Collaborative Care for Better Outcomes

15 YEAR ANNIVERSARY

LOWER EXTREMITY REVIEW

September 24 / volume 16 / number 9

Shopping Cart-Related Lower Extremity Injuries

NOW OPEN

lerMARKETPLACE

A New Kind of Exhibit Hall

Available 24/7/365

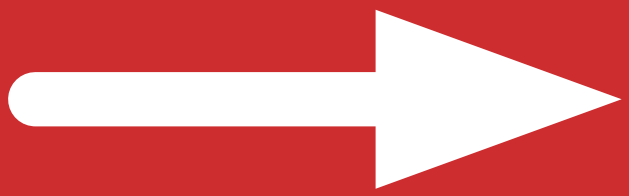
lerMARKETPLACE.com is THE place to learn about the products you need now from the names you trust.

*48HR

ORTHOTIC LAB TURNAROUND

FIRE YOUR LAB — HIRE US

WE'RE NOT KIDDING



TRY US

*Our company average turnaround time.

HERE'S WHAT YOU ARE GOING TO LOVE:

- ✓ 48 Hour Turnaround Time
- ✓ Outstanding Clinical Service
- ✓ High Quality, Custom Orthotics
- ✓ Dedicated & Experienced Territory Managers
- ✓ 45-Day Money Back Guarantee

START TODAY
Call 833-496-2340

Footmaxx®

Fall in Love With Your Orthotic Lab

Unrivaled custom orthotics are just the beginning at Orthotica Labs

MAY WE TELL YOU MORE?

888.895.1305
orthotica.com/learn-more

ORTHOTICA Labs

LOWER EXTREMITY REVIEW

ler

VOLUME 16 NUMBER 9 LERMAGAZINE.COM

September 2024

contents

GUEST PERSPECTIVE

SHORTTAKES FROM THE LITERATURE

COVER STORY

AD INDEX

NEW & NOTEWORTHY

THE LAST WORD

Designed by @YLMSportScience

FEATURE ARTICLES

DIGITSOLE PRO

UNLOCK YOUR PATIENTS BIOMECHANICS SECRETS!

Powered by our **EXCLUSIVE AI ALGORITHM,** Digitsole Pro is your in clinic digital partner to objectively measure biomechanical data not observed by the naked eye.

- Run and walk analysis
- Remotely monitor mobility with our Digitsole smart insole
- Discover rich biomechanical data to guide clinical discussions for Plantar Fasciitis, Hallux Valgus, Achilles injuries, and more.

RUN
All terrain including treadmills

WALK
For use in any environment

COMING SOON - **REHAB Analysis**

SMART MOTION, EMPOWERING YOU

SCAN HERE TO REGISTER FOR OUR WEBINARS

ASK ABOUT OUR EARLY ADOPTER PROMOTION!

TO LEARN MORE AND ACCESS A FREE DEMO GO TO **DigitsolePro.com**
Contact us at: USASALES@DIGITSOLE.COM

LOWER EXTREMITY REVIEW

ler

Richard Dubin
Publisher and Chief Executive Officer
rich@lermagazine.com | 518.221.4042

STAFF

Editor
Janice T. Radak | janice@lermagazine.com

Associate Editor
Laura Fonda Hochnadel | laura@lermagazine.com

Marketing Manager
Glenn Castle | glenn@lermagazine.com

Graphic Design/Production and Website Development
Anthony Palmeri | PopStart Web Dev
webmaster@lermagazine.com

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.

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

LOWER EXTREMITY REVIEW
41 State St. • Suite 604-16 • Albany, NY 12207
518.452.6898

Lower Extremity Review Mission

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

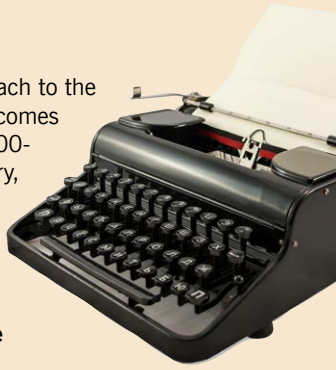
EDITORIAL PILLARS

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

EDITORIAL ADVISORY BOARD

INFORMATION FOR AUTHORS

LER encourages a collaborative multidisciplinary clinical approach to the care of the lower extremity with an emphasis on functional outcomes using evidence-based medicine. We welcome manuscripts (1000-2000 words) that cross the clinical spectrum, including podiatry, orthopedics and sports medicine, physical medicine and rehabilitation, biomechanics, obesity, wound management, physical and occupational therapy, athletic training, orthotics and prosthetics, and pedorthics.



See detailed Author Guidelines at lermagazine.com – click the Editorial tab on the homepage.

ELECTRONIC SUBMISSIONS

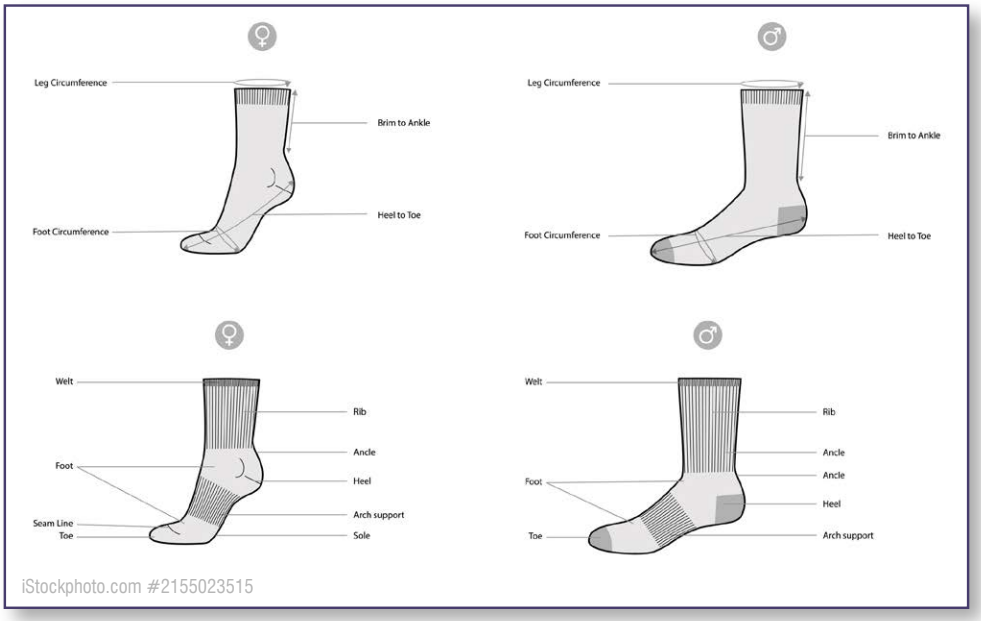
Please attach manuscript as an MS Word file or plain text. Tables may be included in the main document, but figures should be submitted as separate jpg attachments. Send to: **janice@lermagazine.com**

Guest **Perspective**

Socks Matter!

By Robert Weil, DPM

A better understanding of pedal biomechanics combines with textile science and evolving manufacturing techniques to take this humble piece of clothing to the next level.



I've been doing my radio show, The Sports Doctor, for 40 years now and we've covered a lot of topics in that time. Ankle sprains, parenting young athletes, cleat placement, new shoe designs, bunions, all the usual stuff…but there's something new in the air. Lately we've been discussing, believe it or not, socks! Socks are essential to sports as well as everyday activities, especially for those who spend all day on their feet. They provide comfort, support, and protection for feet during physical activities, and also play a role in expressing personal style and fashion preferences. I remember growing up the blandness of getting socks as a present – how boring! Now colors and designs can make socks great fun! I Love my Cheech & Chong socks!

But seriously, today, this humble piece of clothing is suddenly all the rage in both fashion and athletics with wild colors, different styles and heights, varying degrees of compression measures, different fiber sources, odor-blocking abilities, even sunscreen and copper. Heck, a single sock even played a critical role in the Harry Potter series, freeing the enslaved house elf Dobby from the evil Malfoys. Socks are definitely no longer boring!

It's a little funny, given all that we have today, but I can remember a time in the sports world where there was a lack of real attention to our socks. Shoes we paid attention to, but socks? Not so much. But the truth is, the right pair of socks can make a significant difference in your overall comfort and performance, whether you're hitting the field, going about your day, or spending significant time on your feet. And entrepreneurs have picked up the challenge using cutting edge technologies.

There is a wide range of innovation in sockware and these 2 manufacturers show some of that breadth:

Hurdle Apparel, founded in 2020, took on the task of right vs left. That's right, their matrix technology designs socks that conform to the direction of the foot, so they have a right sock, to be used on the right foot, and a left sock, to be used on the left…and no, you really shouldn't swap them. Each sock follows the form of the foot its intended for, allowing for better arch support placement and cushioning as required for the ball of the foot. Co-founder Tosha Hays drew inspiration from her background in fabric technology at Massachusetts Institute of Technology. Hurdle Apparel owns its own manufacturing technology, and the items are designed collaboratively by high-tech engineers, footwear designers, and athletes.

OS1st (short for Our Socks, Sleeves, Service First) has focused on compression bracing bringing together 3 generations in one family business. They started by addressing the compression needs of those suffering from plantar fasciitis and bunions, and grew to expand their offering for serious runners, then tackled diabetic and comfort foot care with nano-bamboo charcoal, seamless, non-binding, cushioned socks for sensitive feet, and their offerings have grown to address additional lower extremity compression. And their Pickleball Sock, which is designed to protect against impact and prevent blisters, is the official sock of Major League Pickleball! (See what I wrote about this fast-paced sport in "Pickleball's Fast Growth and Game Pace Present Clinical Challenge" in the April 2024 issue of *Lower Extremity Review*.)

Today's sock manufacturers – and there are many – are paying attention to arch support in socks not just for sports/athletics, but also for everyday use. Multiple manufacturers are using multi-grade fabric technology to deliver socks that will fit in athletic shoes as well

Continued on page 13

BAUERFEIND®

GenuTrain® OA
TARGETED RELIEF AND COMPLIANCE DELIVERED

GenuTrain® OA

- **INNOVATIVE UNLOADING SYSTEM**
  PROVIDES TARGETED PAIN RELIEF
- **EASY ADJUSTABLE RELIEF**
  WITH BOA® FIT-SYSTEM
- **ALL-DAY WEARING COMFORT**
  LIGHTWEIGHT, LOW-PROFILE DESIGN

For more information
Please contact info@bauerfeindusa.com
or call (800) 423-3405

BAUERFEIND.COM

"Excellent as always! As prescribed, as designed, as promised. A real time saver for my clinical hours. "

– Joshua U., CPO

Discover the DAFO® Experience

We offer a wide variety of bracing solutions with dynamic, flexible support for your patients' unique needs.

Fast Fit® Chipmunk®

JumpStart® Leap Frog®

DAFO 3.5

DAFO 2

DAFO FlexiSport

DAFO Turbo

cascadedafo.com

Helping kids lead healthier, happier lives®

CASCADE dafo

1360 Sunset Avenue, Ferndale, WA 98248 | ph: 800.848.7332 | fax: 855.543.0092 | intl: +1 360 543 9306

Continued from page 10

as dress shoes and still provide much needed support, motion & friction control, and shock absorption. As with everyday socks, attention needs to be paid to moisture, odor control, and limited bulk. High-tech fabric technology combines all these key components in thinner materials and creates socks in a variety of lengths and widths: no-shows, ankle, quarter crew, crew, calf-height, knee high, wide calf, no elastic bands...the list seems almost endless.

The best socks for running and sports are specifically designed to provide comfort, support, friction reduction, and moisture wicking properties.

- Look for socks with cushioning & shock absorbing technology in ball of foot and heel.
- Look for seamless toe closures to prevent chafing & blisters, and moisture wicking technology to keep feet dry. Often synthetic materials play a part with wetness control.
- Socks with variable compression levels can enhance arch support, stimulate circulation, and reduce muscle fatigue.
- Always choose socks that fit well, complement your sports or work shoes to prevent blisters and ensure optimal performance. Change them at least daily.
- Look for socks with more options in fit than small, medium and large—you'll get a better fit.

In today's reality, socks are a form of personal protective equipment (PPE) as they are essential to sports as well as everyday activities, particularly for those who spend all day on their feet or those with chronic conditions such as diabetes. Socks provide support for arches, ankles, and blood flow; comfort from the friction of chafing inside even the best-fitting shoe; and protection from the elements—both inside and outside the shoe.

Any way you look at it, socks matter! ler

Robert A. Weil is a sports podiatrist in private practice in Lisle, Illinois. He hosts "The Sports Doctor," a live weekly radio show on bbsradio.com, or you can visit his website, thesportsdoctorradio.com. His book, #HeySportsParents written with Sharkie Zartman, is available on Amazon.com. Dr. Weil was inducted into the prestigious National Fitness Hall of Fame in April 2019. Find him at thesportsdoctorradio.com.

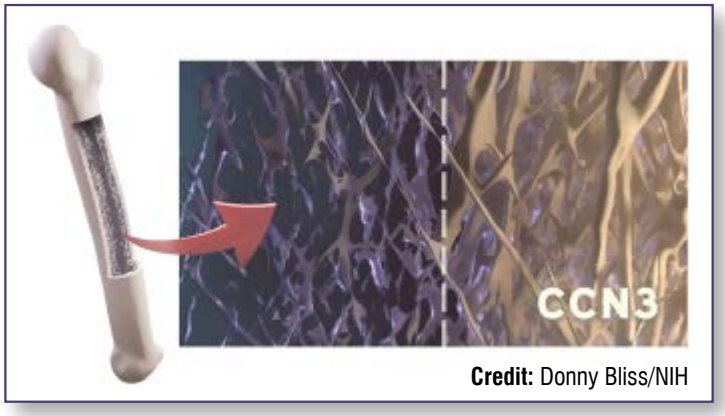
LER WANTS YOUR OPINION!

To celebrate our 15th anniversary year, our November issue will focus on innovation.

We want to know what YOU think has been the top innovation over the last 15 years...smartphones, a new blood test, a new technique? We want your thoughts in 250 words or less.

Send an email explaining what you think was the top innovation and WHY to ***Janice@lermagazine.com*** *Put* ***INNOVATION*** *in the subject line.*

MATERNAL BRAIN HORMONE STRENGTHENS BONES, COULD TREAT OSTEOPOROSIS, BONE FRACTURES



Credit: Donny Bliss/NIH

More than 200 million people around the world have osteoporosis, and women are at especially high risk after menopause due to declining levels of the hormone estrogen, which helps keep bones strong. While osteoporosis rarely has noticeable symptoms, it can lead to serious injuries when otherwise minor falls cause broken bones that lead to further fracture risk and fracture-related mortality. Now, a new research from the National Institutes of Health's National Institute on Aging suggests a surprising candidate for strengthening bones: a maternal hormone produced in the brain.

The study in mice reported in the journal *Nature* shows that this newly discovered hormone maintains and rebuilds bone strength in lactating females, even as estrogen levels dip and calcium is lost to the demands of milk production. The findings suggest this hormone — or a drug that acts similarly — could be key to treating osteoporosis and preventing and healing broken bones.

The findings[1] come from a team led by Holly Ingraham, PhD, University of California, San Francisco. The researchers knew from studies in mice and humans that a protein related to the parathyroid hormone, which is made in the mammary glands, is the main driver for stripping calcium from maternal bones for milk production. As a result of this process, nursing mothers tend to lose a lot of bone. In humans, this bone loss is 10% on average, compared to nearly 30% in mice. Fortunately, these losses are reversed after lactation ends, suggesting to the researchers there must be some other bone-strengthening factor in play.

Previous NIH-supported work[2] in Ingraham's lab offered other clues. That research team found that in female mice, blocking a certain estrogen receptor in select neurons in a small area of the brain led to the development of bones that were exceptionally dense and strong. This was an early hint that an unidentified hormone might have a role. The team's search in this most recent study led them to brain-derived communication network factor 3 (CCN3).

