DPM, DABFAS
- **Coronavirus and Gout**
  - May 20, 2023, 04:00 PM – 04:30 PM
  - Frederick Day III, DPM, DABFAS, FACFAS

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Pediatric Cutaneous Warts and Verrucae: An Update

By Ivan Bristow, PhD, FFPM, RCPS (Glasg)

Plantar warts have plagued humans for thousands of years, but newer therapies, including immunotherapy and microwave treatments, offer promise in improving therapeutic outcomes for these frustrating challenges.

Warts and verrucae are benign growths occurring in the skin and mucous membranes due to infection with various strains of the Human Papilloma Virus (HPV). Depending on their location and morphology they may be referred to as common, plane, flat, plantar, or genital warts. This paper aims to review recent evidence from published reviews and other research regarding cutaneous (non-genital) warts in children with a specific focus, where possible, on plantar lesions (verrucae).

Prevalence and Risk Factors for Warts

The cutaneous manifestations of HPV infection are cutaneous warts and verrucae, which have been shown to be unusual before the age of 4 but most prevalent in secondary school-aged children. A cross-sectional study of the hands and feet of 1465 children aged between 4 and 15 from 4 Dutch schools showed a prevalence of 33% with most children having only 1 or 2 lesions with no gender predilection. Prevalence rates within this study demonstrated a 15% prevalence in 4-year-old school children rising significantly to 44% in 11-year-olds. Within this cohort, 59% of children exclusively had plantar lesions, with 13% showing hand and foot involvement. Warts were more common in Caucasian than non-Caucasian children. Interestingly, barefoot activities and swimming pool visits did not increase the risk of developing warts. In other works conducted on children with warts, additional risk factors identified included Caucasian skin type, sharing shoes, coming from a large family, having a father who was a manual worker and having siblings or classmates with warts. Regional geographical variations in incidence were also noted in a UK study of schoolchildren. Data on prevalence rates in older children and young adults are scarce, but 1 study of over 15,000 Chinese college students suggested a prevalence of around 1.4%. The presence of verrucae in a group of children with rheumatological disease showed a prevalence no higher than the prevalence in healthy children, even though most were known to be taking immune-modifying medication. Lesions in these patients were no more numerous or atypical compared to other children.

HPV Type and Carriage of Infection

Cutaneous warts are caused by small DNA viruses which have adapted to infect the skin and mucosal surfaces. Over 450 species have been identified amongst the 5 genera of the HPV viruses (alpha, beta, gamma, mu, and nu), based on genotyping of the L1 capsid gene. The HPV virus responsible for cutaneous warts can be routinely detected from normal skin swabs in children. However, skin swabs of wart-free skin are more frequently positive in children who have warts elsewhere. The sole of the foot has been found to show highest positivity for wart virus carriage on normal skin in a pediatric population.

This article has been excerpted from "Paediatric Cutaneous Warts and Verrucae: An Update," from the *International Journal of Environmental Research and Public Health*. 2022; 19:16400. https://doi.org/10.3390/ijerph192416400. Editing has occurred and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

Continued on page 36

Continued from page 35

Figure 1. Dermoscopy of a debrided plantar wart showing a frog spawn like appearance with white halos, with capillaries at the center of the lesion.

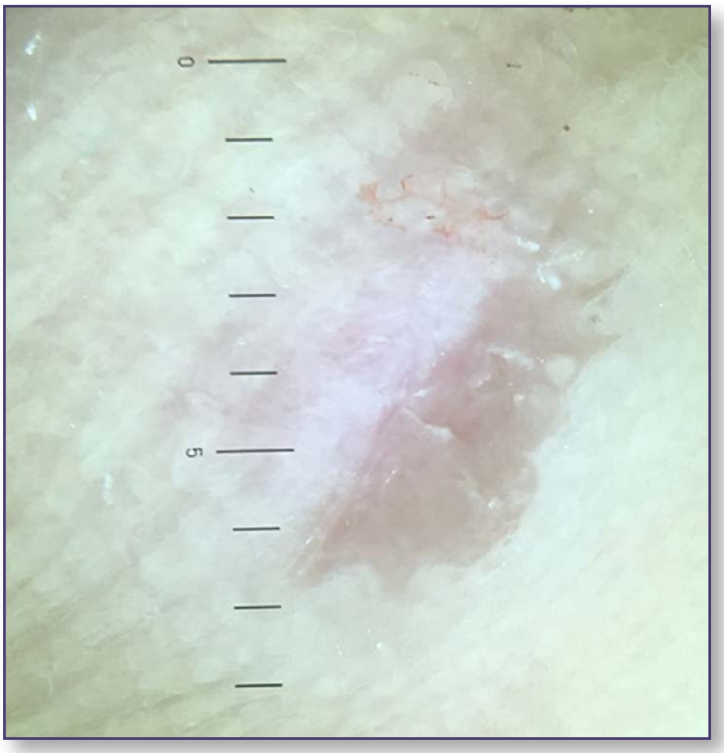

Figure 2. Dermoscopy of callus showing a central featureless reddish area.

Few studies have investigated the most common HPV sub-types responsible for causing cutaneous warts. Researchers in the Netherlands selected 31 children (age 10–12 years) from 3 schools who were medically diagnosed with warts on the hands and feet. Skin swabs taken from their lesions and samples were analyzed for the presence of HPV DNA using a polymerase chain reaction (PCR) test assay capable of being detected in 23 known HPV types. In total, HPV was detected in 92% of warts. In 40 plantar lesions, the most common sub-types were HPV 2, HPV 27, HPV 57, and HPV 63 (but HPV 1, HPV 4, HPV 10, HPV 41, HPV 65, HPV 88, and HPV 95 were also detected). A small number demonstrated multiple HPV strains within the same lesion. These findings broadly concur with a Spanish study which exclusively genotyped plantar warts (n = 105) which were all positive for 1 HPV subtype. The most prevalent genotype was HPV 57 (37.1%), followed by HPV 27 (23.8%), HPV 1a (20.9%), HPV 2 (15.2%), and HPV 65 (2.8%). In children under 11 years of age HPV 1a was the most prevalent type. Tomson and colleagues in their 2011 study reported HPV types 2, 27, and 57 as being the most common cause of plantar lesions.

Diagnosis

The diagnosis of warts is predominantly clinical, visual analysis of the lesion being the most common method, particularly as the cost of genotyping using PCR precludes its use in regular day-to-day practice in many countries. In children, there are few differential diagnoses that may mimic plantar warts. A study undertook development of a visual assessment tool to assist clinicians in the identification of cutaneous warts. The CWARTS tool, published in 2018, was developed to test inter-observer agreement on 9 clinical features of warts. Good inter- and intra-observer agreement was achieved with the presence of black dots within the lesion having the highest agreement amongst observers and a latter publication showed it to be the strongest predictor of HPV presence within a lesion.

In recent years, the use of dermoscopy has increased in the assessment and recognition of skin lesions. Dermatoscopic evaluation of the visual features of warts has been undertaken. Observable reported features in warts include the presence of dots and globules—these can be red, brown, or black in color and probably represent dilated capillaries. These capillaries are situated at the center of white halos giving a frog spawn like appearance (Figure 1). In some lesions, abrupt interruption of the natural dermatoglyphics is easily observable under the polarized light of the dermatoscope. Callus, a common differential diagnosis on the sole, lacks the typical dots and globules seen in warts whilst there is no interruption in the natural dermatoglyphics (Figure 2). In addition, callus displays central reddish to bluish structureless pigmentation.