The new findings showed that, in lactating female mice, CCN3 is produced in the same brain area identified in the previous study. When the researchers prevented the brain from making CCN3, lactating female mice rapidly lost bone. The researchers also found that male and female young adult and older mice gained a considerable amount of bone mass and strength when their levels of circulating CCN3 were boosted over a 2-week period. In fact, in some female mice that were very old or completely lacked estrogen, the hormone more than doubled their bone mass. Tests showed that the animals' bones weren't just denser, but also stronger.

Further studies conducted by co-author Thomas Ambrosi, PhD, University of California, Davis, revealed that bone stem cells were responsible for receiving signals and generating the new bone. When those cells were exposed to CCN3, they ramped up bone production even more. When the researchers applied a hydrogel patch containing CCN3 to the sites of bone breaks, this spurred the formation of new bone. As a result, the researchers saw rapid bone healing in older mice comparable to what would be expected in much younger mice.

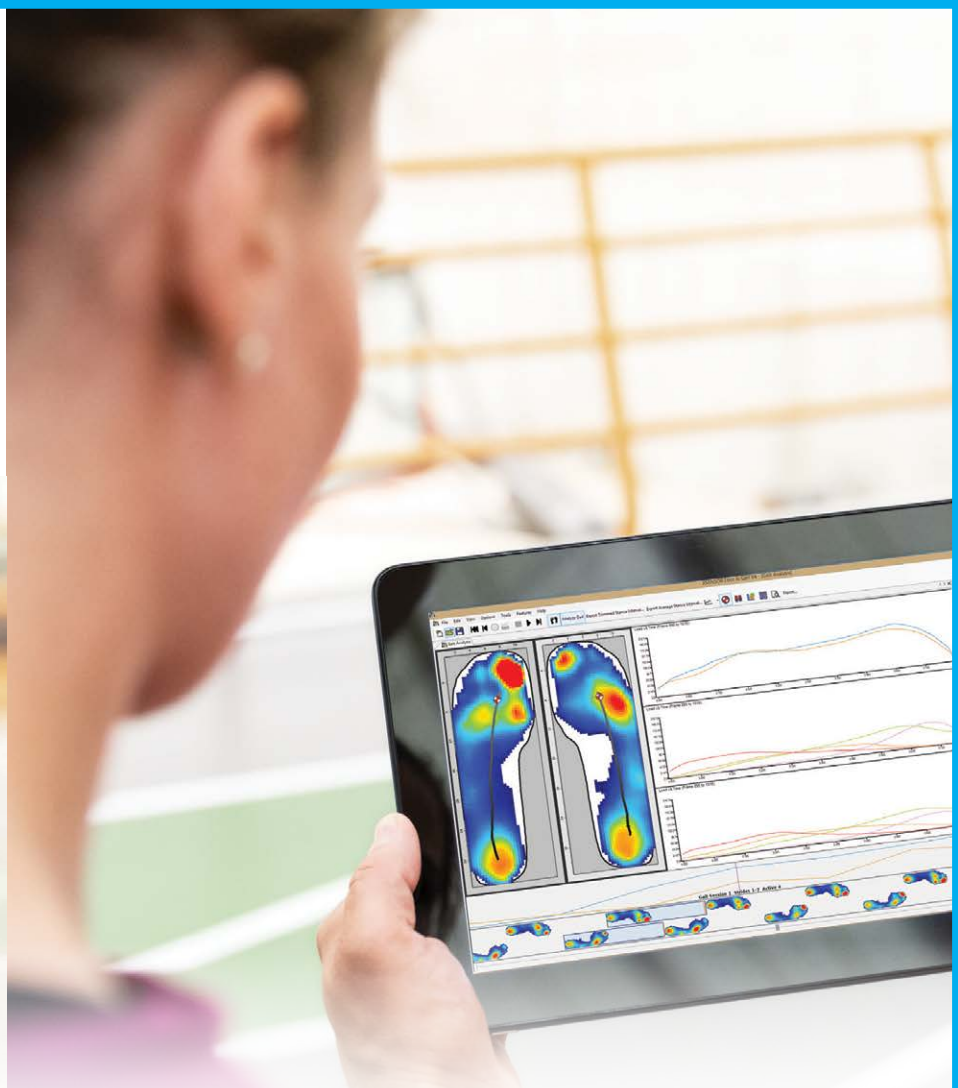
In future studies, the researchers want to gain insight into the underlying mechanisms of CCN3. They also plan to explore the hormone's potential for treating bone loss in people at increased risk, including postmenopausal women, breast cancer survivors taking estrogen blockers, and those with other conditions leading to unhealthy bone mass, such as genetic bone disorders, chronic kidney disease, or premature ovarian failure. They suggest that more immediate local uses for CCN3 include fracture repair, cartilage regeneration, and bone improvements for anchoring dental implants. It's a great example of how finding an answer to a scientific puzzle — like how maternal bones stay strong during breastfeeding — can potentially lead to advances that help many more people. ler

Sources: *1) Babey ME, Krause WC, Chen K, et al. A maternal brain hormone that builds bone. Nature. 2024 Aug;632(8024):357-365. doi: 10.1038/s41586-024-07634-3. 2) Herber CB, Krause WC, Wang L, et al. Estrogen signaling in arcuate Kiss1 neurons suppresses a sex-dependent female circuit promoting dense strong bones. Nat Commun. 2019;10(1):163. doi: 10.1038/s41467-018-08046-4.*

NEW STUDY: MS APPEARS TO PROTECT AGAINST ALZHEIMER'S

People with multiple sclerosis (MS) are far less likely than those without the condition to have the molecular hallmarks of Alzheimer's disease (AD), according to new research from Washington University School of Medicine in St. Louis.

Continued on page 16



MAKE CONFIDENT DECISIONS WITH RELIABLE, HIGH-RESOLUTION LAB-QUALITY INSOLE PRESSURE DATA

For foot clinicians and physical therapists, XSENSOR®'s X4 Intelligent Insole System provides accurate foot function, gait analysis, and plantar pressure data for any patient evaluation scenario. With fast, compact, and discreet on-shoe wireless electronics paired with durable, thin, and flexible sensors, the X4 system offers assurance of quality data to better understand the impact of orthotic, surgical, or therapeutic interventions and pathology.

EASY TO USE
Fast set-up and user-friendly software means you can capture and review plantar data in under 10 minutes

UNPARALLELED IMAGERY
Highest quality, high-resolution dynamic pressure data and imagery

ADVANCED FUNCTIONALITY
Complete analysis for clinical and research testing with XSENSOR's Foot & Gait VU software

LAB-QUALITY DATA
High-speed sampling allows for collection of anatomically accurate in-shoe data from 230 sensing points per foot

WIRELESS & UNDETECTABLE
Ultra-thin sensors conform to the footbed and compact on-shoe electronics are virtually undetectable to the wearer

ROBUST SENSORS & ELECTRONICS
Easy-to-use sensors are ready out of the box and support trouble-free testing

CONTACT US TODAY TO LEARN MORE
www.**xsensor**.com | **sales@xsensor**.com

XSENSOR
Intelligent Dynamic Sensing

CELIARUIZ®

Diabetic & Therapeutic Wellness Footwear

We have developed an innovative footwear collection, which combines functional footwear designs for various types of pathologies with clinically tested materials.Our current collection uses COOLMAX® fabric lining with Carbon threads.
COOLMAX® polyester fibers are known for their high breathability due to their hollow fiber design and aeration channels, which helps to release moisture quickly and efficiently.
By combining COOLMAX® fibers with Carbon fibers we have created a one of a kind fabric with the ability to create a dry, and airy environment while maintaining freshness.
In a test for Staphylococcus aureus and Klebsiella pneumoniae, two bacteria that can proliferate under normal conditions of humidity and temperature caused by sweating our Coolmax-Carbon fabric has demonstrated bacteriostatic properties. Preventing bacterial reproduction, reducing odors and the risk of allergies.

Unlike other fabrics, Coolmax-Carbon fabric does not receive any chemical treatments such as microencapsulation, or ion application. These treatments degrade over time resulting in the fabric losing its properties.

Our innovative footwear collection that combines functional designs and advanced Coolmax-Carbon fabric ensures the general comfort and safety of the wearers.

Franki T

Wallaby T

Marc T

Bacteriostatic
Prevents bacterial reproduction, reducing odors and the risk of allergies.

Free of harmful chemical agents
OEKO-Tex Standard 100 certified fabric according to REACH regulations.

Biocompatibility
Tested by the ISO EN10993 approved standard, guaranteeing perfect skin compatibility.

A5500

MEDICARE APPROVED

MADE IN SPAIN

ISO 13485
BUREAU VERITAS Certification

Contact: Jerry Friedman Email: jfshooze@comast.net Website: www.celiaruizusa.com Phone: (410) 206-8890

Continued from page 14

The discovery suggests a new avenue of research through which to seek Alzheimer's treatments, said Matthew Brier, MD PhD, an assistant professor of neurology and radiology and the study's first author.

"Our findings imply that some component of the biology of MS, or the genetics of MS patients, is protective against Alzheimer's," Brier said in a press release. "If we could identify what aspect is protective and apply it in a controlled way, that could inform therapeutic strategies for Alzheimer's."

The study, an example of clinical observations directly impacting research, was published in the *Annals of Neurology*.[1]

A collaboration between WashU Medicine experts in Alzheimer's and MS, the study was prompted by a suspicion Brier's mentor and collaborator Anne Cross, MD, had developed over decades of treating patients with MS. Although her patients were living long enough to be at risk of Alzheimer's or had a family history, they weren't developing the disease.

"I noticed that I couldn't find a single MS patient of mine who had typical Alzheimer's disease," said Cross, the Manny and Rosalyn Rosenthal and Dr. John Trotter MS Center Chair in Neuroimmunology. "If they had cognitive problems, I would send them to the memory and aging specialists for an Alzheimer's assessment, and those doctors would always tell me, 'No, this is not due to Alzheimer's disease.'"

Cognitive impairment caused by MS can be confused with symptoms of Alzheimer's disease; Alzheimer's can be confirmed with blood and other biological tests.

To confirm Cross' observation, the research team used a new, FDA-approved blood test that was developed by Washington University researchers. Known as PrecivityAD2, the blood test is highly effective at predicting the presence of amyloid plaques in the brain, an indicator of AD that previously only could be verified with brain scans or spinal taps.

Brier, Cross, and their colleagues recruited 100 patients with MS to take the blood test, 11 of whom also underwent PET scans. Their results were compared with the results from a control group of 300 individuals who did not have MS but were similar to those with MS in age, genetic risk for Alzheimer, and cognitive decline.

"We found that 50% fewer MS patients had amyloid pathology compared to their matched peers based on this blood test," Brier said. This finding supported Cross' observation that AD appeared to be less likely to develop among those with MS. It is not clear how amyloid accumulation is linked to the cognitive impairment typical of Alzheimer's, but the accumulation of plaques is generally understood to be the first event in the biological cascade that leads to cognitive decline.

The researchers also found that the more typical the patient's MS history was, in terms of age of onset, severity, and overall disease progression, the less likely they were to have amyloid plaque accumulation in that patient's brain compared with those with atypical presentations of MS. This suggests there is something about the nature of MS itself that is protective against Alzheimer's disease, which Brier and Cross are planning to investigate.

MS patients generally have multiple flare-ups of the illness over the course of their lifetimes, during which the immune system attacks the central nervous system. It's possible that this immune activity also reduces amyloid plaques, the researchers said.

"Perhaps when the Alzheimer's amyloid pathology was developing, the patients with MS had some degree of inflammation in their brains that was spurred by their immune responses," Brier said. Referring to work by co-author neurologist David M. Holtzman, MD, Brier noted that activated microglia, which are part of the brain's immune response in MS, have been shown to clear amyloid from the brain in animal models.[2]

Brier and Cross have begun the next steps of this research, both to tease out the possible human genetics involved, as well as to test amyloid plaque development in animal models representing.

Sources: *1) Brier MR, Schindler, SE, Salter A, et al. Unexpected low rate of amyloid-β pathology in multiple sclerosis patients. Ann Neurol. July 4, 2024. DOI: 10.1002/ana.27027. 2) Yin Z, Rosenzweig N, Kleemann KL, et al. APOE4 impairs the microglial response in Alzheimer's disease by inducing TGFβ-mediated checkpoints. Nat Immunol. 2023;24(11):1839-1853. doi: 10.1038/s41590-023-01627-6.*

GUJARATI TRANSLATION FOR WALKING IMPAIRMENT QUESTIONNAIRE FOR PAD

The Walking Impairment Questionnaire (WIQ) is a common and easy-to-use assessment of walking incapacity in people with claudication due to peripheral artery disease (PAD). It has 4 subscales: pain severity, walking distance, walking speed, and ability to climb stairs. It is one of several clinical measurements useful for predicting patients' functional limitations, assessing fitness for surgery or endovascular procedures, or inclusion for clinical trials.

Researchers have now translated this often-used test into Gujarati, an Indo-Aryan language native to the state of Gujarat on the western edge of the India subcontinent. It is 1 of 22 official languages of the In-

Continued on page 18

Continued from page 17

dian Union and the 6th most widely spoken language in India, with 55.5 million speakers. Further, it is the 26th most widely spoken language in the world. Most important for *LER* readers, it is one of the fastest-growing languages in the United States. ler

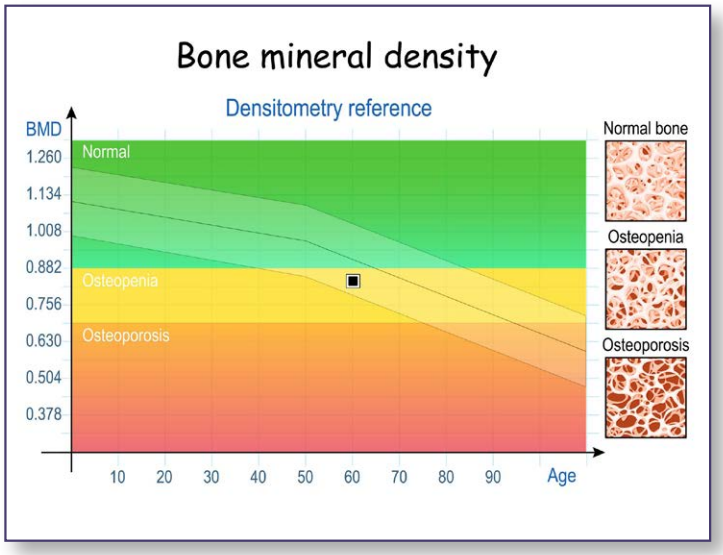
Source: *Tollenaere Q, Métairie A, Le Pabic E, Le Faucheur A, Mahé G. Use of the Walking Impairment Questionnaire and Walking Estimated-Limitation Calculated by History questionnaire to detect maximal walking distance equal to or lower than 250 m in patients with lower extremity arterial disease. Front Cardiovasc Med. 2023;21;10:968213. doi:10.3389/fcvm.2023.968213.*

DEATH BY DIABETES: AN EPIDEMIC OF AMPUTATIONS

> About 38 million Americans have diabetes, and each year a staggering 154,000 Americans will suffer amputations, roughly 80% of which will be the result of complications from diabetes. Their life expectancy following this procedure is five years; the probability of a second amputation is up to 35%. By comparison, a total of 1,700 American soldiers had limbs removed since 2002 due to injuries sustained during combat tours in Iraq and Afghanistan.

Source: *Barsky N. Death by diabetes: America's preventable epidemic. The Guardian. July 25, 2024. Available at https://www.theguardian.com/us-news/ng-interactive/2024/jul/25/diabetes-amputations-crisis. Accessed Sept. 3, 2024.*

META-ANALYSIS OF ROMOSOZUMAB FOR OSTEOPOROSIS



Romosozumab, a humanized monoclonal antibody sclerostin inhibitor, was FDA-approved in 2019 for the treatment of osteoporosis in postmenopausal women and men who are at increased risk of fracture. Significantly, the FDA applied a black box warning for the drug noting the potential risk of myocardial infarction, stroke and cardiovascular death.

Now, a research team from Saga University in Japan recently published a meta-analysis of 6 controlled clinical trials that looked at the efficacy and safety of romosozumab (210 mg, subcutaneously, 1x/month; Evenity®; Amgen) in 7990 patients with a follow-up period of 6–12 months. They looked at percent change in bone mineral density (BMD), falls, fractures, and adverse events (AEs), and calculated mean differences (MDs) with 95% confidence intervals (CIs).

Their findings show that compared to placebo, romosozumab significantly increased lumbar spine bone mineral density (BMD) (MD = 12.69; 95% CI 11.10-14.29), total hip BMD (MD = 4.42; 95% CI 3.03-5.80), and femoral neck BMD (MD = 3.99; 95% CI 2.42-5.57) at 12 months. Romosozumab significantly decreased falls (RR = 0.80; 95% CI 0.68-0.93) and major osteoporotic fractures (RR = 0.37; 95% CI 0.25-0.54), but increased injection-site reactions (RR = 1.83;95% CI 1.46-2.30) within 12 months. No significant differences were observed in other AEs (including cardiovascular AEs) within 12 months.

They concluded that romosozumab treatment resulted in a significant BMD gain, reduced falls and major osteoporotic fractures and was generally well-tolerated, including the cardiovascular aspects. However, the occurrence of minor AEs (eg, injection-site reactions) should be considered. ler

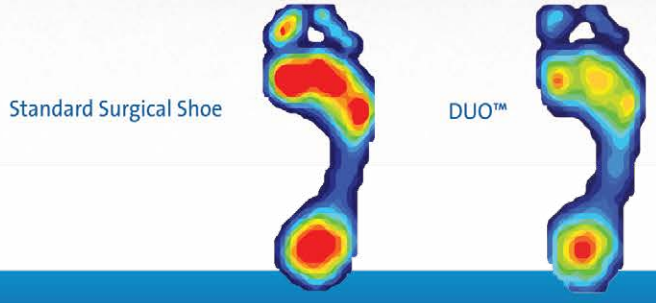
Source: *Kobayashi T, Hara M, Shimanoe C, et al. Efficacy and safety of romosozumab: a meta-analysis of placebo-controlled trials. J Bone Miner Metab. 2024. https://doi.org/10.1007/s00774-024-01531-5.*

Continued on page 21

Introducing the new

DARCO DUO

Dual Density



The MedSurg Duo™ shoe combines two different densities of EVA to provide excellent pressure relief long term. The sole provides 4x better shock absorption than a standard TPR sole. The MedSurg DUO™ shoe is built to last.

DUO™ Features and Benefits

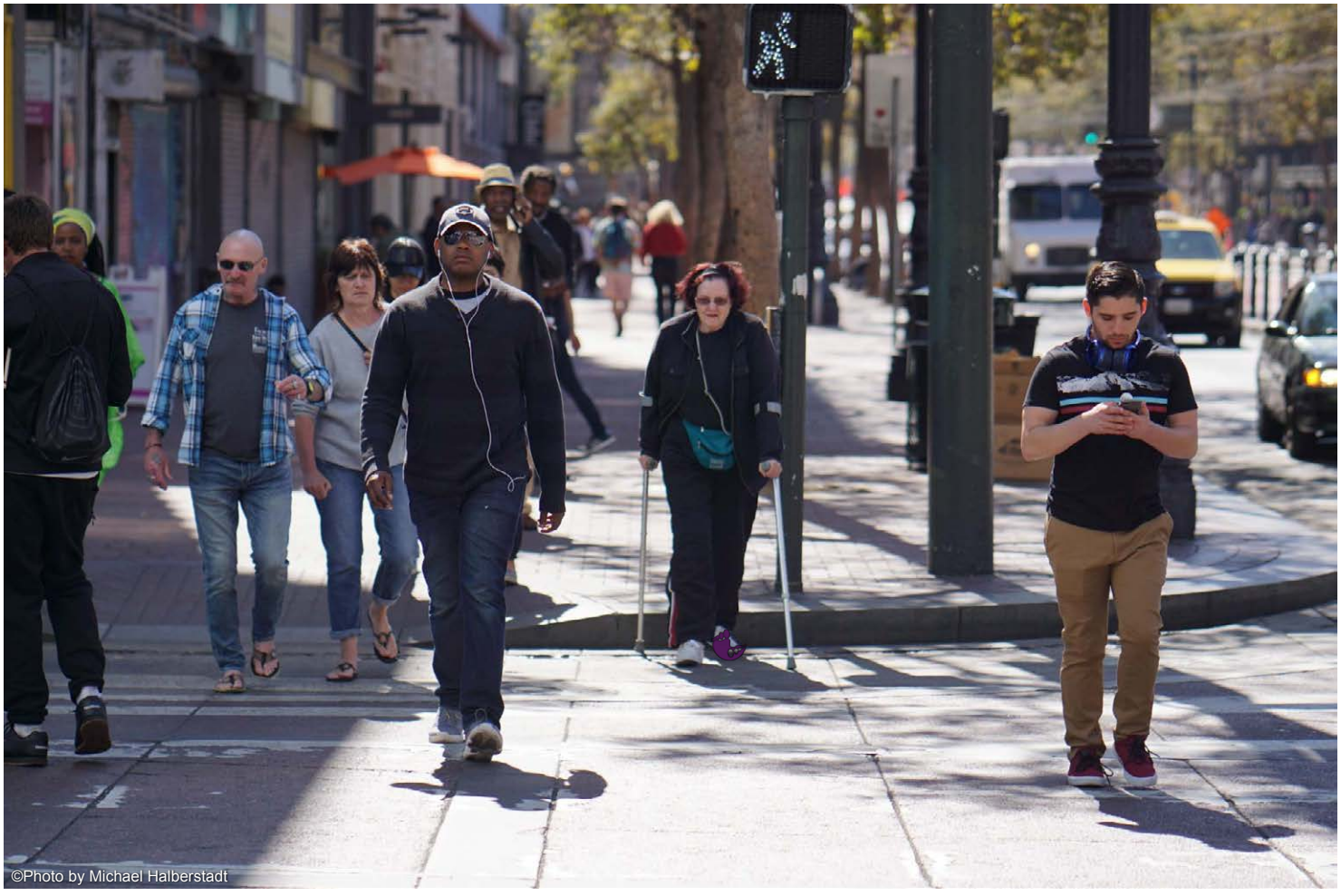
- The Dual Density EVA sole is lightweight, more durable, and provides better shock absorption.
- Adjustable ankle strap with ankle pad is softer, meaning more patient comfort.
- Dual Buckle means strap and pad can be switched left or right
- The DUO™ is compatible with the PQ - Peg Assist Offloading Insole to form the premier offloading combination on the market.
- 5 Sizes means reduction in inventory.
- Duo EVA sole provides up to 40% pressure reduction over a standard post op. shoe.

Pair with the PQ Peg Assist to enhance offloading.

www.darcointernational.com
Contact your DARCO distributor today!

ProtoKinetics

The **New** Standard in Gait Analysis



Healthcare innovation is no longer optional. **Technology Driven Progression** is required to make patient care more efficient, evidence-based and profitable.

Managing and synthesizing accurate gait and balance data are vital to **Optimizing Patient-Centered Mobility Performance** and understanding the effectiveness of interventions that portray patients' mobility in, and capacity for, daily activities.

Contact us today to learn how quickly and easily you can integrate the **Zeno Walkway Powered by PKMAS Software** into your operations!

www.protokinetics.com **610.449.4879** **info@protokinetics.com**

Continued from page 18

OBSTRUCTIVE SLEEP APNEA, OSTEOARTHRITIS & BMI

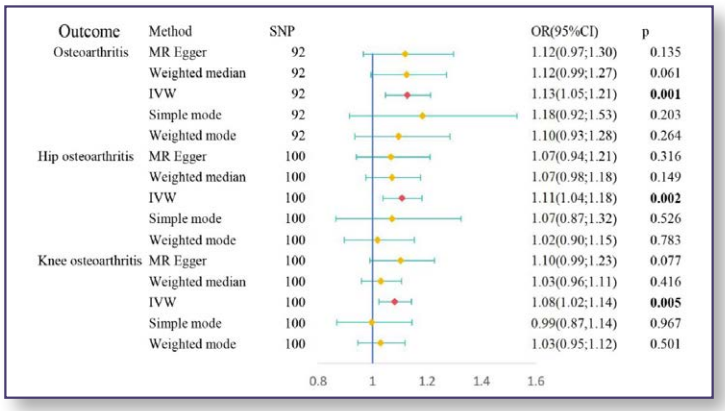


Figure: Causal relationships between obstructive sleep apnea and osteoarthritis risk performed by Mendelian randomization. IVW, inverse variance-weighted approach;SNP, single nucleotide polymorphism;

This study, the first of its kind, aimed to explore the connection between Obstructive Sleep Apnea (OSA) and osteoarthritis (OA) and evaluate causality using Mendelian randomization (MR), utilizing large-scale observational study data and genetic datasets. Cross-sectional observational analysis identified significant relationships between OSA and OA, while findings based on the MR study did support a causal role. The analysis of potential mediating factors found that BMI was an important factor between OSA and OA.

Previous studies found that the prevalence of OSA among individuals with OA was significantly higher than that in the general population, 66% versus 17%, respectively.

Sleep, as a period of physiological recovery, creates an environment conducive to cell proliferation, migration, and differentiation, with cell division and protein synthesis peaking during sleep. OSA causes airway collapse, leading to oxygen deprivation and disruption of sleep rhythm. Previous studies revealed that OSA can cause increases in inflammatory, oxidative stress, and metabolic abnormalities, such as abnormal blood lipids, uric acid, and blood sugar, which may lead to the future development of OA.

In this study, the MR analysis provided evidence of a causal relationship between OSA and OA, substantiated by rigorous examinations of horizontal pleiotropy and heterogeneity. These findings were further reinforced by 2-way MR analysis, eliminating the possibility of reverse causality.

Obesity and inflammation are potential pathogenic mechanisms by which OSA leads to OA. Previous studies, through bioinformatics analysis, have found that shared inflammation genes between OSA and OA are significantly enriched in the TNF pathway and the IL-17 pathway.

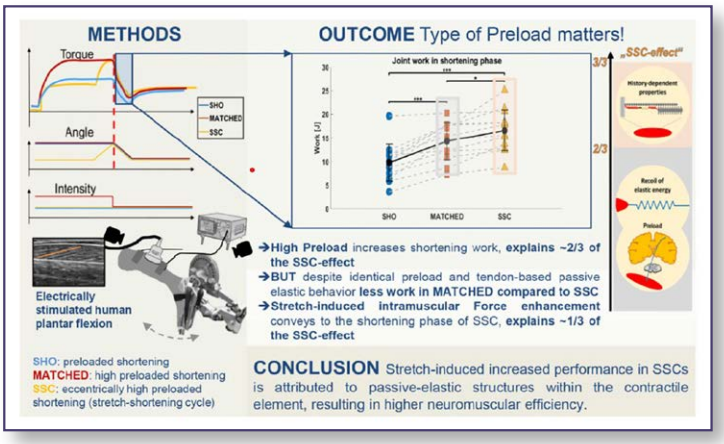
The correlation between OSA and BMI has been a focal point of research for quite some time. The sleep fragmentation due to OSA can result in a state of effective sleep deprivation, which, in turn, can cause daytime drowsiness, a reduction in physical activity, and, consequently, an increase in body weight. One key factor contributing to weight gain in individuals with OSA is insulin resistance. Studies have indicated that the development of insulin resistance in the context of sustained intermittent hypoxia is closely tied to the disruption of leptin signaling pathways.

These authors observed significant mediated effects of BMI on the associations between OSA and OA risk. In particular, other obesity and insulin resistance markers mediated no association between OSA and OA risk, among which the mediated proportion of BMI was 36.9%, consistent with previous research. These findings suggested that OSA may increase obesity and finally aggravate OA.

A high BMI or obesity leads to overloading the joints due to excess weight, which, in turn, leads to the destruction of articular cartilage. Others attributed it to excess fat tissue, which secretes hormones and proinflammatory cytokines, contributing to low-grade systemic inflammation. Given that BMI is a relatively controllable mediating factor, effectively managing BMI in OSA patients could potentially reduce the incidence of OA.

Source: *Yang Z, Lv T, Jin L, et al. The relationship between obstructive sleep apnea and osteoarthritis: evidence from an observational and Mendelian randomization study. 2024: Front. Neurol. 15:1425327. doi: 10.3389/fneur.2024.1425327*

THE IMPACT OF ECCENTRIC PRELOAD ON MUSCLE PERFORMANCE



Source: Goecking T, Holzer D, Hahn D, Siebert T, Seiberl W. Unlocking the benefit of active stretch: the eccentric muscle action, not the preload, maximizes muscle-tendon unit stretch-shortening cycle performance. J Appl Physiol (1985). 2024 Aug 1;137(2):394-408. doi: 10.1152/japplphysiol.00809.2023. Copyright © 2024 the American Physiological Society; all rights reserved.

Continued on page 22

Continued from page 21

ASSESSING LOWER LIMB PERFUSION IN DIABETIC FOOT ULCER: AWPI VS ABPI

The presence of peripheral artery disease (PAD) in patients with diabetic foot ulcers (DFUs) is a significant risk factor for chronicity and amputation. Ankle–brachial pressure index (ABPI) is a screening tool for PAD. Brachial systolic pressure measurement, used as a denominator in the calculation of ABPI, produces inaccurate results in patients with obesity and the presence of heavy clothing. The wrist, however, is easily accessible, and the ankle–wrist pressure index (AWPI), if comparable with ABPI, may be useful in screening selected patients. This study aimed to assess the efficacy of AWPI in diagnosing perfusion in DFUs and compare it to ABPI in patients with DFUs.

ABPI and AWPI were calculated by measuring systolic blood pressure in the arteries of the ankle, arm and wrist with a handheld Doppler. Actual perfusion was determined by the presence or absence of PAD by duplex ultrasound.

A total of 46 lower extremities in 41 patients were studied. The prevalence of PAD was 61%. Duplex ultrasound confirmed that the sensitivity of ABPI and AWPI in detecting PAD in patients with DFUs was 67.9% and 71.4% respectively, whereas the specificity of ABPI and AWPI was 94.4% and 88.9% respectively. On receiver operating characteristic analysis, the area under the curve of ABPI and AWPI was 0.804 and 0.795, respectively. A statistically significant positive correlation between ABPI and AWPI was found ($r=0.986$; $P<0.001$).

ABPI and AWPI values were categorized into 3 groups, value <0.9 as presence of PAD, 0.9–1.3 as normal value, and >1.3 as poorly compressible arteries. The figure shows the distribution of patients in different categories of ABPI and AWPI with a comparison between the presence and absence of PAD confirmed on duplex scan.

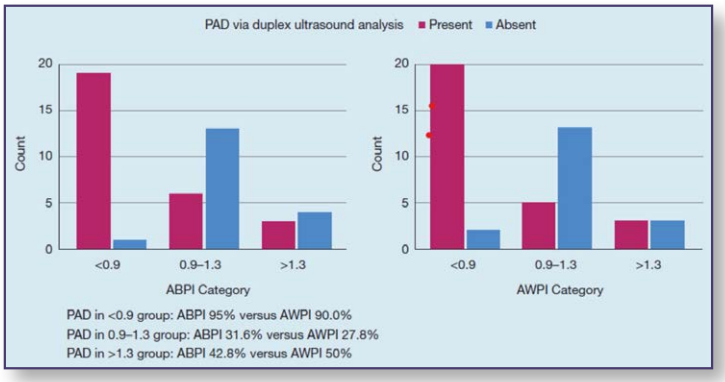


Figure: Bar diagrams comparing peripheral arterial disease (PAD) categories between ankle-brachial pressure index (ABPI) and ankle-wrist pressure index (AWPI) based on duplex ultrasound scans

The authors found there was a good correlation between ABPI and AWPI over a wide range of values. ABPI and AWPI may have a similar role in predicting perfusion in patients with DFUs. AWPI could be used in place of ABPI in selected patients in whom measuring ABPI may be difficult.