Natural Wart Regression

It is well established that cutaneous warts and verrucae may undergo spontaneous regression—the underlying mechanisms responsible for this are not fully understood however several

Continued on page 39

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Continued from page 36

observational studies of warts in children have reported spontaneous clearance. A follow-up study of 364 children (age 11) with warts discovered only 7% had them by age 16—demonstrating a 93% regression rate. A Dutch study of 366 schoolchildren diagnosed with warts reported 50% of subjects were wart-free within a year. In addition, a younger age and non-Caucasian ethnicity was shown to favor faster resolution. In a further study by the same authors, it was demonstrated that the HPV subtype of plantar warts influenced outcomes following treatment, particularly for children with the HPV1 type. HPV1 induced plantar lesions were more likely to regress with no treatment versus HPV 2, HPV 27, HPV 57 (58% versus 7%). Moreover, following treatment with salicylic acid the HPV1 type was more likely to respond to treatment than HPV2, HPV 27, and HPV 57 types (92% versus 25%). This work suggests that wart typing may allow optimization of treatment as identification of the plantar warts caused by HPV 1 type have an 8-fold chance of spontaneous regression. Other HPV types causing plantar lesions may confer more resistance to treatment, but this warrants further investigation.

Treatment of Warts in Children

In the last 10 years there have been several systematic reviews undertaken investigating wart treatments and outcomes. Some have focused exclusively on plantar lesions; others have included all types of cutaneous warts. Other reviews have pooled adults and pediatric data in their analyses or have looked exclusively at pediatric data. These reviews have uncovered areas of uncertainty in many aspects of wart treatment and have renewed calls for more research to investigate suitable treatment regimens using robust methodologies.

In 2014, a published systematic review by Loo and Tang examined the effectiveness of various cutaneous wart treatments in adults and children concluding that topical salicylic acid showed benefit with cryotherapy and immunotherapy showing less convincing evidence of effectiveness. Other therapies such as bleomycin, photodynamic therapy, duct tape, surgical excisions, lasers, and candida antigen had unknown effectiveness. Similar guidelines published in the same year from the British Association of Dermatologists echoed the findings, concluding that most evidence of effectiveness for salicylic acid over cryotherapy with other therapies needing more investigation to draw conclusions. Within this paper it was also reported that plantar warts were likely to show reduced levels of responses compared to cutaneous warts elsewhere on the skin, reporting response rates to salicylic acid and cryotherapy of just over 30% for plantar lesions.

Systematic reviews of the treatment of warts in children specifically are lacking. Warts in children are known to regress more quickly than in adults, which may give different efficacy rates to adults. In addition, younger patients may be less tolerant of painful interventions limiting the available treatment options. In 2020, a review of topical treatments for cutaneous warts in children was published, reviewing 38 published papers from 1969 – 2021. Papers were only included if they held specific pediatric data but excluded case series and case reports. A wide range of interventions were included and detailed, but no systematic analysis was performed. The authors conclude with a suggested algorithm for children and adolescents suggesting plantar lesions in younger or uncooperative children should be approached with a "watch and wait" approach or salicylic acid-based preparations. Older children may be treated with a similar approach, but cryotherapy could also be employed as an alternative. Stubborn lesions failing these modalities may be considered for third-line treatments such as immunotherapies or laser treatment where less evidence of effectiveness exists.

> Observable reported features in warts include the presence of dots and globules—these can be red, brown, or black in color and probably represent dilated capillaries.

Treatment of Plantar Warts (Verrucae)

A recent systematic review by Hekmatjah et al focused exclusively on studies reporting treatments for plantar warts. The authors only included studies which had 100 or more subjects. A total of 9 studies involving 1557 patients (adults and children) met their inclusion criteria. The review found most research published around salicylic acid (in various concentrations and in some studies compounded with other agents), cryotherapy (with a small number reporting the use of carbon dioxide), and pulses dye lasers. They concluded that salicylic acid showed broadly similar outcomes to cryotherapy but was more cost-effective. In addition, there was modest evidence that lasers may demonstrate positive benefit but evidence for many other modalities was lacking (curettage, cautery, photodynamic therapy, intralesional injections and zinc therapy).

A systematic review published in 2022 by Garcia-Oreja et al reviewed randomized controlled trials involving cryotherapy of plantar warts (including patients of all ages). A total of 14 papers met the inclusion criteria and were evaluated (1084 patients, average patient age was 27 years). The review included comparisons of differing cryotherapy regimes (method of application, timings, etc.) and trials comparing cryotherapy with other treatments (40% trichloroacetic acid, duct tape, carbon dioxide laser, 10% formaldehyde, adapalene gel, radio frequency ablation, salicylic acid, Nd:YAG laser, and acyclovir). The work concluded that there was no evidence to suggest that cryotherapy was either superior or inferior.

Another study, published earlier in 2020 also by Garcia-Oreja et al, systematically reviewed topical treatments for plantar warts including patients of all ages. The review

Continued on page 41

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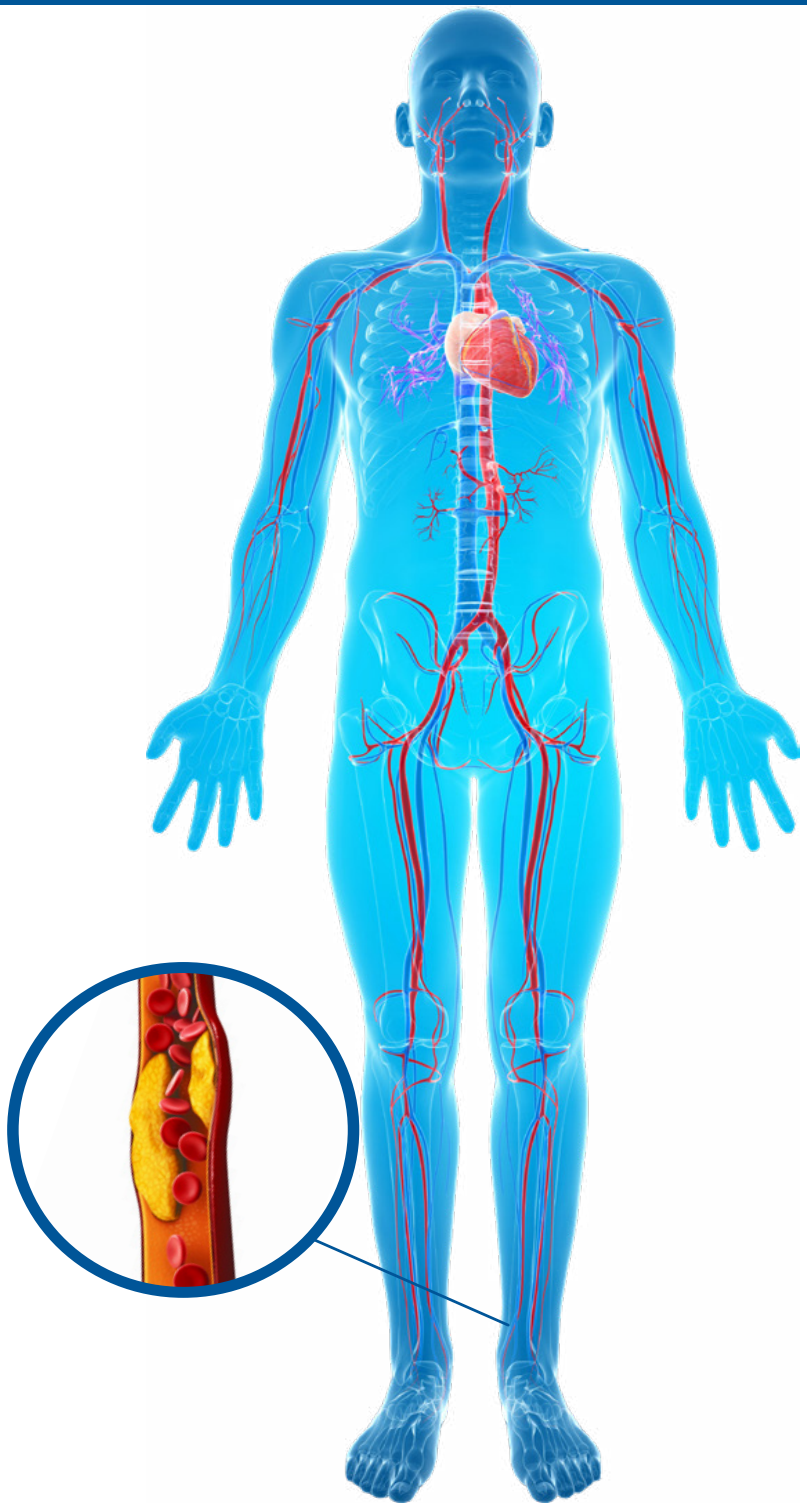