Source: *Roshan R, Chaudhary N, Chouhan U, Huda F, Basu S. Correlation of ankle–wrist pressure index with ankle–brachial pressure index to assess lower limb perfusion in diabetic foot ulcer: a pilot study .J Wound Care. 2024:33(7): 519-525.*

AGING BABY BOOMERS & ANKLE FRACTURES

Ankle fractures are common among healthy adults, but even moreso among elderly patients. And the population of so-called Baby Boomers (today's 60–78-year-olds) is expected to nearly double by 2050. Ankle fractures in patients with osteopenia and in diabetic patients with deranged bone remodeling constitute high-risk injuries that may result in catastrophic complications.

Successful outcomes in the surgical treatment of the fractured ankle require methods that respect the soft tissue envelope and establish a stable mortise for functional rehabilitation. These patients present unique care challenges (eg, tenuous soft tissues, incision skin margin necrosis, neuropathy) and should not be approached in the same manner as their healthy counterparts. These authors present the principles of treatment in high-risk ankle fractures, operative treatment philosophy illustrating techniques frequently used at our institution, and a review of current literature.

Source: *Krcal CE Jr, Collman DR. Management of high-risk ankle fractures. Clin Podiatr Med Surg. 2024;41(1):73-101. doi: 10.1016/j.cpm.2023.06.003.*

Continued on page 25

MultiMotion

Pediatric Hip Abduction System

FOR SAFE TREATMENT
of correctable pediatric hip contractures!

- **Safe and gradual joint mobilization**
- **Improved joint movement**
- **Stretch spastic muscles**

allard USA

allardusa.com

ALLARD USA, INC.
300 Forge Way, Suite 3
Rockaway, NJ 07866-2056

info@allardusa.com
Toll Free 888-678-6548
Fax 800-289-0809

Introducing

THE MOORE BALANCE BRACE

Signature Edition

Developed by Jonathan Moore, DPM, in collaboration with Orthotica Labs, the *MBB Signature Edition* will help seniors maintain and prolong independent living by reducing their risk of falling.

Compelling new features, enhanced patient outcomes...

Faithfully captures the contour of the arch

Rearfoot extrinsic post for enhanced stability

Single Velcro® closure for easier donning & doffing

Premium leather inside and out for superior durability and comfort

If Dr. Moore hasn't signed it,
it's not an MBB

Jon Moore

ORTHOTICA Labs

Call to order or for more information.

888.895.1305

orthotica.com/learn-more

Continued from page 22

UNDERSTANDING THE BENEFITS AND LIMITATIONS OF ORTHOTIC USE IN CMT AND CP

Noting a lack of evidence-based guidance on mobility challenges in individuals with neuropathic conditions, in particular Charcot-Marie-Tooth (CMT) disease and Cerebral Palsy (CP), researchers from the University of Iowa in Iowa City identified a critical need for a better understanding of how surgical correction affects mobility, balance confidence, and gait compared to ankle-foot-orthosis (AFO) bracing.

They propose using 1) prospective studies in select patient cohorts to compare conservative vs. surgical management, 2) objective laboratory-based evaluations of patient mobility, balance, and gait using reliable methods, and 3) use of patient-centric outcome measures related to health and mobility.

Among their initial findings was this:

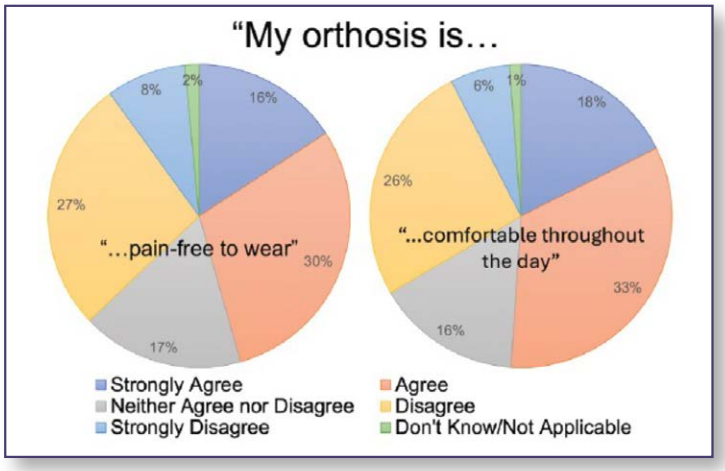


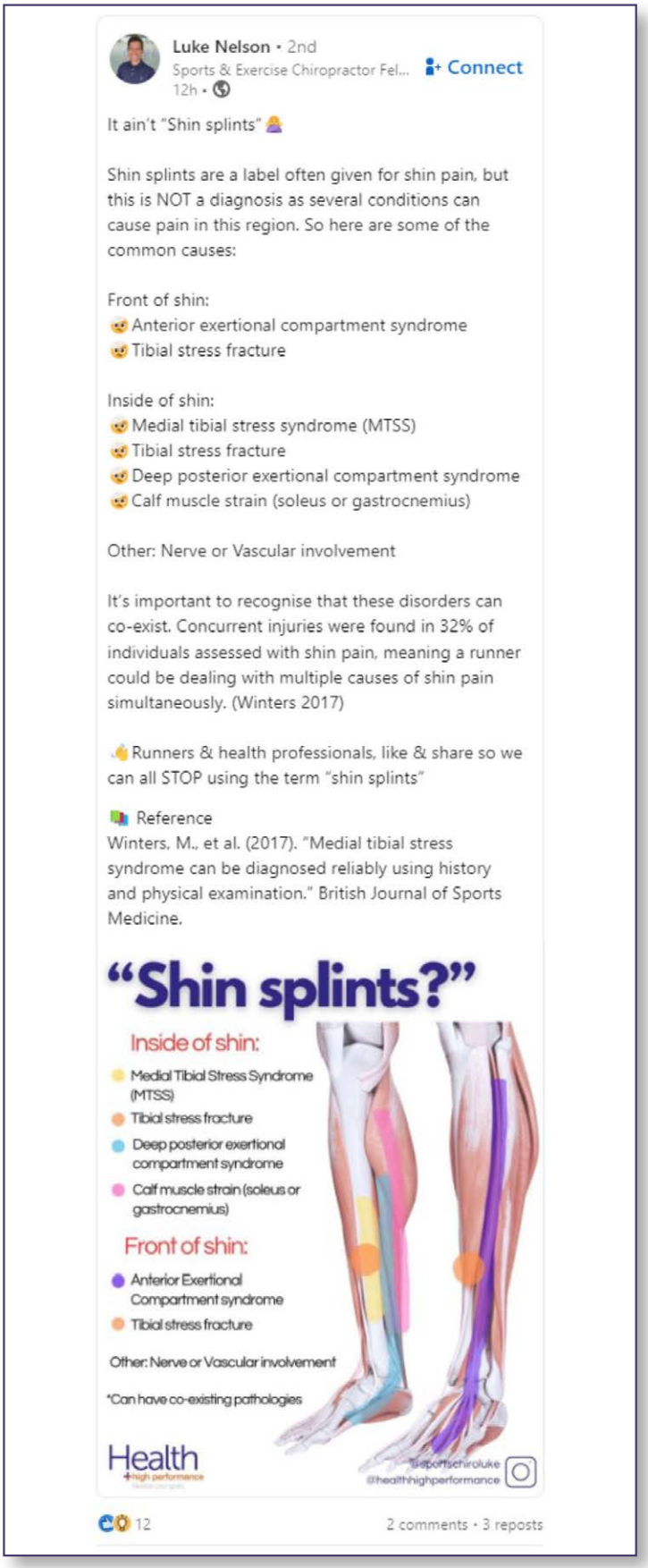
Figure: To gain insight into satisfaction with daily use, 329 individuals with CMT who use an AFO were queried utilizing a questionnaire that included 11 device-specific questions and 10 service-related questions. Patients rated their level of agreement to statements using a six-level Likert scale. Less than half of participants strongly or very strongly agreed that their orthosis was pain-free to wear, and only half similarly agreed that their orthosis is comfortable to wear throughout the day. These findings suggest the need to further enhance AFO related care to overcome the weakness, pain, and impaired function associated with CMT. (Expanded from Zuccarino et al. 2021).

Other findings include a discussion of morphologic measurements using weight-bearing CT scans, and dual fluoroscopy (DF), which leverages 2 orthogonally-placed X-ray videos to measure 3D bone movement.

They conclude by noting that "There is variation in orthotics services, and clinicians report problems with acceptance and use of AFOs amongst people with these conditions, possibly due to a mismatch between patient needs and device provision."

Source: *Chrea B, Anderson DD, Roach K, Wilken J. Research toward understanding the benefits and limitations of orthotic use to improve mobility and balance for individuals with neuropathic conditions. Iowa Orthop J. 2024;44(1):37-45.*

LINKEDIN POST OF THE MONTH



Continued on page 26

Continued from page 25

BURDEN OF INFECTED DIABETIC FOOT ULCERS

Diabetic foot is a common complication of diabetes that affects quality and prognosis of life for patients and often requires hospitalization. Infection, alone or in association with ischemia, is the main cause of hospital admission and impacts prognosis. The aim of this study is to analyze the costs of diabetic foot lesions and assess factors that influence the economic impact, focusing on infection.

These authors included all people with diabetes with a first visit for diabetic foot during 2018 in their diabetic foot center. Database interrogation identified 422 patients. Diabetic foot treatment required hospitalization for 242 patients (58%), while 180 (42%) were treated in outpatient services. Healing time was different between the two groups: it was 136 ± 124 days (mean ± SD) for outpatients and 194 ± 190 days for patients that require hospitalization ($P < 0.001$). Costs: Treatment of 422 patients for diabetic foot globally costs 2063 million EUR (2284 USD) and the mean cost for patients is 4888 EUR (5411 USD), with hospital stay having a high impact on this, accounting for 88% of the costs. Infection impacts hospitalization duration and ischemia impacts healing time. Ischemia and infection prolonged hospitalization duration and costs. Our work underlines that hospital treatment costs have a high impact on total costs. (ler)

Source: *Da Ros R, Assaloni R, Michelli A, et al. Burden of infected diabetic foot ulcers on hospital admissions and costs in a third-level center. Diabetology. 2024;5(2):141-150. https://doi.org/10.3390/diabetology5020011*

Parameter	No Ischemia Infection (n = 25)	Ischemia Not Infection (n = 191)	Ischemia and Infection (n = 40)	Test T Ischemia With/Without Infection	Test T Infection With/Without Ischemia
Hospital stay (days), mean ± DS	12.5 ± 9.7	9 ± 9	16 ± 13	< 0.01	n.s
Healing time (days), mean ± SD	135 ± 121	263 ± 243	268 ± 287	n.s.	0.04
Hospitalization costs (EUR) ± DS	6486 ± 2860	6514 ± 2632	7657 ± 2175	0.01	n.s.

Table: Hospital stay, healing time, and hospitalization costs.

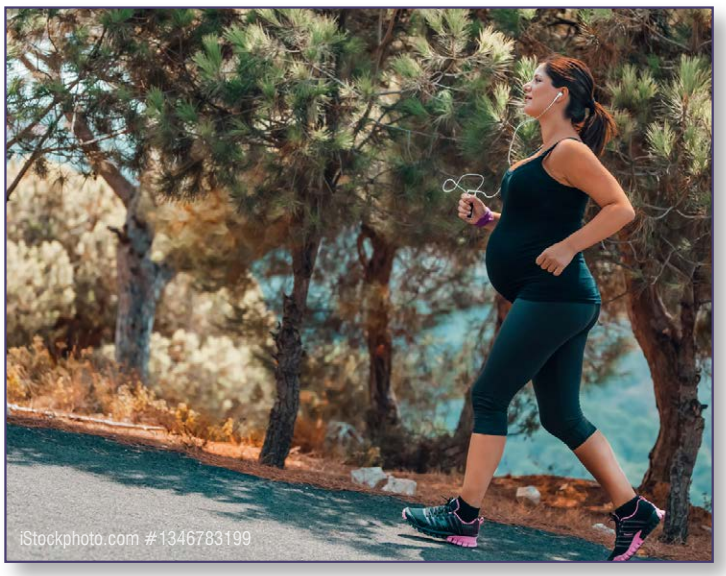
CHANGES IN FOOT BIOMECHANICS DURING PREGNANCY

The current review sought to analyze the evidence for changes in foot biomechanics during pregnancy and the postpartum period.

These authors found that around half of the body mass acquired during pregnancy is in the woman's abdominal region (anterior part of the trunk), which leads to changes in the center of gravity and more significant oscillations in the center of pressure. These factors induce disturbances in the pregnant woman's gait. Changes in foot size may also be due to fluid retention during pregnancy. In the study by Alcahuz-Grinan, a slight increase was reported during the third trimester, which normalizes after delivery.

…In addition, the increases in step width and the kinetic parameters of hip and ankle gait characterize the regular gait pattern in late pregnancy, implying greater use of the hip abductor, hip extensor, and ankle plantar flexor muscle groups. Overuse of these muscle groups during pregnancy can be a contributing factor to lower back pain, foot pain, and painful muscle cramps in gastrocnemius.

…Starting exercise programs in the early stages of pregnancy will help adjust to changes in static and dynamic grip parameters and balance, especially in the third trimester. (ler)



Source: *Zangão MOB, Poeira AF, Branco M, Santos-Rocha R. Changes in foot biomechanics during pregnancy and postpartum: scoping review. Inter J Environ Res Publ Health. 2024;21(5):638. https://doi.org/10.3390/ijerph21050638*

Continued on page 29

Put Some Spring in Their Step

Posterior Spring AFO Stores & Releases Energy with Every Step

A Dynamic AFO with Progressive Flexibility from Heel to Toe

Ultra Light Carbon Fiber Construction

Made from Prepreg Carbon Fiber

Custom Foot Bed with Foam Padding

Or Custom Proflex® SMO for Enhanced Ankle Control

Easily Fits in Shoe

Dynamic Energy Return

Adjustable Anterior Shell

Overlapping posterior section allows for compression of the proximal tiba. Removable for easy donning.

Open Heel Design

Provides soft initial floor contact preventing sudden knee flexion

Suggested L- Codes: L1945, L2755, L2820

CustomComposite

Custom Composite Manufacturing, Inc.

www.cc-mfg.com | 866-273-2230

EXPLORE MORE.
ADVENTURE MORE.

The lightweight and breathable Expedition orthotic is engineered for repeated impact and shock absorption.

Start providing Footmaxx orthotics today!

1.800.779.3668

Footmaxx™

Footmaxx.com/get-started

Continued from page 26

ULTRASOUND IMAGING OF THE QUADRICEPS FEMORIS IN KOA

Knee osteoarthritis (KOA) is a common disease in elderly adults. While previous studies have mainly focused on pathological changes, such as synovial and cartilage alterations, these authors sought to focus on changes in muscle quality. Echo intensity, shear modulus, and Myoton PRO (Tallinn, Estonia) are all potential and convenient tools for evaluating muscle properties. In addition to measuring muscle morphology, echo intensity and shear modulus also expand the scope of ultrasound assessment of muscles by quantifying muscle composition and stiffness, thereby providing more information about muscles. This study used ultrasound to assess the muscle echo intensity and shear modulus and employed Myoton PRO to evaluate the tone and stiffness in patients with KOA on both affected and unaffected sides. Additionally, they assessed these parameters in age-matched healthy older individuals on their dominant sides and examined the correlation between these muscle parameters and clinical severity scores (VAS, WOMAC, K-L grade) among KOA patients.