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Continued from page 39

showed that traditional first-line and second-line treatments such as salicylic acid and cryotherapy showed lower rates of effectiveness for plantar lesions concurring with the earlier review by Sterling et al. The authors suggest that an alternative approach may be required, such as immunotherapies with intralesional treatments. However, firm conclusions could not be drawn, as despite more impressive cure rates, the data was drawn from lower-level studies such as case series, prompting the call for more robust research into these treatments.

As the above reviews have highlighted, intralesional treatment for pediatric warts may have a place as a third-line treatment for more resistant lesions, particularly for the less responsive plantar warts. For natural clearance of warts, it is generally accepted that cell-mediated immunity is required. Immunity is facilitated through both innate and adaptive pathways within the skin. Intralesional immunotherapies increase host cell ability to recognize and eradicate HPV infection by facilitating cell-mediated immunity. One review qualitatively evaluated studies which included the use of Candida antigen, the Mumps-Measles-Rubella vaccine (MMR), Tuberculin (purified protein derivative [PPD]) or Bacillus Calmette-Guerin (BCG) as a an intralesional injection. A total of 20 studies were identified (which included adult data). Complete resolution rates ranged from 39%–88% for candida, 26%–92% for MMR, 23.3%–94.4% for PPD, and 33.3%–39.7% for BCG. One study did show higher clearance rates in its younger patients (MMR and PPD). Local side effects for these treatments include injection pain or burning sensation or blistering whilst use of these agents have caused edema, fever, and myalgia in some cases.

The HPV vaccine has been available for several years to protect against oncogenic strains of the HPV responsible for the majority of genital and anal cancers. Case reports have been published reporting cutaneous wart clearance following vaccination with the quadrivalent vaccine (Gardasil®) which is active against HPV strains 6, 11, 16, and 18. Following this, a study of 6 children with warts persisting for more than 2 years (which had failed other therapies) was undertaken. They received 3 intramuscular injections of the vaccine at 0, 2, and 6 months. At 8 months, all lesions had regressed. Whilst a promising result, the authors highlighted how the response was probably age related, as older children and adults who had received the same treatment latterly showed disappointing response rates. They postulated that the response was more apparent in pre-pubescent children. With the beginning of puberty, the major histocompatibility complex (MHC) class I molecule of the HPV-infected cells disappears, resulting in a decrease in the vaccine-induced HPV-specific cytotoxic T-cell immune response. This could have been a factor explaining the age-dependent therapeutic response to the vaccine.

Emerging Treatments

The HPV vaccine has been available for several years to protect against oncogenic strains of the HPV responsible for the majority of genital and anal cancers. Although previous authors have remarked on the scant progress in efficacy for wart treatments in the last few decades, with a lack of new treatments, new therapeutic approaches are being developed clinically. Research in recent decades has focused on the effects of heating tissue to around 41–44 degrees centigrade (termed the hyperthermic range) which is non-lethal to cells but has been shown to promote immune function within tissues. Previous work has established that wart persistence exists due to mechanisms induced by HPV infection that down regulate antigen processing and presentation, suppressing the normal immune response. Heating tissues to within the hyperthermic range has been shown to elicit the release of Heat Shock Proteins (HSP) from cells which have several immune-promoting effects, including maturation and migration of Langerhans cells, particularly in HPV infected skin, increasing cytokine and interferon release. Clinically, increased clearance of plantar warts has been observed in a randomized controlled trial where 54% of the hyperthermia treated group resolved, as opposed to just 12% in the placebo arm. Similarly, a study of 29 warts treated with controlled heating or placebo favored the former (86% resolution versus 41% of untreated lesions).

Clinically, the use of hyperthermia by way of a microwave device has shown benefit in the treatment of plantar warts. In the laboratory, a study of the effects of the microwave device on skin explants showed increased antigen presenting cell activity and presentation to CD8+ T cells and increased γ-interferon release. A clinical study undertaken by the author treated 54 treatment-resistant warts in 32 adults. Following 4 treatments, a clearance of 75.1% (41 warts) of lesions was noted. Further clinical research is currently underway.

Summary

Cutaneous warts affect a significant number of children with limited evidence of effective treatment in this patient group. The most recent systematic reviews report little change in the last 20 years in the evidence base, with topical treatments such as salicylic acid and cryotherapy being the most studied. These show moderate effectiveness in pediatric and adult populations. Newer treatment modalities such as injection or immunotherapies and microwave heating show promise but further robust research is required to ensure effectiveness in this population group. ler

Ivan Bristow, PhD, FFP, RCPS (Glasg) is a podiatrist, academic, and authorin the United Kingdom. He has worked for more than 30 years in the profession, specializing in podiatric dermatology. Follow his blog at foot.expert/blog.

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To hear Dr. Bristow discuss this study in further detail, visit lerEXPO.com: go to Events; click on past events and scroll down to New Frontiers in Dermatology: Warts, IPKs & Microwave Therapy, sponsored by Swift. There you'll find not only Dr. Bristow's talk, but also "Warts: Condition Profile," by Tracy Vlahovic, DPM, FFPM, FCPS (Glasg), in which she explores the condition profile for warts and what makes HPV such a challenging virus to treat effectively and with consistency. This program, including the talk by Robert Conenello, DPM, FACFAS (see page 43) is approved for 2.0 CME.

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Microwave Therapy & Plantar Verrucae

By Robert Conenello, DPM, FACFAS

We all know that several of the things we've been doing for years to treat plantar warts are just not that effective. It's frustrating for the patients and it's frustrating for us as clinicians. So we have to think outside the box.

And that's what got me interested in learning more about microwave therapy for this everyday condition that we don't have a successful treatment for…or at least we didn't.

What Is Microwave Therapy?

Microwave therapy is a type of electromagnetic energy that induces a thermal response—both in food and in humans. When you compare the therapeutic microwave we're using in the office, its energy output – 8GHz Power: 8W – is closer to a mobile phone (GSM 0.8 – 1.9GHz Power: 2W) than a kitchen microwave (2.45GHz Power: 1000W). So, if you want to explain it to a patient, you could say it's more like putting your foot next to your mobile phone than it is actually putting your foot in a microwave, which many people think we're going to be doing when we first discuss this therapy with them.

This is a rapid, in-office treatment that doesn't use a lot of bandages or other supplies. It's quick and easy to learn. Microwave therapy works by rapidly elevating tissue temperature into the hyperthermic range; it heats it up, but doesn't destroy it like ablation. Microwaving these tissues leads to a cascade of immune system responses that create the heat shock protein [for details on heat shock protein, see Pediatric Cutaneous Warts and Verrucae: An Update on page 35]. That heat shock protein increases the release of interferon. So using the microwave basically allows the natural immune system to do what it's supposed to do.

I did a small study with my own patients and found that on average, it took 2.4 treatments (typically, 1 treatment = 5 doses/2 seconds each delivered about a month apart) for the lesions to resolve. Some lesions were going away after 1 treatment, some were taking 3 or more. It didn't seem to matter if the patients were treatment naïve or had failed several other therapies previously. What we did find was a link with the age of the lesions: The longer the lesion had been around, the longer it took to get rid of it.

My study included 59 patients, with an average age of 24 years, but we included kids and even some who were close to 80 years old. Again, there was no difference in terms of getting rid of the lesions. Same with sex of the patient, it was pretty much equal across the board.

Another interesting finding was that this group overall said they started feeling better after the very first treatment—and this was an active population, a lot of runners.

Key finding from the study is that out of 59 patients, we saw 87.8% clearance rate with the microwave treatment. Compare that to 30% effectiveness of what we had been doing before.

Case Studies

Patient A was a 14-year-old male with a 3-year history of mosaic lesions on both feet. We saw him every 2/3 weeks for 1 year and tried salicylic acid (SA), cryotherapy, and imiquimod. His reported pain level was 1/10.

We did 2 microwave treatments and he reported resolution at 12 weeks.

Patient B was a 46-year-old male with a 4-week history of lesion to left second digit. He's a physical therapist in general good health and an avid runner. Previous treatments included SA and home cryotherapy. His pain level was 5/10.

We did 1 treatment with a Microwave Dose: 6 watts for 2 seconds x 5. He reported no pain 1 week after the treatment.

Continued on page 44

Continued from page 43

Patient C was an 8-year-old healthy female, level 5 gymnast. She had a 3-month history of 15 lesions (8 on the left, 7 on the right). She reported a pain level of 6/10 while on the balance beam and tumbling. Previous treatment had been Compound W.

Her microwave dose was 8 watts at 2 seconds x 5. She reported complete resolution at 8 weeks.

Robert Conenello, DPM, FACFAS, is the owner of Orangetown Podiatry in xxxx New York, where he's been a practicing podiatrist for more than 20 years. He is also a member of the Lower Extremity Review Editorial Advisory Board. He discloses that he is a compensated clinical consultant for Saorsa, Inc., maker of the Swift product discussed here.

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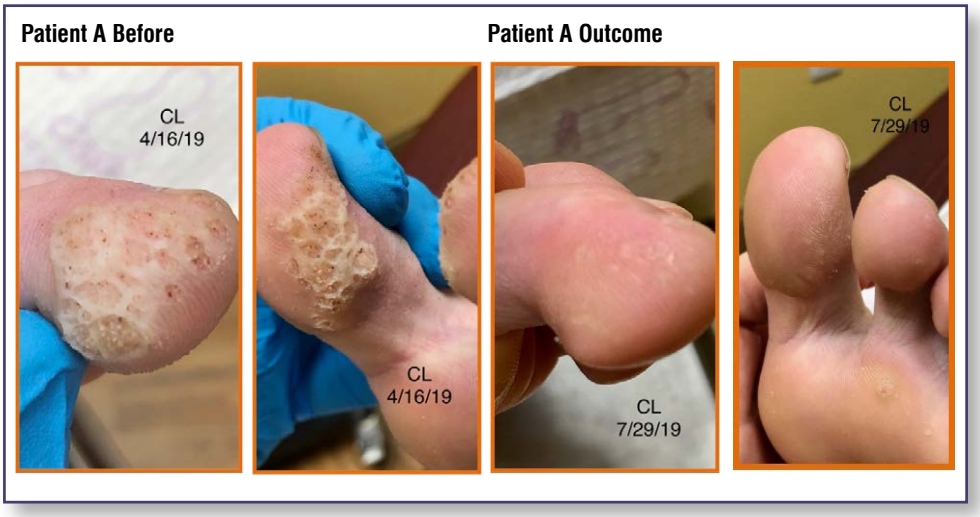
This article is excerpted from an lerEXPO.com event. To hear Dr. Conenello discuss his study in further detail and provide other case studies, visit lerEXPO.com: go to Events; click on past events and scroll down to New Frontiers in Dermatology: Warts, IPKs & Microwave Therapy, sponsored by Swift. There you'll find not only Dr. Conenello's talk, but also "Warts: Condition Profile," by Tracy Vlahovic, DPM, FFPM, FCPS (Glasg), in which she explores the condition profile for warts and what makes HPV such a challenging virus to treat effectively and with consistency. This program, including a detailed discussion by Ivan Bristow, PhD, FFPM, RCPS (Glasg), on his study using microwave therapy in pediatric cutaneous warts and verrucae, is approved for 2.0 CME.



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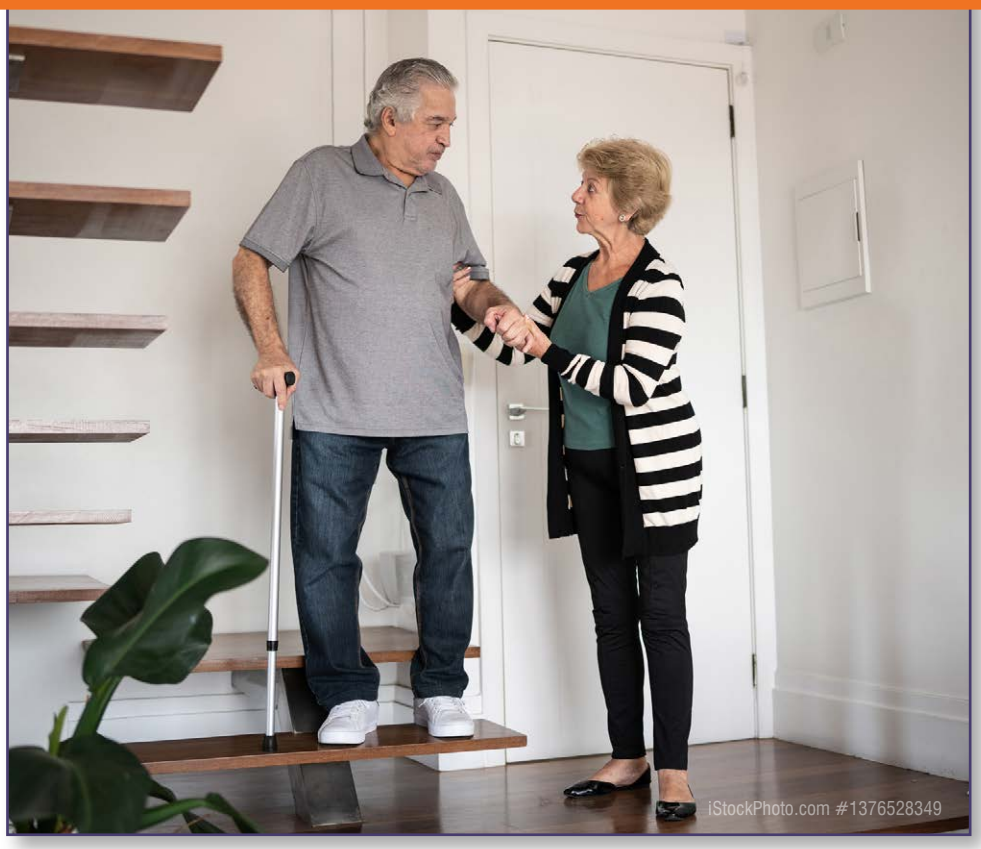
Foot and Ankle Characteristics Associated with Fear of Falling, Mobility in Older People

By Fateme Pol, Zahra Khajooei, Sayed Mohsen Hosseini, Alireza Taheri, Saeed Forghany, and Hylton B. Menz



It has been demonstrated that foot problems increase the risk of falls in older people.