The differences in ultrasound and muscle properties of the superficial quadriceps muscle between elderly patients with KOA and healthy elderly individuals were preliminarily investigated and the authors reported a weak to moderate correlation was found between muscle echo intensity and K-L grade, as well as between tone and pain score in KOA. They concluded that future prevention and treatment strategies for KOA in clinical settings should take into account differences in muscle parameters. The authors hope that this study serves as a reference for clinicians to use the objective tools and methods to evaluate muscle quality around the knee in patients with KOA. In the future, it is expected that the muscle differences in patients with KOA will attract more attention from researchers. Additionally, we hope for wider utilization of scientific and objective assessment tools and methods in the clinical evaluation of muscle quality to assist clinicians in developing appropriate intervention strategies. ler

Source: *Li J, Wu Z, Lu B, Li C, Wang S, Zhang J, Shen X, Xiang R, Chen J, Jiang T, Zhao C, Liu W, Xu X. The Differences in Parameters in Ultrasound Imaging and Biomechanical Properties of the Quadriceps Femoris with Unilateral Knee Osteoarthritis in the Elderly: A Preliminary Observational Study. Clin Interv Aging. 2024;19:1479-1491. https://doi.org/10.2147/CIA.S442610*

ATHLETIC PERFORMANCE DECLINE OVER THE LIFE SPAN

Loss of muscle power has a significant impact on mobility in geriatric

populations, so this study sought to determine the extent and time course of performance decline in power-centric events throughout the life span via retrospective analyses of masters and elite track-and-field data.

Four track-and-field events were selected based on maximal power output: the 100-m dash, long jump, high jump, and triple jump. Elite and masters athlete data were gathered from the World Masters Outdoor Championships and the International Amateur Athletic Federation World Athletics Championships (17,945 individual results). Data were analyzed by fitting individual and group results to quadratic and linear models.

Average age of peak performance in all events was 27.8 (0.8) years for men and 28.3 (0.8) years for women. Athlete performance decline best matched a linear model for the 5 years following peak performance (mean R2 = .68 [.20]) and for ages 35–60, but best matched a quadratic model for ages 60–90 and 35–90 (mean R2 = .75 [.12]). The average rate of decline for the masters data ages 35–60 ranged from 0.55% per year for men's 100-m dash to 1.04% per year for women's long jump. A significant age × sex interaction existed between men and women, with men declining faster throughout life in all events except the 100-m dash.

Performance decline begins in the early 30s and is linear through middle age. This pattern of decline provides a basis for further research on power-decline pathophysiology and preventive measures starting in the 30s. ler

Source: *Pfeifer B, Nelson WB, Hyldahl RD. Athletic Performance Decline Over the Life Span: Cross-Sectional and Longitudinal Analyses of Elite and Masters Track-and-Field Data. Int J Sports Physiol Perform. 2024;19(9):897-904. doi: 10.1123/ijspp.2023-0431.*

Shopping Cart-Related Lower Extremity Injuries Treated at United States Hospital Emergency Departments

By Mathias B. Forrester, BS

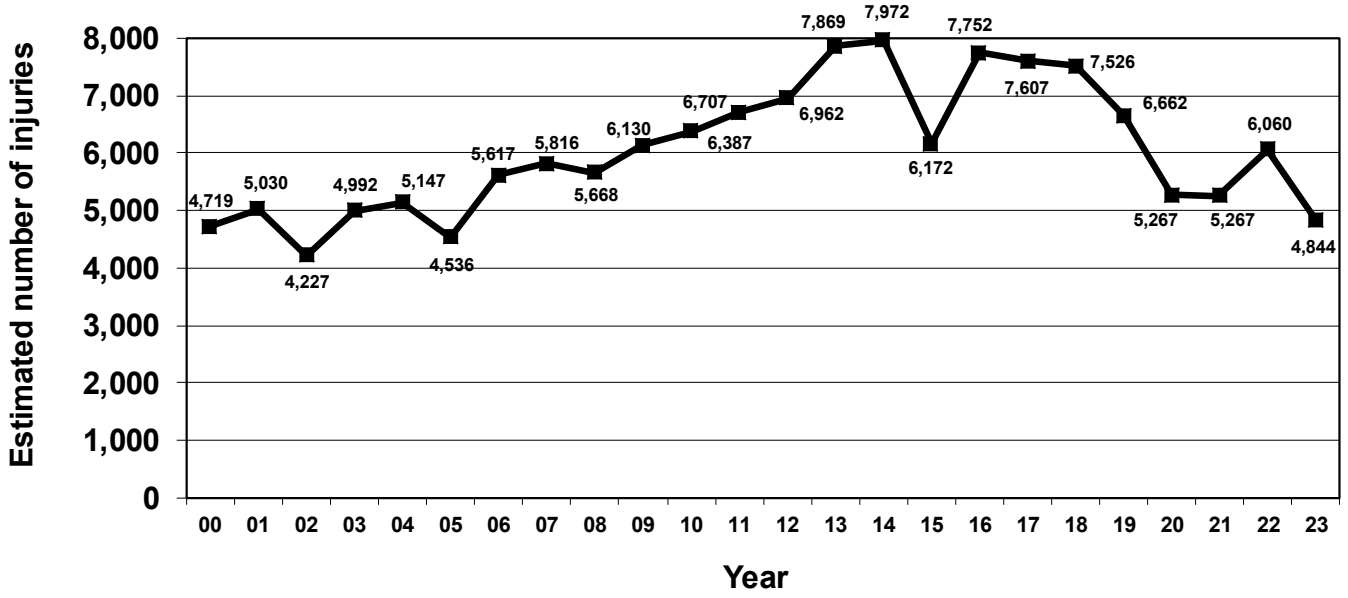
Tens of thousands of shopping cart-related injuries are treated at United States (US) hospital emergency departments (EDs) each year. This study described shopping cart-related lower extremity injuries treated at US hospital EDs.

Methods: An analysis was performed of shopping cart-related lower extremity injuries reported to the National Electronic Injury Surveillance System during 2000-2023. National injury estimates were calculated for selected variables.

Results: An estimated 144,935 shopping cart-related lower extremity injuries were treated at US hospital EDs during 2000-2023, 17.5% of the estimated 828,254 total shopping cart-related injuries affecting any body part. The distribution of the lower extremity injuries by body part was 25.8% lower leg, 20.2% knee, 18.7% foot, 16.2% ankle, 13.2% toe, and 5.9% upper leg. The injury mechanisms were 37.8% hit or hit by shopping cart; 21.1% fall, trip, or slip and shopping cart involved (patient not in or on shopping cart); 11.5% run over by shopping cart; and 29.7% all other or unknown. The patients were 12.5% 0-5 years, 10.0% 6-19 years, and 77.5% 20 years and older; 72.0% of the patients were female, and 28.0% were male. The injury type was 41.4% contusion or abrasion, 15.1% strain or sprain, 13.0% fracture, 8.8% laceration, and 21.8% other/not stated; 94.3% of the patients were treated or examined at the ED and released.

Conclusion: Shopping cart-related lower extremity injuries treated at US hospital EDs occurred via a variety of mechanisms, the most common being hit or hit by shopping cart; fall, trip, or slip and shopping cart involved (patient not in or on shopping cart); and run over by shopping cart. The majority of patients were age 20 years or older, and most patients were female. The most common type of injury was contusion or abrasion, followed by strain or sprain and fracture. Most patients were treated or examined in the ED and released.

Figure 1. Annual estimated number of shopping cart-related lower extremity injuries reported to the National Electronic Injury Surveillance System, 2000-2023



The United States Consumer Product Safety Commission considers an estimate unstable and potentially unreliable when the estimate is <1,200.

A shopping cart, also called by other terms such as basket, buggy, carriage, wagon, or wheelbasket in the United States (US), is a wheeled cart for people to transport items, primarily merchandise, inside or from a store. Most shopping carts have 4 wheels and are comprised of metal or a combination of metal and plastic. Shopping carts come in a variety of sizes and designs. The standard shopping cart is the most common type of shopping cart found in (and owned by) supermarkets and grocery stores. It typically features a frame, a handlebar for pushing, and a basket or compartment for holding items. The child-friendly shopping cart is designed to accommodate young children; it may feature a built-in child seat or a designated area where a child may sit. The double-decker shopping cart has 2 baskets or compartments stacked on top of each other, allowing shoppers to separate items. The mini shopping cart is a smaller-sized cart designed for shoppers who only need a few items or who have limited space for shopping. The electric shopping cart is primarily an electric wheelchair or scooter with a basket and is for persons with disabilities.[1,2] There also is the personal shopping cart (typically owned by the individual), which is generally a smaller, folding cart, sometimes with only 2 wheels, that people may use to transport merchandise to their homes.

Tens of thousands of shopping cart-related injuries are treated at US hospital emergency departments (EDs) each year.[3,4] These injuries occur by a variety of mechanisms, such as falls out of a shopping cart, cart tip overs, patient body part caught in a cart (entrapment), being struck or run over by a cart, and running into or falling over a cart.[3,5-7] Common shopping cart-related injuries include closed head injuries or concussions, internal injuries, lacerations, fractures, and contusions or abrasions and can affect all parts of the body, including the lower extremity.[3,4,7] Death may also result from shopping cart-related injuries.[8]

Much of the literature on shopping cart-related injuries has focused on the pediatric population.[3-7,9,10] The objective of this study was to describe shopping cart-related lower extremity injuries affecting patients of all ages.

Methods

This retrospective, descriptive study used data from the National Electronic Injury Surveillance System (NEISS), available at https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx. The NEISS database has been described in detail in *Lower Extremity Review* previously.[11] In brief, NEISS is operated by the US Consumer Product Safety Commission (CPSC) and is a database of consumer product-related injuries collected from a representative sample of approximately

Continued on page 32

Continued from page 31

Table 1. Mechanism of shopping cart-related injuries treated in United States hospital emergency departments, National Electronic Injury Surveillance System, 2000-2023

Mechanism	Lower extremity (LE) injuries		Total injuries		LE/total injuries (%)
	Estimate	%	Estimate	%	
Fall, trip, or slip mentioned	41,339	28.5	548,668	66.2	7.5
Fell from or in shopping cart (no mention shopping cart tipped or fell over)	6,902	4.8	375,157	45.3	1.8
Shopping cart tipped or fell over (patient in or on shopping cart)	3,905	2.7	23,226	2.8	16.8
Fall, trip, or slip and shopping cart involved (patient not in or on shopping cart)	30,533	21.1	150,285	18.1	20.3
Fall, trip, or slip not mentioned	103,596	71.5	279,586	33.8	37.1
Hit or hit by shopping cart	54,770	37.8	116,127	14.0	47.2
Run over by shopping cart	16,610	11.5	25,676	3.1	64.7
Shopping cart tipped or fell over (no mention patient in or on cart)	8,528	5.9	19,334	2.3	44.1
Entrapment of body part in shopping cart or between shopping cart and another object	4,671	3.2	32,410	3.9	14.4
Pushed, pulled, lifted, or carried shopping cart (no other factor mentioned)	5,714	3.9	34,330	4.1	16.6
Other or unknown mechanism	13,301	9.2	51,709	6.2	25.7
Total	**144,935**		**828,254**		**17.5**

Estimate = Weighted estimate (sum of the Weight numeric field in the National Electronic Injury Surveillance System database). The numbers in the Weight field are not whole numbers but include decimals. As a result of rounding to whole numbers when performing analyses, the sum of the estimates for a given variable might not equal the total. The Consumer Product Safety Commission considers an estimate unstable and potentially unreliable when the estimate is <1,200.

100 US hospital EDs. National estimates are calculated from database records according to the sample weight assigned to each case based on the inverse probability of the hospital being selected for the NEISS sample.[12,13] The data are publicly available and de-identified, so the study is exempt from institutional review board approval. Previous studies have used NEISS data to examine shopping cart-related injuries; however, these studies examined only the pediatric population and did not focus on injuries of the lower extremity.[3,4,9]

Cases were shopping cart-related injuries reported to the NEISS during 2000-2023. Cases were identified in a multi-stage process. First, all records with product code 1679 (Grocery or shopping carts, unpowered) in the Product_1, Product_2, or Product_3 numeric fields were identified. There was no product code specifically for powered grocery or shopping carts. (The Product_3 field was added in 2018 but does not appear to have been used until 2019;[13] only 9 of the records included in the study had product code 1679 in this field.) Next, the Narrative

Table 2. Patient demographics and circumstances of shopping cart-related injuries treated in United States hospital emergency departments, National Electronic Injury Surveillance System, 2000-2023

Variable	Lower extremity (LE) injuries		Total injuries		LE/total injuries (%)
	Estimate	%	Estimate	%	
Patient age (years)					
0-5	18,147	12.5	450,617	54.4	4.0
6-19	14,510	10.0	63,182	7.6	23.0
20+	112,278	77.5	314,449	38.0	35.7
Unknown	0	0.0	5	0.0	0.0
Sex					
Female	104,321	72.0	469,834	56.7	22.2
Male	40,614	28.0	358,406	43.3	11.3
Unknown	0	0.0	14	0.0	0.0
3-month period					
December-February	27,494	19.0	192,323	23.2	14.3
March-May	36,907	25.5	207,046	25.0	17.8
June-August	44,137	30.5	216,340	26.1	20.4
September-November	36,397	25.1	212,545	25.7	17.1
Location of incident					
Other public property	120,430	83.1	724,481	87.5	16.6
Home	3,021	2.1	15,236	1.8	19.8
Street or highway	2,125	1.5	9,019	1.1	23.6
Other	245	0.2	2,374	0.3	10.3
Not recorded	19,113	13.2	77,143	9.3	24.8
Total	**144,935**		**828,254**		**17.5**

Please see footnote in Table 1.

Continued on page 34

Continued from page 33

Table 3. Type of injury and disposition of shopping cart-related injuries treated in United States hospital emergency departments, National Electronic Injury Surveillance System, 2000-2023

Variable	Lower extremity (LE) injuries		Total injuries		LE/total injuries (%)
	Estimate	%	Estimate	%	
Type of injury (diagnosis)*					
Contusion or abrasion	59,941	41.4	232,197	28.0	25.8
Internal organ injury	0	0.0	209,051	25.2	0.0
Laceration	12,713	8.8	85,450	10.3	14.9
Fracture	18,807	13.0	75,155	9.1	25.0
Strain or sprain	21,813	15.1	63,915	7.7	34.1
Other/not stated**	31,660	21.8	162,486	19.6	19.5
Disposition					
Treated or examined and released from emergency department	136,713	94.3	769,382	92.9	17.8
Treated and admitted for hospitalization (within same facility)	5,884	4.1	33,281	4.0	17.7
Treated and transferred to another hospital	535	0.4	8,171	1.0	6.5
Held for observation (includes admitted for observation)	356	0.2	3,605	0.4	9.9
Left without being seen/Left against medical Advice	1,441	1.0	13,491	1.6	10.7
Not recorded	6	0.0	323	0.0	1.8
Total	**144,935**		**828,254**		**17.5**

*Type of injury includes only the diagnosis listed in the first of 2 diagnosis fields in the National Electronic Injury Surveillance System database. The second diagnosis field was only used for records during 2019-2023.

**Includes ingested foreign object, aspirated foreign object, burn, amputation, concussion, crushing, dislocation, foreign body, hematoma, dental injury, nerve damage, puncture, anoxia, hemorrhage, electric shock, poisoning, avulsion, conjunctivitis or dermatitis, other/not stated, and unknown.

Please see footnote in Table 1.

field (a text field that briefly summarizes the circumstances of the injury) for each record was reviewed to identify those records that met the study criteria as well as attempt to identify the mechanism of the injury. Injuries only peripherally related to the shopping cart (eg, being hit by an object that fell from the shopping cart, hitting an object while riding in a shopping cart, being injured while an object was being placed into or removed from a shopping cart) were excluded from the study. An exception was made for injuries that occurred when the patient was being placed in or removed from a shopping cart or the patient was placing another individual (usually a child) into or removing them from a shopping cart, which were included in the study. Injuries involving all types of shopping carts were included in the study because the specific type of shopping cart was not often noted in the Narrative field.