Fear of falling has been described as ongoing concern about falling that ultimately limits the performance of daily activities. It is multifactorial in etiology, and common among community-dwelling older adults, with prevalence ranging from 26–55%. While fear of falling is associated with falls, the causal relationship is unclear and may be bi-directional, as the 2 outcomes share risk factors. One such risk factor is foot structure and function. The foot provides the only contact source while standing and walking, and it has been demonstrated that foot problems increase the risk of falls in older people. However, the associations between foot characteristics, fear of falling, and mobility have not been examined in detail. Therefore, building on their previous work, the study authors set out to investigate whether a comprehensive range of foot characteristics (covering the domains of foot posture, muscle strength, range of motion (ROM), tactile sensitivity, deformity, foot pain, and plantar pressure) have an association with fear of falling and mobility impairment in community-dwelling older people.

Methods

The cohort comprised 187 community-dwelling older adults (106 females) age 62–90 years (mean 70.5 ± 5.2) from Isfahan, Iran, who were recruited between April and November 2020. People were deemed ineligible for the study if they were unable to ambulate for at least 10m without an assistive device, scored < 7 for the Short Portable Mental Status Questionnaire, had diabetic foot syndrome, neurological diseases, or previously had lower extremity surgery.

Foot and ankle characteristics (foot posture, ROM, muscle strength, deformity, tactile sensation, pain, and dynamic function), fear of falling (Fall Efficacy Scale International (FES-I)) and mobility (Timed Up and Go (TUG) test) were measured. Multivariate linear regression analyses were conducted to identify variables independently associated with fear of falling and mobility.

Foot posture was assessed using foot posture index, arch index, and normalized navicular height truncated. Isometric muscle strength of the ankle (dorsiflexion, plantar flexion, inversion, and eversion) was measured with a hand-held dynamometer. Hallux and lesser toe muscle strength were quantified by having participants push down as hard as possible on a pressure plate.

Two measures of foot and ankle passive ROM, passive ankle dorsiflexion, and hallux first metatarsophalangeal (MTP) joint extension were performed via a single standard video camera. Frame-by-frame advance was used to identify the instance of the maximum ROM. Hallux valgus was documented using the Manchester scale.

This article has been excerpted from "Foot and Ankle Characteristics Associated with Fear of Falling and Mobility in Community-dwelling Older People: A Cross-sectional Study" J Foot Ankle Res 15, 86 (2022). https://doi.org/10.1186/s13047-022-00593-w. Editing has occurred, including the renumbering of tables, and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

Continued on page 49

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Continued from page 47

Table 1. Descriptive statistics for foot and ankle characteristics. Data presented as mean (SD) unless specified.

Domain	Variable (unit)	Mean (SD)	Range
Foot posture	FPI	4.20 (3.1)	-3-12
	Arch index	0.23 (0.03)	0.16–0.34
	NNHt	0.26 (0.03)	0.19–0.36
Muscle strength	Plantarflexor (kg)	10.46 (1.5)	7.77–15.85
	Dorsiflexor (kg)	8.09 (1.24)	5.33–12.92
	Invertor (kg)	5.98 (1.09)	3.67–8.94
	Evertor (kg)	5.12 (1.10)	3.35–14.95
	Hallux (%BW)	11.77 (5.98)	6-26.56
	Lesser toe (%BW)	8.66 (3.82)	2.43–22.29
Range of motion	Ankle dorsiflexion (°)	15 (7.04)	2-34.67
	First MTP extension (°)	47.55 (6.22)	29.67-66
Peripheral sensation	Ankle tactile sensation, n (%)	51 (27.3)	-
Deformity	Hallux valgus, n (%)	77 (41.2)	-
Foot pain	MFPDI	7.66 (8.8)	0–34
Plantar pressure	CPEI (%)	16.42 (6.64)	0.73–31.09
	Pressure-time integral (%BW*S/cm^2)	3.44 (1.244)	1.52–7.92
	COP velocity (cm/s)	19.71 (402)	11–29

Abbreviations: FPI Foot posture index, *NNHt* Normalized navicular height truncated, *MTP* Metatarsophalangeal, *MFPDI* Manchester Foot Pain Diasability Index, CPEI Centre of pressure excursion index, *kg* kilogram, BW Bodyweight, *BW*S/cm^2* Body weight second per square centimeter, COP Centre of pressure, *cm/s* centimeter per second

Tactile sensitivity at the ankle was assessed using a single Semmes–Weinstein-type pressure monofilament. The presence of foot pain was determined with the Manchester Foot Pain and Disability Index (MFPDI).

Foot function was assessed using barefoot plantar pressure analysis using the pressure plate and scientific software was used to calculate the pressure-time integral (PTI) in the total foot, center of pressure (COP) velocity of the total foot, and the center of pressure excursion index (CPEI), a measure of the mediolateral shift in COP throughout the gait cycle.

The Falls Efficacy Scale International (FES-I) was used to assess the level of concern of falling during 16 activities of daily living, including social activities. Mobility was assessed using the TUG test.

Results

Of the 187 participants recruited into the study, 109 (58.6%) had poor visual acuity (using a 10% low-contrast letter chart), 40 (21.5%) used psychoactive medications, and 95 (51.1%) reported taking >4 medications per day.

Tables 1 and 2 show the associations between the foot and ankle characteristics with fear of falling and mobility performance on continuous (Pearson's r) and dichotomous variables (independent sample t-tests), respectively. Independent sample t-tests revealed that participants who failed the ankle tactile sensation and vision test and use >4 medications per day scored worse on FES-I and TUG test ($p < 0.001$). FESI scores were worse in older adults who used psychoactive medications ($p = 0.06$).

Linear regression analysis revealed that less ankle plantar flexor muscle strength, greater pressure-time integral, foot pain, and reduced tactile sensitivity of the ankle were significantly and independently associated with increased fear of falling. The total variance explained by the model was 59%. Less ankle plantar flexor muscle strength, greater pressure-time integral, and slower center of pressure velocity were significantly and independently associated with poorer mobility. The total variance explained by the model was 48%. (Table 3)

Discussion

The study findings indicate that foot and ankle characteristics contribute to both fear of falling and impaired mobility in older adults. Decreasing plantar flexor muscle strength and increasing PTI, foot pain, and tactile sensitivity were

Table 2. Associations between fear of falling and mobility with foot and ankle characteristics (Pearson's r).

Domain	Variable	FESI	TUGT
Foot posture	FPI	-0.05	0.0
	Arch index	-0.11	-0.11
	NNHt	-0.03	0.06
Muscle strength	Plantarflexor	-0.49	-0.45
	Dorsiflexor	-0.45	-0.46
	Invertor	-0.45	-0.39
	Evertor	-0.29	-0.24
	Hallux	-0.13	-0.2
	Lesser toe	-0.16	-0.22
Range of motion	Ankle dorsiflexion	-0.18	-0.26
	First MTP joint extension	-0.35	-0.3
Foot pain	MFPDI	0.58	0.38
Plantar pressure	Pressure-time integral	0.34	-0.3
	COP velocity	-0.36	-0.39
	CPEI	-0.17	-0.18

Abbreviations: FESI Falls Efficacy Scale International, *TUG* Timed Up and Go Test, *FPI* Foot posture index, *NNHt* Normalized navicular height truncated, *MTP* Metatarsophalangealt, *MFPDI* Manchester Foot Pain and Disability Index, *COP* Centre of pressure, *CPEI* Centre of pressure excursion index

Continued on page 50

Continued from page 49

significantly and independently associated with increased fear of falling. Independent associations between decreased plantar flexor muscle strength and increased PTI and decreased COP velocity with impaired mobility were observed.

The study results confirm that leg muscles play an important role in balance as ankle plantar flexor muscle strength was independently and significantly associated with the FES-I and TUG test.