The mechanism of injury was grouped into 2 broad categories: (1) fall, trip, or slip mentioned or (2) fall, trip, or slip not mentioned. The mechanism of injury was further divided into the following categories:

- Fall, trip, or slip mentioned:
  - fell from or in shopping cart (no mention shopping cart tipped or fell over)
  - shopping cart tipped or fell over (patient in or on shopping cart)
  - fall, trip, or slip and shopping cart involved (patient not in or on shopping cart)
- Fall, trip, or slip not mentioned:
  - hit or hit by shopping cart
  - run over by shopping cart
  - shopping cart tipped or fell over (no mention patient in or on cart)
  - entrapment of body part in shopping cart or between shopping cart and another object
  - pushed, pulled, lifted, or carried shopping cart (no other factor mentioned)
  - other or unknown mechanism

If the injury involved a mechanism in the fall, trip, or slip not mentioned group but a fall, trip, or slip occurred, then it was coded in the fall, trip, or slip mentioned group. For example, if a patient was hit by a shopping cart and fell, the record was coded in the fall, trip, or slip mentioned group. If multiple mechanisms of injury were described in the Narrative field, such as the patient being hit by a shopping cart and then becoming entrapped in a shopping cart, the first mechanism to occur (hit by a shopping cart) in the sequence was coded.

> This study found that 38.0% of total injuries and 77.5% of lower extremity injuries involved patients age 20 years and older.

The variables examined were injury mechanism, treatment year and month (grouped into three-month periods), patient age and sex, location of incident, type of injury (diagnosis), affected body part, and disposition. The NEISS database contains 2 numeric fields for coding the affected body part (Body_Part and Body_Part_2) and two numeric fields for coding the type of injury or diagnosis (Diagnosis and Diagnosis_2). The Body_Part_2 and Diagnosis_2 fields were added in 2018, although they do not appear to have been used until 2019.[13] For consistency over the entire study period, the Body_Part and Diagnosis fields alone was examined for the analysis.

Analyses were performed using Microsoft 365 Access and Excel (Microsoft Corporation, Redmond, Washington, US). For the selected variables, the distribution of the national injury estimates was determined for both total shopping cart-related injuries affecting any body part and the subset of shopping cart-related lower extremity injuries. Comparisons were made between the 2 groups for the studied variables by calculating the percent of total injuries that were lower extremity injuries. National injury estimates were calculated by summing the values in the Weight numeric field in the publicly available NEISS database. The CPSC considers an estimate unstable and potentially unreliable when the estimate is <1,200.[12]

Results

There were an estimated 144,935 shopping cart-related lower extremity injuries treated at US hospital EDs during 2000-2023, representing 17.5% of the 828,254 total estimated shopping cart-related injuries affecting any body part. The distribution of the lower extremity injuries by body part was 37,426 (25.8%) lower leg, 29,227 (20.2%) knee, 27,060 (18.7%) foot, 23,548 (16.2%) ankle, 19,114 (13.2%) toe, and 8,560 (5.9%) upper leg.

Table 1 shows the distribution of shopping cart-related injuries by injury mechanism. A fall, trip, or slip was mentioned in most total injuries; however, a fall, trip, or slip was not mentioned in the majority of lower extremity injuries. For total injuries, the most common mechanisms of injuries were fell from or in shopping cart (no mention shopping cart tipped or fell over); fall, trip, or slip and shopping cart involved (patient not in or on shopping cart); and hit or hit by shopping cart. For lower extremity injuries, the most common mechanisms were hit or hit by shopping cart; fall, trip, or slip and shopping cart involved (patient not in or on shopping cart); and run over by shopping cart.

When the annual estimated number of shopping cart-related lower extremity injuries was examined (Figure 1), the estimated number of injuries increased from 4,719 in 2000 to 7,972 in 2014 and then declined to 4,844 in 2023. The annual estimated number of total injuries demonstrated a similar pattern, increasing from 32,388 in 2000 to 40,581 in 2010 and then decreasing to 27,532 in 2023. The proportion of total injuries comprised by lower extremities was 18,969/133,135 (14.2%) during 2000-2003, 21,116/140,392 (15.0%) during 2004-2007, 24,891/152,938 (16.3%) during 2008-2011, 28,975/151,795 (19.1%) during 2012-2015, 29,547/144,177 (20.5%) during 2016-2019, and 21,437/105,815 (20.3%) during 2020-2023.

Continued on page 36

Continued from page 35

Table 2 presents the distribution of shopping cart-related injuries by patient demographics and injury circumstances. While most patients with total injuries were age 0-5 years, most patients with lower extremity injuries were age 20 years and older. The majority of patients in both groups were female; however, this proportion was higher among patients with lower extremity injuries. The highest proportion of lower extremity injuries were treated in June-August, and the lowest proportion were treated in December-February. Total injuries did not exhibit a similar seasonal pattern. For both total injuries and lower extremity injuries, most injuries occurred at other public property.

Table 3 shows the distribution of shopping cart-related injuries by type of injury (diagnosis) and disposition. The most common diagnoses among total injuries were contusion or abrasion, internal organ injury, and laceration. The most common diagnoses among lower extremity injuries were contusion or abrasion, strain or sprain, and fracture. For both groups, most patients were treated or examined at the ED and released.

Discussion

This study examined shopping cart-related injuries, assessing total injuries affecting all body parts and injuries affecting the lower extremity in particular. Tens of thousands of people are treated at US hospital EDs for shopping cart-related injuries each year (thousands of which involve lower extremity injuries). Examination of lower extremities is important because this study found that 17.5% of total shopping cart -related injuries affected the lower extremity. Furthermore, while previous studies used NEISS data to examine shopping cart-related injuries,[3,4,9] these studies included only pediatric patients. This study found that 38.0% of total injuries and 77.5% of lower extremity injuries involved patients age 20 years and older.

Shopping cart-related lower extremity injuries increased during 2000-2014 and then decreased during 2015-2023. The decline in injuries during the last 9 years may be due to improvements in shopping cart safety and prevention efforts. Although total shopping cart-related injuries demonstrated a similar trend, they peaked a few years earlier, in 2010. Furthermore, the proportion of total injuries involving the lower extremity increased during the study period, from 14.2% during 2000-2003 to 20.3% during 2020-2023. These observations suggest that the factors related to the decline in shopping cart-related injuries did not affect lower extremity injuries to the same degree as it affected injuries of other body parts.

> Although the majority of total injuries involved patients age 0-5 years, most lower extremity injuries involved patients age 20 years and older.

Shopping cart-related lower extremity injuries differed from total injuries in several respects. In most total injuries, a fall, trip, or slip was mentioned; however, in most lower extremity injuries a fall, trip, or slip was not mentioned. For total injuries, the most common injury mechanisms were fell from or in shopping cart (no mention shopping cart tipped or fell over); fall, trip, or slip and shopping cart involved (patient not in or on shopping cart); and hit or hit by shopping cart. For lower extremity injuries, the most common mechanisms were hit or hit by shopping cart; fall, trip, or slip and shopping cart involved (patient not in or on shopping cart); and run over by shopping cart. These differences are likely related to the body parts most likely to be injured by a specific mechanism. When a person hits or is hit by a shopping cart, the lower extremity might be expected to be the body part most often involved in the hit. When a person is run over by a shopping cart, the lower extremity might be expected to be the body part most often run over. However, when a person falls from or in a shopping cart, depending on how they fall, any body part might be injured.

Although the majority of total injuries involved patients age 0-5 years, most lower extremity injuries involved patients age 20 years and older. While most patients in both injury groups were female, this proportion was higher for lower extremity injuries (72.0%) than for total injuries (56.7%). People of a certain age or sex may differ in their likelihood of experiencing a certain injury mechanism. For instance, children age 0-5 years might be more likely to ride in a shopping cart, and thus more likely to fall from or in a shopping cart (94.6% of total injuries in this study) or be in or on a shopping cart that tipped or fell over (82.6% of total injuries in this study). In contrast, 72.4% of the patients in this study who hit or were hit by a shopping cart were age 20 years or older, and 47.8% of the patients who were run over by a shopping cart were age 20 years or older.

The most common diagnoses among lower extremity injuries were contusion or abrasion, strain or sprain, and fracture. Most such injuries might not be expected to require treatment beyond the ED; in this study, 94.3% of the patients with lower extremity injuries were treated or examined in the ED and released.

Although the estimated number of shopping cart-related injuries treated at US hospital EDs has declined over the last decade, in 2023 there still were an estimated 27,532 total injuries and an estimated 4,844 lower extremity injuries. Thus, prevention of these injuries is still important. Previous publications have extensively discussed ways to prevent shopping cart-related injuries, particularly among children.[3,4,14,15] These articles discuss public education, encouraging safe use of carts and adult supervision, provision of alternatives to placing children in carts while their caregivers shop, design changes to carts to prevent tip-overs and falls, and legislation.

There are limitations to this study. First, potential cases were initially identified by searching the 3 product code fields for product code 1679 (Grocery or shopping carts, unpowered). If this code was not used for a shopping cart-related injury, then the injury would not

have been included in the study. Second, identification of the injury mechanism was performed by review of the Narrative field by a single person (the author). The injury circumstances in the Narrative field are not standardized. If the summary was incomplete or unclear, then the proper mechanism might not have been coded. Third, this study only included shopping cart-related injuries treated at hospital EDs. Examination of injuries not treated at hospital EDs would provide a more complete view of shopping cart-related injuries.

In conclusion, shopping cart-related lower extremity injuries treated at US hospital EDs occurred via a variety of mechanisms, the most common being hit or hit by shopping cart; fall, trip, or slip and shopping cart involved (patient not in or on shopping cart); and run over by shopping cart. The highest proportion of patients were age 20 years or older, and most patients were female. The most common type of injury was contusion or abrasion, followed by strain or sprain and fracture. Most patients were treated or examined in the ED and released. Considering that the pattern of shopping cart-related lower extremity injuries differed from total injuries in several respects, prevention activities may need to be modified to target those injury mechanisms and demographic groups most associated with lower extremity injuries. 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.

References

1. Carriage Trade Service Company. What are the different types of shopping carts? August 5, 2022. Available at https://shopcarriage-trade.com/blog/what-are-the-different-types-of-shopping-carts/. Accessed Aug. 28, 2024.
2. Wuhan Suyuan Commercial Equipment Co., Ltd. What are the different types of shopping carts? March 7, 2024. Available at https://www.suvametal.com/info/what-are-the-different-types-of-shopping-carts-93189209.html. Accessed Aug. 28, 2024.
3. Martin KJ, Chounthirath T, Xiang H, Smith GA. Pediatric shopping-cart-related injuries treated in US emergency departments, 1990-2011. Clin Pediatr (Phila). 2014;53(3):277-285.
4. Smith GA, Dietrich AM, Garcia CT, Shields BJ. Epidemiology of shopping cart-related injuries to children. An analysis of national data for 1990 to 1992. Arch Pediatr Adolesc Med. 1995;149(11):1207-1210.
5. Vilke GM, Stepanski BM, Ray LU, Lutz MW, Murrin PA, Chan TC. 9-1-1 Responses for Shopping Cart and Stroller Injuries. Pediatr Emerg Care. 2004;20(10):660-663.
6. Parry ML, Morrison LG, Chalmers DJ, Wright CS. Shopping trolley-related injuries to children in New Zealand, 1988-97. J Paediatr Child Health. 2002;38(1):51-54.
7. Smith GA, Dietrich AM, Garcia CT, Shields BJ. Injuries to children related to shopping carts. Pediatrics. 1996;97(2):161-165.
8. Jensen L, Charlwood C, Byard RW. Shopping cart injuries, entrapment, and childhood fatality. J Forensic Sci. 2008;53(5):1178-1180.
9. Wright JW, Griffin R, MacLennan PA, Rue LW 3rd, McGwin G. The incidence of shopping cart-related injuries in the United States, 2002--2006. Accid Anal Prev. 2008;40(3):1253-1256.
10. Woo EK. Shopping trolley-related accidents in the UK: a preventable cause of morbidity. J Paediatr Child Health. 2003;39(2):157-158.
11. Forrester MB. Pickleball-related injuries involving the lower extremity treated in emergency departments. Lower Extremity Review. 2021;13(5):24-30.
12. United States Consumer Product Safety Commission. National Electronic Injury Surveillance System (NEISS). Available at https://www.cpsc.gov/Research--Statistics/NEISS-Injury-Data/Explanation-Of-NEISS-Estimates-Obtained-Through-The-CPSC-Website. Accessed Aug. 29, 2024.
13. United States Consumer Product Safety Commission. NEISS Coding Manual. January 2021. Available at https://www.cpsc.gov/s3fs-public/January-2021-NT-CPSC-only-NEISS-Coding-Manual.pdf?xa_nMM1kB4SGpuSMOwf0NHkkkIqNcn8F. Accessed Aug. 29, 2024.
14. Smith GA; Committee on Injury, Violence, and Poison Prevention, American Academy of Pediatrics. Shopping-cart-related injuries to children. Pediatrics. 2006;118(2):e540-e544.
15. Committee on Injury, Violence, and Poison Prevention, American Academy of Pediatrics. Shopping-cart-related injuries to children. Pediatrics. 2006;118(2):825-827.

Shopping cart-related lower extremity injuries increased during 2000-2014 and then decreased during 2015-2023.

Varicose Veins of the Lower Extremities: A Primer Part II

By Angela Kelley, PA-C, MSM

Varicose veins affect nearly one third of the adult population and are considered early warnings of the more serious chronic venous insufficiency. Early recognition and prevention are key to suppressing potential life-threatening damage and maintaining patient quality of life.

Varicose veins (VVs)—those bulging, twisted blood vessels typically seen on the legs—are more than an esthetic issue. They can be painful and affect patients' quality of life; left untreated, they can lead to life-threatening chronic venous insufficiency and venous ulcers and warrant a clinician's attention.

VVs are a common occurrence noted in healthcare. This article is the second of a 2-part-primer and includes information on treatment, prevention, and complications of this condition. Part I appeared last month and included information on anatomy, physiology, and pathophysiology, how to diagnose VVs, risk factors for occurrence, clinical presentation, and differential diagnoses. This article will focus on treatment, prevention, and complications of this condition. There are additional terms that will be explored such as chronic venous insufficiency (CVI), and chronic venous disease (CVD); however, it is important to note at the outset that these terms are not interchangeable with the term varicose veins.

Definitions

Varicose Veins

Varicose veins (VVs) are superficial veins that are dilated and bulging with diameters measuring 3 mm or greater that can progress to become more enlarged and more tortuous.[1] Patients with VVs can be either asymptomatic or have pain and even bleeding if progression occurs. VVs are the most common manifestation of CVD and usually manifest as stage C2 in the CEAP (see below).[2]

Chronic Venous Disease

Chronic venous disease (CVD) is a general term describing complications in the venous system caused by dysfunctional valves and venous reflux.[3] Differentials related to CVD should include causes of lower extremity edema including hypoalbuminemia, cardiac insufficiency, hypothyroidism, and more.[2,4]

Chronic Venous Insufficiency

Chronic venous insufficiency (CVI) is mainly caused by ambulatory venous hypertension due to abnormal blood flow from reflux of venous valves, obstruction of venous valves, or a combination of both.[1] The causes of CVI include VVs as well as reticular veins, telangiectasias, pigmentation, edema, lipodermatosclerosis, eczema, venous ulcers, and atrophie blanche. These additional exam findings are important to note to determine differential diagnoses that could cause venous abnormalities.[5]

CEAP Classification

VVs represent one aspect of venous disease, which is generally reported using the international standard known as CEAP: Clinical-Etiology-Anatomy-Pathophysiology Classification (Table 1).[2] CEAP, which is based on clinical manifestations of chronic venous disorders, helps to standardize diagnoses, improve communications among clinicians, and facilitates research. Class C0 represents no visible sign of venous disease; classes C1–3 typically denote CVD, while classes C4-6 are indicative of the more severe CVI.