The association between plantar loading patterns during walking with fear of falling and mobility performance is a novel finding. The significant association between increased PTI with higher FES-I and TUG test scores is noteworthy. According to the study authors, the underlying mechanism for this is difficult to determine, but the greater duration and magnitude of plantar loading when walking may predispose to foot pain, which has been shown to impair balance and functional ability in older people. Alternatively, an increased PTI may be a reactive response to perceived instability to increase the duration of foot contact with the ground.

Foot pain was found to be independently associated with fear of falling. Clinicians working with older adults should therefore consider foot pain as an individual risk factor for fear of falling.

Older adults who failed the tactile sensitivity test scored worse in FES-I, and the results of the linear regression model showed that it has a strong association with the FES-I score. The integration of visual, vestibular, and somatosensory information is necessary to generate appropriate balance responses. Individuals rely primarily on proprioceptive and cutaneous input to maintain standing balance, and several studies have shown that age-related peripheral sensory loss is associated with increased postural sway and is an independent predictor of falls. The perceived loss of balance due to impaired tactile sensitivity may therefore induce fear of falling in older people.

The COP on the plantar surface of the foot reflects the progression of the whole-body center of mass during gait, therefore the forward velocity of the COP may potentially affect walking speed and sit to stand, the 2 components of the

Table 3. Linear regression analysis showing an association between fear of falling and mobility (dependent variables) and foot and ankle characteristics (independent variables).

	Fear of falling (FESI)			
R^2	0.59			
Independent variable	β	SE	Beta	*p*-value
PTI	1.08	0.43	0.13	0.01
Plantarflexor muscle strength	-1.31	0.36	-0.2	<0.001
MFPDI	0.45	0.06	0.39	<0.001
Tactile sensitivity test	4.60	1.20	0.2	<0.001
Medications (four or more excluding vitamins)	4.9	1.15	0.24	<0.001
	Mobility (TUGT)			
R^2	0.48			
PTI	0.38	0.19	0.14	0.04
Plantarflexor muscle strength	-0.35	0.14	-0.17	0.01
COP velocity total foot	-0.002	0.001	-0.26	<0.001
Vision	1.15	0.38	0.17	0.003
Medications (four or more excluding vitamins)	0.88	0.44	0.13	0.04
FESI	0.11	0.02	0.36	<0.001

Abbreviations: β unstandardized coefficient, *Beta* standardized coefficient, MFPDI Manchester Foot Pain and Disability Index, *PTI* Pressure-time integral, *COP* Centre of pressure, *FESI* Falls Efficacy Scale International

TUG test. The negative association observed between COP velocity and higher TUG test scores (indicative of poorer mobility) suggest that both walking speed and sit to stand, to some extent, require the same strategies in which the goal is to regulate speed and to remain upright during the transfer of bodyweight.

Conclusion

Foot and ankle characteristics, particularly plantar flexor weakness and higher plantar pressures when walking, are associated with fear of falling and mobility impairment in community-dwelling older people. Given that these characteristics are modifiable, clinical interventions such as foot strengthening programs, footwear, and foot orthoses may play a role in reducing fear of falling and optimizing mobility impairment in this age group when combined with other targeted interventions such as medication review, home hazard modification, and balance exercises. ler

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BOOK EXCERPT

Sources of Pain

By Richard Blake, DPM

The 3 aspects of pain – mechanical, inflammatory, and neuropathic – should be considered, tracked and discussed at every visit for patients on a rehabilitation pathway.

In this book on mechanical treatments for various injuries and pain syndromes, a discussion into the 3 sources of pain is as crucial as an understanding of the 3 phases of rehabilitation and what phase your patient presents with at each visit. Treating the patient out of phase can be dangerous as in only treating mechanical pain when there is so much nerve and inflammatory pain present.

In medicine, we constantly deal with the 3 sources of pain: mechanical, inflammatory, and neuropathic. Many injuries can have components of all 3 aspects of pain. Treatment of an injury may need strictly mechanical treatment (like a varus wedge, Aircast Airlift PTTD Brace, strengthening for chronic posterior tibial symptoms), or strictly anti-inflammatory measures for arch strain after an episode of overuse (like 5 minutes ice roll of the arch with a frozen sports bottle), or strictly nerve treatment for a flare-up of Morton's neuroma (like topical Neuro-Eze or Neuro-One creams, warm water soaks, pain free massage or neural flossing 3 times a day). However, the treatment of many problems tends to involve more than 1 source of pain, and the recognition of this problem can vary from visit to visit, as the nerves get more or less hypersensitive, or the inflammation gets in and out of control.

An injury can start as a simple mechanical issue (like excessive supination weakening the peroneal tendons and allowing them to strain), or an inflammatory issue (like stubbing a big toe which already had some arthritis), or a nerve issue (like overstretching the sciatica nerve during stretching the gastrocnemius, especially if they have some genu recurvatum), yet 1 issue can lead to the other 2 sources of pain developing with inflammation typically first, and nerve hypersensitivity developing later as a general rule with plenty of exceptions. Even in the treatment of inflammatory arthritis (inflammatory) or complex regional pain syndrome (neuropathic), mechanical treatments to immobilize, rest trigger points, etc., can be vital.

An example to illustrate this point would be a sesamoid fracture. Imagine an athlete running barefoot on the beach striking the tibial sesamoid on a rock hidden under the sand. The injury is acute, inflammation sets in, and the body starts to compensate by walking on the outside of the foot. After several weeks, with no reduction in pain, the nervous system takes over and the area becomes hypersensitive, and the lateral side of the foot becomes painful. When you see the patient for a visit, you would assume that a mechanical off-weighting of the sesamoid should alleviate all the symptoms. But, this is not true when the inflammation or nerve hypersensitivity takes over protecting the area. There are so many scenarios where the patient needs treatment for all 3 sources of pain: mechanical protection of the bone, anti-inflammatory measures, and a decrease in nerve hypersensitivity. This can involve a simple or complex treatment plan based on how the patient responds. Each office visit should involve some thought into each of these 3 sources of pain. Some nerve pain responds to anti-inflammatory treatment, or mechanical treatment, but not always. Some inflammatory pain responds to mechanical changes, but not always.

Morton's neuroma is a common problem that has a variety of treatments in these 3 areas that must be individualized to the patient. It is a nerve problem, of course, but can respond to mechanical and anti-inflammatory treatment alone. Thus, metatarsal padding or custom orthotic devices to off-weight the sore area and spread out the metatarsals, and 1 or 2 cortisone

Continued on page 55

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Continued from page 53

shots, can do the trick. But, when this does not help, think about nerve treatment. Perhaps this nerve treatment may involve alcohol shots, neural flossing of the sciatic nerve, topical nerve medications like Neuro-One or Neuro-Eze (OTC) or prescription compounded medications, oral nerve medications like Lyrica, low back treatments if the source (or another nerve irritation) is above the foot, etc. If you constantly think about these 3 sources of pain, then you will be able to change treatments when one direction is not as helpful as you like in getting the overall pain between 0-2 consistently.

Practical Biomechanics Question #23: Even though this book is on mechanical treatments of injuries and mechanical causes of injuries, what other 2 areas of treatment do you have to consider?