Treatment

Treatment for VVs depends upon the cause, symptomatology, and severity of the condition. Treatment of the underlying causes, conservative management, combination therapy, and interventional treatments all have their place.[5] Cosmetic treatment may also be chosen if patients are asymptomatic and more concerned with appearance[12]; however, the potential lack of

Continued on page 41

Prevent Falls & Gain

Stability

THE STABILIZER

DEVELOPED BY surestep

A GAIT STABILIZING ORTHOSIS FOR ADULTS

The Surestep Stabilizer is a device that provides mediolateral stability, as well as stabilizing the foot/ankle in the sagittal plane, facilitating clearance during swing phase for patients with dropfoot. With the carbon fiber insert on the posterior strut, the Stabilizer helps to bring the foot up as the leg swings across, but also helps to assists with deceleration of the foot after heel strike. This makes for a much more normal, natural gait.

Visit our website for resources including our **fall risk assessment** and **measurement order form**.

17530 Dugdale Drive | South Bend, IN 46635 | 877.462.0711 | surestep.net

CELIARUIZ®

It's Not Just **Footwear**
It's Your **Health**

Find Comfort in Fully Adjustable
Therapeutic Wellness Footwear

Shop Now

www.celiaruizusa.com

Phone: 410-983-3982

E-mail: info@celiaruizusa.com

Continued from page 38

medical coverage for cosmetic procedures must be discussed with patients.[19]

Conservative Management

Treatment options for VVs vary based on the concern for appearance as well as the level of pain and potential for progression of the condition. Conservative management for VVs includes modifications of lifestyle, such as avoiding straining or prolonged standing and wearing clothing that is nonrestrictive; interventions to decrease edema in lower extremities; and reduction of cardiovascular risk.[5] Additional measures such as compression stockings and phlebotonics, such as dietary supplements, are available; however, long-term evidence is lacking as compression stockings have only been recommended as first-line treatment for VVs in pregnant patients.[1,5,6] Compression stockings have been noted, however, to allow for venous return, reduce venous hypertension, and reduce effects of higher hydrostatic pressure.[6] If compression stockings do reduce symptomatology in patients, there are different classes of stockings with specific pressures that can be prescribed based upon the level of pressure a given patient can tolerate; however, a thorough examination to determine sufficiency of arterial supply should be performed prior to prescribing compression stockings to avoid vascular complications.[6] Some recent research has shown that compression stockings could potentially prolong the time to progression of VVs toward CVI.[3,12] Weight loss and elevation of the lower extremity may be helpful in some patients, as well as advice on skin care.[5,6,12]

Medical Treatment

Certain venoactive or venotrophic drugs have been used to treat VVs when the patient is symptomatic.[1,19] The goals of these drugs are to improve capillary permeability and venous tone; however, there is a lack of data to support their use and the exact mechanism of these medications is unknown.[1] There is data to show that micronized purified flavonoid fraction (MPFF)[10] can reduce symptoms of pain and heaviness in the legs, frequency of leg cramps at night, and great saphenous vein reflux in the evening.[10,20] These medications are only used for symptomatic support and do not treat underlying causes of venous reflux.[19]

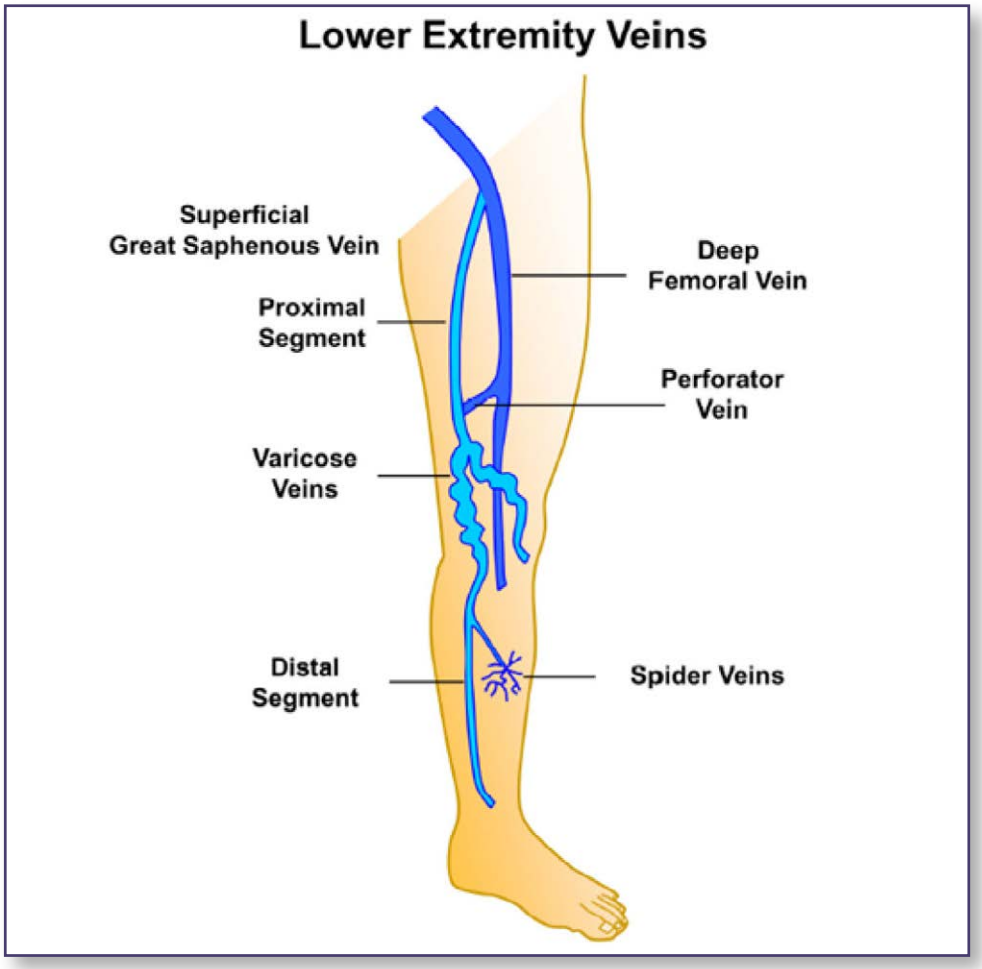


Figure 1: The lower extremity venous system, and changes to varicose veins. The lower extremity has an intricate system of superficial and deep veins connected by perforator veins. Excessive vein wall dilation and incompetent venous valves lead to superficial dilated spider veins or engorged and tortuous varicose veins. Image reprinted from Chen Y, Peng W, Raffetto JD, Khalil RA. Matrix Metalloproteinases in Remodeling of Lower Extremity Veins and Chronic Venous Disease. Prog Mol Biol Transl Sci. 2017;147:267-299. DOI: 10.1016/bs.pmbts.2017.02.003. Elsevier Copyright ©2017; all rights reserved.

Although minimal data exists within the last 5 years, a 2016 article published in the *Journal of the American Heart Association* indicated that 2 medications, atorvastatin and rosuvastatin, partially inhibited varicose vein development by interfering with proteins involved with stress mediating activity in venous smooth muscle cells.[21] The authors also theorized that these medications may also reduce recurrence of VVs after surgical repair of varicosities. In a 2022 paper where researchers were studying the effects of atorvastatin on the venous system, they also found that the anti-inflammatory properties of statins may slow the progression of CVD in general.[22] This study referred to other data regarding the relationship between statins and thromboembolism as well as CVI, but noted that additional studies need to be performed with long-term data to determine the full effects of statins on CVD.

Non-surgical Cosmetic Treatment

Sclerotherapy: Sclerotherapy with sclerosing agents and use of ultrasound has been shown to cause vasoconstriction, thrombosis, and occlusion in VVs,[3] and has been noted to be the least invasive percutaneous technique for closure of VVs.[1] Foam sclerotherapy could be considered in pregnant patients only if a bleeding VV causes transfusions or recurrent hospitalizations.[6] Sclerotherapy is usually preferred for smaller and medium sized veins, 1–3 mm, and 3–5 mm respectively, or in the treatment of post-surgical recurrent VVs.[5,23]

Continued on page 42

Continued from page 41

Table 1.[2] Last Revision of CEAP Classification on CVD.

Clinical (C) Classification		Etiologic (E) Classification		Anatomic (A) Classification		Pathophysiologic (P) Classification	
Co	No visible or palpable signs of venous disease	Ep	Primary	As	Superficial	Pr	Reflux
C1	Telangiectasias or reticular veins	Es	Secondary	Old	New Description	Po	Obstruction
C2	Varicose veins	Esi	Secondary-intravenous	1.	Tel Telangiectasia	Pro	Reflux and obstruction
C2r	Recurrent varicose veins	Ese	Secondary—extravenous	1.	Ret Reticular veins	Pn	No pathophysiology identified
C3	Edema	Ec	Congenital	2.	GSVa Great saphenous vein above knee		
C4	Changes in skin and subcutaneous tissue secondary to CVD	En	No cause identified	3.	GSVb Great saphenous vein below knee		
C4a	Pigmentation or eczema			4.	SSV Small saphenous vein		
C4b	Lipodermatosclerosis or atrophie blanche			AASV	Anterior accessory saphenous vein		
C4c	Corona phlebectatica			5.	NSV Nonsaphenous vein		
C5	Healed			Ad	Deep		
C6	Active venous ulcer			6.	IVC Inferior vena cava		
C6r	Recurrent active venous ulcer			7.	CIV Common iliac vein		
				8.	IIV Internal iliac vein		
				9.	EIV External iliac vein		
				10.	PELV Pelvic veins		
				11.	CPV Common femoral vein		
				12.	DPV Deep femoral vein		
				13.	FV Femoral vein		
				14.	POPV Popliteal vein		
				15.	TIBV Crural (tibial) vein		
				15.	PRV Peroneal vein		
				15.	ATV Anterior tibial vein		
				15.	PTV Posterior tibial vein		
				16.	MUSV Muscular veins		
				16.	GAV Gastrocnemius vein		
				16.	SOV Soleal vein		
				Ap	Perforator		
				17.	TPV Thigh perforator vein		
				18.	CPV Calf perforator vein		
				An	No venous anatomic location identified		

CEAP: clinical-etiology-anatomy-pathophysiology; CVD: Chronic venous disease.

Image reprinted from reference 2. Use is per the Creative Commons Attribution (CC BY) license.

Laser Treatment

Thermal Ablation with Endovenous Laser Therapy or Radiofrequency Ablation: Ablation therapy uses heat to repair damaged veins. Two key methods, an external laser or an endovenous catheter used in endovenous laser therapy (EVLT) or radiofrequency waves, used in radiofrequency ablation (RFA), use heat to clot and close the vein in order to reroute the flow of blood to competent veins.[5,24,25] EVLT, also known as endovenous later ablation (EVLA), has shown benefits such as reduction of damage to surrounding tissues and less downtime for patients who chose this option over surgical treatment.[26] External laser ablation works best for telangiectasias, whereas EVLT is more appropriate for larger veins.[5] Additional forms of endovenous thermal ablation include steam vein sclerosis (SVS) and endovenous microwave ablation.[19]

Non-Thermal, Non-Tumescent Techniques (NTNTs)

Mechanochemical Ablation and Cyanoacrylate Glue: One of the newer forms of treatment involves 2 additional options known as mechanochemical ablation (MOCA) and cyanoacrylate glue (CAG).[27] These techniques, however, are not considered first line for VV treatment, due to a lack of long-term studies as well as the lack of indication in the algorithm provided by the National Institute of Clinical Evidence (NICE).[27] These options have been successful for pain symptoms and a reduction in injury to surrounding nerves. A comprehensive review of treatments for chronic venous disorder published in 2021 discussed these new techniques, with terms of MOCA and cyanoacrylate embolization (CAE)[28] as possibly establishing this technique as a newer novel system in the future for treatment options of venous disease. However, cost may outweigh the benefits of using cyanoacrylate treatment for VVs in today's economic environment.[2,29]

Surgical Treatment

Surgical treatment options are dependent on VV location. For example, surgery is the main treatment for greater saphenous varicose veins (GSSV).[30] For many years, the standard of treatment for VVs was open surgical therapy,[3] with high litigation stripping of the greater saphenous vein, along with removing large VVs; however, due to complications, endovenous ablation therapy has become the more commonly used VVs surgical treatment.[1,3] Treatment for VVs today mainly involves the use of venoactive drugs for CEAP levels C0–C2 along with sclerotherapy and endovenous treatment,[31,32] although endovenous treatment needs further data for comparison to the surgical approaches.[3] In a 5-year trial for different VVs treatments, participants were found to have improved quality of life after surgery or ablation compared to those treated with foam

Table 2.[34] List of complications on which consensus was reached for varicose vein treatment.

Major	1	Allergic reaction requiring treatment to be aborted and medication to be started or to treatment being aborted and ventilator support as a result of medication
	2	Cellulitis requiring hospital admission for treatment with IV antibiotics or IV antibiotics and ICU support due to hemodynamic instability
	3	Deep wound infection requiring surgical debridement
	4	Hemorrhage requiring one blood transfusion, blood transfusion and limited surgical or endovascular interventions or massive transfusion and extensive surgical intervention
	5	Pulmonary embolism requiring anticoagulant therapy or surgical therapy due to hemodynamic instability
	6	Skin necrosis requiring surgical debridement or split skin graft
	7	Arteriovenous fistula formation requiring endovascular repair or surgical repair
	8	Deep venous thrombosis requiring long-term anticoagulant therapy or lytic therapy
	9	Lymphocele requiring drainage or lymphorrhea with permanent debilitating edema or continuous lymphorrhea
	10	First-degree thermal injury requiring no additional treatment, second-degree thermal injury requiring a topical agent, or third-degree thermal injury requiring surgical intervention
	11	Transient ischemic attack resolved within 24h or stroke resulting in mild or temporary cognitive function impairment or stroke with permanent disability and inability to live independently
	12	Permanent discoloration
Minor	1	Discoloration that resolves after six weeks
	2	Ecchymosis that limits the patient to wearing posttreatment compression stockings
	3	Erythema self-limiting after two weeks
	4	Posttreatment pain requiring no additional treatment
	5	Superficial thrombophlebitis requiring analgesics for two weeks or no additional therapy
	6	Telangiectatic matting requiring additional sclerotherapy or endovenous therapy or no additional therapy
	7	Contact allergy to plaster requiring use of a different plaster
	8	Incomplete obliteration requiring reintervention or no additional intervention
	9	Migraine including migraine aura, requiring triptan therapy after sclerotherapy
	10	Hyperpigmentation resolved within 12 months
	11	Paresthesia resolved within 12 months
	12	Posttreatment pruritus causing skin rash due to scratching

ICU: intensive care unit; IV:

Image reprinted from reference 34. Use is per the Creative Commons Attribution (CC BY) license.

sclerotherapy.[33] The authors of this trial did, however, note that long-term effectiveness needed additional evaluation.

Treatment Discussion That May be Covered for Advanced Classification (C3 and higher)

As mentioned, VVs are noted at level C2 in the CEAP classification. Conditions rated higher than C2 are related to CVI and treatments may not be covered by insurance due to differences in approval of treatments for higher levels of classification. Many of these treatments are specific for first-line options depending upon the CEAP grade as well as the specific vein location. Therefore, only an overview will be discussed for additional treatment options. Both ambulatory, micro-phlebotomy, and transilluminated power phlebotomy have data indicating benefits of post-procedural evaluations.[3] A study published in 2022 noted that patients who underwent subfascial endoscopic perforator surgery (SEPS) along with EVLT had outcomes that showed reduced blood loss, operative time, hospitalization time, and stress response on the body, as well as improved treatment effect.[30] Stab phlebotomy, also known as hook phlebectomy, mini-phlebectomy, and ambulatory phlebectomy, was used prior in conjunction with vein stripping or ligation, but currently is used with ablation of the saphenous vein. More advanced surgical techniques such as stent implantation and bypass surgery are typically reserved for patients with advanced CVI who have failed previous interventions.[1] Valvuloplasty procedures, where a valve from either the axillary or brachial vein is used for surgical reconstruction of incompetent valves, are also reserved for patients with more advanced disease.[1] Earlier referral to a vascular surgeon for VVs, however, should be considered if the patient is at risk for thromboembolism after treatment or if the patient develops severe CVI that would warrant a surgical intervention.[6]

Treatment Options & Complications

VVs can increase the potential for superficial thrombophlebitis, pain, external hemorrhage, and progressive disease that may include the development of leg ulcers, infection, and other signs of CVI.[5,6] Complications of treatments can include recurrence of VVs,[6,12] staining of the skin, nerve injury, thrombophlebitis, bleeding, and allergic reactions.[6] Weighing the risk/benefit ratio for treatment will be important, as well as discussing costs, particularly if the cost of the chosen procedure is not covered by health insurance. Additional complications of treatments for VVs are noted in Table 2,[34] which is a consensus of 43 clinicians that includes 12 major and 12 minor

Continued on page 45

The path to FOOT PAIN RELIEF *has never been* EASIER

NEW CUSTOM POLY

NEW RICHIE BRACES

Better for YOU. *Better for* YOUR PATIENTS.