Practical Biomechanics Question #24: Using the 3 sources of pain, explain how this works when treating a sore heel? ler

Richard Blake, DPM, MS, is adjunct faculty at the California School of Podiatric Medicine. He has practiced podiatry at the Sports and Orthopedic Institute of St. Francis Memorial Hospital in San Francisco, CA. His book, Practical Biomechanics for the Podiatrist, Book 1, *is available from Amazon.com and Barnesandnoble.com, as well as from the publisher at bookbaby.com.*

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PEDIATRIC ACL IMPLANT

Arthrex's ACL TightRope implant is a U.S. Food and Drug Administration (FDA)–cleared device for pediatric indications. It is used in the surgical treatment of orthopedic injuries. The company developed all-epiphyseal and transphyseal techniques and instrumentation for ACL surgery alongside top orthopedic surgeons Frank A. Cordasco, MD, MS, and Daniel W. Green, MD, MS, FAAP, FACS. The Arthrex all-epiphyseal technique was developed for skeletally immature patients and involves avoiding the pediatric growth plates to repair or reconstruct the ACL. With the pediatric-specific instrumentation guides, surgeons drill sockets for the new, reconstructed ACL by avoiding the growth plate to diminish the potential for growth disturbance. The Arthrex ACL TightRope portfolio of fixation devices includes the ACL TightRope II implant, the TightRope attachable button system (ABS) and implant, the FiberTag® TightRope implant, and the ACL Repair TightRope implant with FiberRing™ sutures.

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SOCK LINE FEATURES PROPRIETARY MATRIX FOR SUPPORT

Hurdle Apparel recently launched a tech-infused, athleisure sock line that features precision engineering and patented MicroGravity Matrix—a soft, multi-dimensional support network that offloads weight away from vulnerable areas of the foot and provides support and cushioning for all active lifestyles. This antimicrobial-infused sock line boasts over 2,000 micro air channels for ultimate breathability, keeps feet fresher for longer, and has enhanced blister protection from the ultra-thin Micro-Ply² knitting technology. These anatomically designed socks will be available for men and women and are offered in 3 styles (ankle, crew, and quarter crew) and various colors. Fiber contents: 47% nylon, 36% polyester, 17% combed cotton, and 5% spandex.

Hurdle Apparel
hurdleapparel.com

HANGER ANNOUNCES CEO TRANSITION PLAN

Hanger, Inc. announced that Chairman and Chief Executive Officer (CEO) Vinit Asar will retire from the role of CEO effective May 1, 2023, after more than a decade in the position. In line with a multi-year succession plan, Hanger's Chief Operating Officer (COO) Pete Stoy has been named president and COO, and will assume the role of CEO upon Asar's retirement, in addition to serving on Hanger's board of directors. At that time, Asar's role will transition to Executive Chairman of Hanger's board, where he will assist with strategic initiatives, including mergers and acquisitions, and provide support for Stoy and the Board as needed.

Asar joined Hanger as executive vice president and chief growth officer in December 2008, and served as Hanger's president and COO from September 2011–May 2012 before taking the reigns as CEO. During his tenure, he was instrumental in stabilizing the company's infrastructure to create an environment with a strong foundation to prepare Hanger to grow from a $700M company to a $1.4B company. He also was instrumental in establishing the Hanger Institute for Clinical Research and Education to focus on advancing clinical practice and improving outcomes for those who need life-enhancing O&P care.

Stoy has over 20 years of healthcare experience with leadership in large, complex organizations, and holds a designation as a Fellow of the American College of Healthcare Executives (FACHE). Prior to joining Hanger as COO in November 2020, he served as East Region president for the healthcare business of Sodexo.

TARGETED REVIEW TOOL FOR PODIATRISTS

Online marketer Podiatry Content Connection announces a Targeted Review Tool® to assist podiatrists in growing their practices by quickly reaching patients by text to ask for feedback. Using this new app, podiatrists can text patients they've just seen to ask them to leave a review while the visit is still fresh in their minds. The text would include a link to a review site. When a patient visit has gone well, doctors trigger the app to send a text to that patient. Patients can respond immediately, anywhere, and without opening up a computer.

The cell phone text leads to a doctor-chosen review site where they can leave a review. This makes it easier for patients to leave feedback, which benefits doctors by increasing their number of online reviews.

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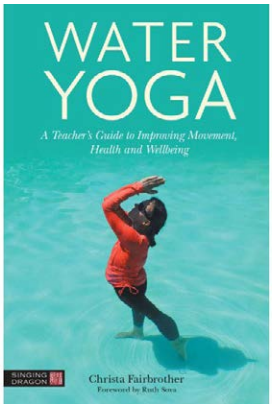
THAILAND UNIVERSITY DEVELOPS DYNAMIC PROSTHETIC FEET

A research team from the Faculty of Engineering, Chulalongkorn University, Thailand, has developed high-quality dynamic prosthetic feet, with input from a network of doctors, prosthetists, and orthotists who shared their expertise and interdisciplinary knowledge. The prosthetic feet are made from carbon fiber, making them light weight but strong and durable. They are also flexible and bendable and can store energy with each step. Users can walk in them on rough terrains, while exercising, and during a light jog. The innovation has received the International Organization for Standardization (ISO) 10328 strength standards from Germany and has been certified with the ISO 13485 for quality. It has also been registered as a medical device with the U.S. Food and Drug Administration (FDA), been granted a petty patent, and registered in Thai SME-GP. The prosthetic feet are currently in the process of being registered with Thai Innovation, requesting the Made in Thailand certificate, and requesting for the CE Marking.

According to Asst. Prof. Pairat Tangpornprasert, PhD, from the Mechanical Engineering Department, Faculty of Engineering, Chulalongkorn University, the dynamic prosthetic feet have undergone clinical trials with 20 patients with disabilities and yielded highly satisfactory results. The users require approximately 2 weeks to adjust to the prosthetic feet. In comparison with the imported prosthetic feet now available on the market, the innovation has comparable qualities and efficiency but costs 5 times less to produce. This can then help reduce the high cost of prosthetic and orthotic imports to the country. Moreover, commercial production of medical devices can expand the market overseas, leading to more generation of income, export opportunities, and the country's competitiveness.

BOOK EXPLORES VALUE OF AQUA YOGA

Water Yoga: A Teacher's Guide to Improving Movement, Health, and Wellbeing shows aquatic physical therapists (PTs) and occupational therapists (OTs) how aqua yoga can contribute to their work and provides another tool in their professional toolbox. By using the tools of yoga, while staying within the parameters of billing codes, aqua PTs and OTs can help people build better interoceptive and proprioceptive body awareness to heal faster and prevent another injury. Aqua yoga also



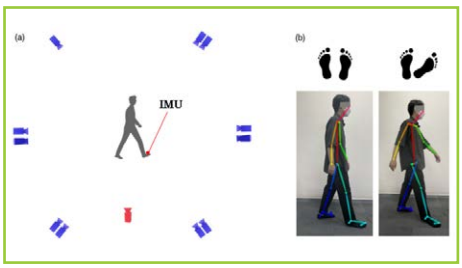
provides a framework to have conversations with people who are frequent clients due to overexercising. For example, yoga philosophy helps people learn discernment around their choices, such as a person with plantar fasciitis who won't cut back on their running. Water Yoga is especially suitable for those with conditions such as arthritis, osteoporosis, multiple sclerosis, joint replacements, and for those who are pregnant. christafairbrother.com/water-yoga-a-teachers-guide

RESEARCHERS WORK TO IMPROVE ACCURACY OF MARKERLESS GAIT ANALYSIS

A team of researchers from the Faculty of Science and Technology, Tokyo University of Science (TUS), and from the Prefectural University of Hiroshima, Japan, have developed a simple and accurate sensor-fusion method for accurate gait analysis. They combined information from a small inertial measurement unit (IMU) sensor attached to the shoe with estimated information on the bones and joints of the lower limb, obtained by capturing the gait from a single RGB (red, green, blue) camera.

To test this innovation, the team used single RGB camera-based pose estimation by OpenPose (OP) and an IMU sensor on the foot to measure ankle joint kinematics under various gait conditions for 16 healthy adult men between 21 and 23 years of age who did

not have any limitation of physical activity. The participants' gait parameters and lower limb joint angles during 4 gait conditions with varying gait speed and foot progression angles were noted using only OP as well combined measurements from OP and the IMUs. The latter was the team's novel proposed method. Results from these techniques were compared to gait analysis using 3DMC, the current gold standard.



TUS researchers developed a method that enables accurate gait analysis by combining information from a small IMU attached to the shoe with estimated information on the bones and joints of the lower limbs, obtained by capturing the gait from a single RGB camera. Image courtesy of Yamamoto and TUS.

The proposed combination method could measure gait parameters and lower limb joint angles in the sagittal plane. Moreover, the mean absolute errors of peak ankle joint angles calculated by the combination method were significantly less compared to OP alone in all the 4 gait conditions. This is a significant development in gait analysis, the team said.

"Our method has the potential to be used not in medicine and welfare, but also to predict the decline of gait function in healthcare, for training and skill evaluation in gyms and sports facilities, and accurate projection of human movements onto an avatar by integrating with virtual reality systems," said TUS Assistant Professor and research team member Masataka Yamamoto, PhD.

AI ULTRASOUND APP FOR MUSCULOSKELETAL IMAGING

The U.S. Food and Drug Administration–cleared MSK AI ultrasound application for

musculoskeletal imaging automatically identifies, highlights, and measures tendon structures in the foot, ankle, and knee, accelerating ultrasound mastery for new users and hastening diagnosis and treatment of musculoskeletal injuries. It is designed to streamline workflows, inform clinical management, and provide training assistance during musculoskeletal scanning for specific anatomical sites, which include: the plantar fascia (foot), Achilles tendon (ankle), and patellar tendon (knee). The AI analyzes ultrasound imaging in real time and displays a transparent color overlay to identify the tendon in view. Upon pausing the image, the AI labels the tendon and determines the greatest thickness, automatically placing measurement calipers that correspond to the top and bottom of the tendon at its thickest region. The user may alter the measurement calipers to make any necessary adjustments to support clinical decision making.

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ORTHOPEDIC PRODUCTS WITH CELLIANT INFRARED TECHNOLOGY

Medline, together with materials science innovator Hologenix®, launched a new line of CURAD® Performance Series® orthopedic products powered by CELLIANT® infrared technology, a proprietary blend of natural minerals that allows textiles to convert body heat into infrared energy, returning it to the body and temporarily increasing local blood flow and cellular oxygenation. This has been clinically demonstrated to support recovery from physical activity and fatigue, increase endurance

and stamina, and boost overall performance in healthy individuals, among other benefits. The following are among the new products: Infrared Ankle Supports and Infrared Knee Supports, Elastic, in large/x-large and small/medium sizes; Infrared Knee Supports, Hot/Cold; and Infrared Multipurpose Supports, Hot/Cold. Medline has engineered the elastic supports to provide targeted compression, with a contoured fit and silicone grips that keep the product in place. The removable hot/cold therapy supports provide adjustable compression and a gel compress.

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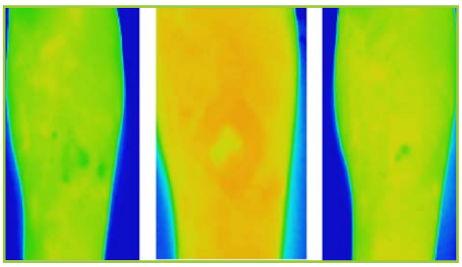
CONTACTLESS SCREENING TOOL FOR CHRONIC WOUND TREATMENT

A thermal-imaging tool to screen for chronic wounds, such as venous leg ulcers (VLUs), could enable nurses to identify these hard-to-heal sores during the first assessment at a person's home. This new method by researchers at Royal Melbourne Institute of Technology (RMIT), Australia, and Bolton Clarke Research Institute (Bolton Clarke) is an artificial intelligence–powered system to predict how leg ulcers will heal based on thermal images from the first assessment.

Their method provides information on spatial heat distribution in a wound and predicts, with 78% accuracy, whether VLUs would heal in 12 weeks without specialized treatment. It is not sensitive to changes in ambient tem-

perature and light, so it is effective for in-home visits to people's homes and even in tropical environments.



Thermal images of a venous leg ulcer showing healthy healing progress over 3 weeks. Image courtesy of RMIT University.

"This means specialized treatment for slow-healing leg ulcers can begin up to 4 weeks earlier than the current gold standard," said Dinesh Kumar, PhD, from RMIT's School of Engineering. The current gold-standard approach requires taking tracings of the wound size after 4 weeks, involving physical contact with the wound, which delays identification of slow-healing wounds. Additionally, the non-contact method reduces infection by minimizing physical contact.

The team will also assess whether their method can predict healing of diabetes-related foot ulcers.

IMPLANTABLE SHOCK ABSORBER RELIEVES KNEE PAIN, DELAYS KNEE REPLACEMENT

The results of a recent clinical trial showed that an implantable device can not only make daily activities more comfortable, but delay the need for a knee replacement. The device involves a piston that anchors to the inner side of the femur and tibia bones with a small plate. Trial data showed significant reduction in pain scores and improvement in function scores for more than 90% of the 81 trial participants. The shock absorber had a success rate of 86% compared to the most common procedure, high tibial osteotomy, which has a success rate of 66% and is typically used to treat symptomatic osteoarthritis of the medial compartment of the knee.

"There really hasn't been much to offer for knee arthritis between the more basic options like medications, therapy, and injections all the way to joint replacement," said David Flanigan, MD, professor of orthopedics and director of the Cartilage Restoration Program at The Ohio State University Wexner Medical Center. "This shock absorber could be an in between step patients need. When you're walking, doing activities, it's going to take away about 30% of that shock or stress on the knee every time you put weight on your leg."

The 2-year collective clinical trial data has been submitted to the U.S. Food and Drug Administration and is under regulatory review.

COMPRESSION KNEE SLEEVE

Through patented technology, Copper Fit Ice infuses micro-encapsulated menthol into the knee fabric of its Ice Compression Knee Sleeve, which is then released by the wearer's movements. The strong, circular-knit compression sleeve is designed to help temporarily relieve muscle and joint aches and pains. It boasts 4-way stretch for 360-degree flexibility, and the circular knit is seamless, so it's anti-chaffing and provides superior comfort. The knee sleeve offers strong compression for maximum support, without slipping off or stretching out over time. The sleeve is infused with copper to reduce odor, and the fabric is breathable and moisture wicking.

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SUPPLEMENTS TO HELP REMODELLING & RECOVERY FROM MUSCLE DAMAGE

Reference: Bongiovanni et al. EJAP 2020

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1.8–3.0 g taken daily. Doses could be modified based on the study and quantification of omega-3 ingested with foods

CREATINE

20 g/day for 5 days followed by 5 g/day thereafter or 0.3–0.4 g/kg of body weight daily, for a period of 10 weeks

TART CHERRIES

60 mL/day of tart cherries concentrate or 500 mL/day of tart cherries juice. Can also been taken in the form of jellies, candies, or other recovery snacks

BEETROOT JUICE

125–500 mL taken daily (can be used to prepare puddings with dark chocolate or cocoa or to prepare other snacks)

POMEGRANATE JUICE

500–1250 mL/day of juice or 60–120 mL/ day of concentrate

Source: Bongiovanni T, Genovesi F, Nemmer M, Carling C, Alberti G, Howatson G. Nutritional interventions for reducing the signs and symptoms of exercise-induced muscle damage and accelerate recovery in athletes: current knowledge, practical application and future perspectives. Eur J Appl Physiol. 2020 Sep;120(9):1965-1996. doi: 10.1007/s00421-020-04432-3.

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