$

Northwest Podiatric Laboratory provides industry-leading value

✓

Everything you need - custom & OTC orthotics, scanning, AFOs & more

Since 1964

Unbeatable NWPL support, reliability & patient outcomes for nearly six decades

EST. NW 1964
PODIATRIC LABORATORY

LEARN MORE AT NWPODIATRIC.COM

Continued from page 43

complications that should be communicated to patients who are considering treatments including sclerotherapy, open surgery, and endovascular treatments.

Prevention

Counseling patients to elevate legs and monitor skin for changes should be part of routine communication for prevention of VVs.[12] Predisposing factors, such as being overweight or obese, and sedentary lifestyle risks should be communicated with patients to reduce the development of VVs as well as stall the progression time to later-stage CVI.[3] In female patients, risks regarding pregnancy and the use of estrogen supplements should be discussed as preventtive measures, particularly if there is a family history of VV. ler

"Varicose Veins of the Lower Extremities: A Primer Part I" appeared in the August issue of Lower Extremity Review and can be found here: https://lermagazine.com/article/varicose-veins-of-the-lower-extremities-a-primer-part-i

Angela Kelley, PA-C, is Associate Professor and Director of Didactic Education, Physician Assistant Program at Gannon University in Ruskin, Florida, and a Regional Director Health Coach with Optavia (www.optavia.com/us/en/coach/angela).

References

1. Youn YJ, Lee J. Chronic venous insufficiency and varicose veins of the lower extremities. Korean J Intern Med. 2019;34: 269–283. doi.org/10.3904/kjim.2018.230.
2. Ortega MA, Fraile-Martinez O, Garcia-Montero C, et.al. Understanding chronic venous disease: A critical overview of its pathophysiology and medical management. J Clin Med. 2021;10(15):3239. doi: 10.3390/jcm1015323.
3. Raffetto JD, Khalil RA. Mechanisms of lower extremity vein dysfunction in chronic venous disease and implications in management of varicose veins. Vessel Plus. 2021;5:36. doi: 1020517/2574–1209.2021.16.
4. Trayes KP, Studdiford, JS, Pickle S, Tully AS. Edema: diagnosis and management. Am Fam Phys. 2013;88:102–110.
5. Raetz J, Wilson M, Collins K. Varicose veins: diagnosis and treatment. Am Fam Phys. 2019;99(11):682–688.
6. Atkins E, Mughal NA, Place F, et al. Varicose veins in primary care. BMJ. 2020;370:m2509. doi.org/10.1136/bmj.m2509.
7. Onida S, Lane TR, Davies AH. Improving the management of varicose veins. Practitioner. 2013 Nov-Dec;257(1766):21-4, 2–3.
8. Pollack AA, Taylor BE, et al. The effect of exercise and body position on the venous pressure at the ankle in patients having venous valvular defects. J Clin Invest. 1949;28(3):559–63.
9. Shadrina AS, Sharapov SZ, Shashkova TI, Tsepilov YA. Varicose veins of the lower extremities: Insights from the first large-scale genetic study. PLOS Genet. 2019;15(4): e1008110. PMID: 30998689. doi: 10.1371/journal.pgen.1008110.
10. Davies AH. The seriousness of chronic venous disease: A review of real-world evidence. Adv Ther. 2019;36(Suppl 1):S5-S12. doi.org.10.1007s12325-019-0881-7.
11. Raffetto JD, Ligi D, Maniscalco R, et al. Why venous leg ulcers have difficulty healing: Overview on pathophysiology, clinical consequences, and treatment. J Clin Med. 2021;10(1)29. doi.org/10.3390/jcm10010029.
12. Lumley E, Phillips P, Aber A, et al. Experiences of living with varicose veins: A systematic review of qualitative research. J Clin Nurs. 201928(7-8):1085-1099. doi: 10.1111/jocn14720.
13. Racette S, Sauvageau A. Unusual sudden death: two case reports of hemorrhage by rupture of varicose veins. Am J Forensic Med Pathol. 2005;26(3):294–296. doi: 10.1097/01.paf.0000176283.19127.0e.
14. Sudoł-Szopi´nska I, Bogdan A, Szopinski T, Panorska AK, Kołodziejczak M. Prevalence of chronic venous disorders among employees working in prolonged sitting and standing postures. Int. J Occup Saf Ergon. 2011;17(2):165–173. doi: 10.1080/10803548.2011.11076887.
15. Sharma S, Vashist M, Vashist MG. Family history as major predisposing factor in varicose veins disorder. Eur J Biomed Pharm Sci. 2017;4(12):392–396.
16. 16. Vlajinac HD, Radak DJ, Marinkovi´c JM, Maksimovi´c MŽ. Risk factors for chronic venous disease. Phlebology 2012,27, 416–422. doi.org/10.1258/phleb.2011.011091.
17. Gloviczki P, Comerota AJ, Dalsing MC, et al. The care of patients with varicose veins and associated chronic venous diseases: clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum. J Vasc Surg. 2011;53(5 suppl):2S–48S. doi.org/10.1016/j.jvs.2011.01.079
18. National Institute for Health and Care Excellence. Varicose veins: diagnosis and management. Clinical guideline 168. July 2013. https://www.nice.org.uk/guidance/cg168. Accessed May 21, 2018.
19. Whiteley MS. Current best practice in the management of varicose veins. Clin Cosmet Investig Dermatol. 2022; 15: 567–583. doi.org/10.2147/CCID.S294990.
20. Tsukanov YT, Tsukanov AY. Diagnosis and treatment of situational great saphenous vein reflux in daily medical practice. Phlebolymphology. 2017;24(3):144–151.
21. Eschrich J, Meyer R, Kuk H, et.al. Varicose Remodeling of Veins Is Suppressed by 3-Hydroxy-3-Methylglutaryl Coenzyme A

VVs are noted at level C2 in the CEAP classification; conditions rated higher than C2 are related to CVI and treatments may not be covered by insurance due to differences in approval processes...

Continued on page 46

Continued from page 45

Reductase Inhibitors. J Am Heart Assoc. 2016 Feb 23;5(2):e002405. doi: 10.1161/JAHA.115.002405.

22. Matei SC. Statins - From Lipid-Lowering Benefits to Pleiotropic Effects. Statins Effects on Venous Wall in Patients with Chronic Venous Disease. Intech Opening.2023. doi: 10.5772/intechopen.1001303.
23. Tisi PV, Beverley C, Rees A. Injection sclerotherapy for varicose veins. Cochrane Database Syst Rev. 2006(4):CD001732.
24. Reichert D. Evaluation of the long-pulse dye laser for the treatment of leg telangiectasias. Dermatol Surg. 1998;24(7):737–740.
25. Paravastu SC, Horne M, Dodd PD. Endovenous ablation therapy (laser or radiofrequency) or foam sclerotherapy versus conventional surgical repair for short saphenous varicose veins. Cochrane Database Syst Rev. 2016(11):CD010878.
26. Kremastoptis J, Jfri A, Litvinov IV. Treatment modalities for varicose veins of lower extremities. J Cutan Med Surg. 2020. 24(2) 203-204. doi: 10.1177/1203475419891082.
27. Chan SJ, Chan YC, Walsh SR, et.al. Endovenous cyanoacrylate ablation for chronic venous insufficiency and varicose veins among Asians. Ann Acad Med Singap. 50 (3). 2021. doi.annals.edu.sg
28. Chaitidis N, Kokkinidis DG, Papadopoulou Z, et.al. Treatment of chronic venous disorder: A comprehensive review. Dermatol Ther. 2022;35:e15238. 1–15. doi.org/10.1111/dth.15238.
29. Cavezzi,A. Medicine and Phlebolymphology: Time to Change? J.Clin.Med.2020,9,4091.
30. Wang, L. Du, J., Zhang, H. Study of Subendoscopic Perforator Surgery Combined with Endovenous Laser Treatment in the Treatment of Great Saphenous Varicose Veins. J. Healthc. Eng. 2022. doi.10.1155/2022/1801099.
31. Mansilha, A. Early stages of chronic venous disease: medical treatment alone or in addition to endovenous treatments. Adv Ther. 2020 37:S13-S18. doi.org/10.1007/s12325-019-01217-9.
32. Nicolaides A, Kakkos S, Baekgaard N, et al. Management of chronic venous disorders of the lower limbs. Guidelines according to scientific evidence. Part I. Int Angiol. 2018;37(3):181–254. doi: 10.23736/S0392-9590.18.03999-8
33. Brittenden J, Cooper D, Dimitrova M, et.al. Five-year outcomes of a randomized trial of treatments for varicose veins. N Engl J of Med. 2019. 381:10. 912–922. doi: 10.1056/NEJMoa1805186.
34. deMik SML, Stubenrouch FE, Legemate DA, et.al. Treatment of varicose veins, international consensus on which major complications to discuss with the patient: A Delphi study. Phlebology. 2018. 34(3) 201–207. doi: 10.1177/0268355518785482.

SUGGESTED FURTHER READINGS

1. Gloviczki P, Lawrence PF, Wasan SM, et al. The 2023 Society for Vascular Surgery, American Venous Forum, and American Vein and Lymphatic Society clinical practice guidelines for the management of varicose veins of the lower extremities. Part II: Endorsed by the Society of Interventional Radiology and the Society for Vascular Medicine. J Vasc Surg Venous Lymphat Disord. 2024 Jan;12(1):101670. doi: 10.1016/j.jvsv.2023.08.011.
   This Part II of their guidelines focuses on evidence supporting the prevention and management of varicose veins with compression, drug therapies and nutritional supplements, evaluations of varicose tributaries and superficial venous aneurysms, and management of complications.
2. Singh A, Gattani R. A Narrative Review of Advancements in Understanding and Treating Varicose Veins. Cureus. 2023 Nov 1;15(11):e48093. doi: 10.7759/cureus.48093.
   Varicose veins, marked by the presence of dilated and tortuous subcutaneous vessels, precipitate both physical discomfort and cosmetic concerns, frequently necessitating meticulous clinical evaluation coupled with ultrasound studies to secure a precise diagnosis.
3. Tan J, Chen Y, Huang J, Xu W. A systematic review of endovenous ablation for the treatment of small saphenous varicose veins. Vasa. 2023 Nov;52(6):355-365. doi: 10.1024/0301-1526/a001091.
   This systematic review summarizes the results of existing studies on endovenous ablation for the treatment of small saphenous varicose veins, compares its role and efficacy, and provide insights into the future development of endovenous ablation for treating small saphenous varicose veins.
4. Fonseca MM, Mocelin FJ, Poltronieri LR, Guimaraes Filho JL. Treatment of varicose veins using the Cryo laser after foam technique. J Vasc Surg Cases Innov Tech. 2024 May 29;10(4):101549. doi: 10.1016/j.jvscit.2024.101549.
   Cryo laser after foam sclerotherapy is a procedure to treat reticular veins in the lower extremities that utilizes first foam sclerotherapy with polidocanol then immediately followed by transdermal Nd:YAG 1064 laser treatment and can treat veins ≤5 mm.

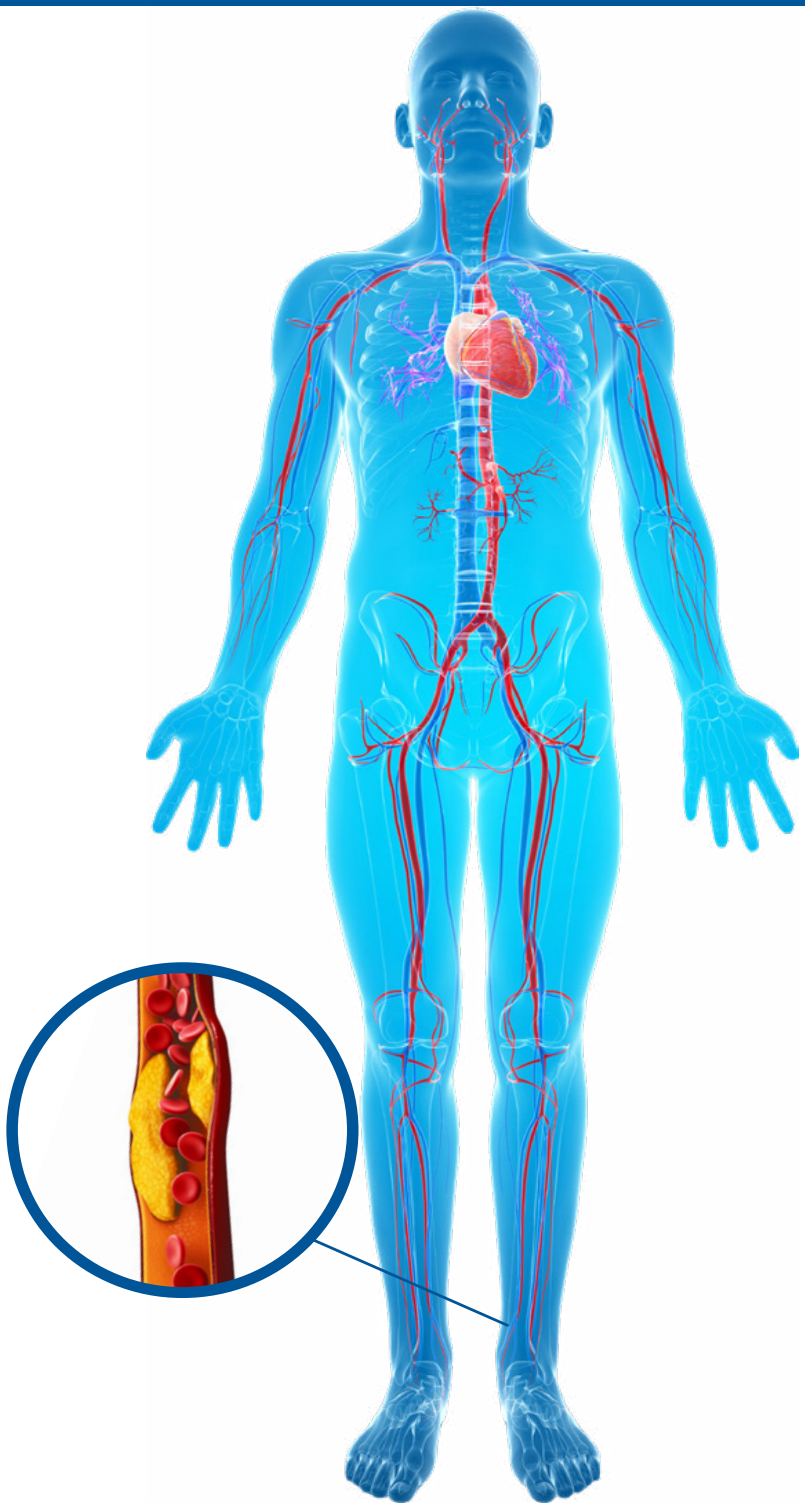
Peripheral Artery Disease

Peripheral Artery Disease (PAD) is a deadly chronic condition that can lead to heart attack, stroke, or amputation.

1 in 3

- » Diabetics age 50+
- » Smokers age 50+
- » Everyone age 70+

Have PAD



$390 billion

annual US healthcare costs attributable to PAD

100,000 amputations

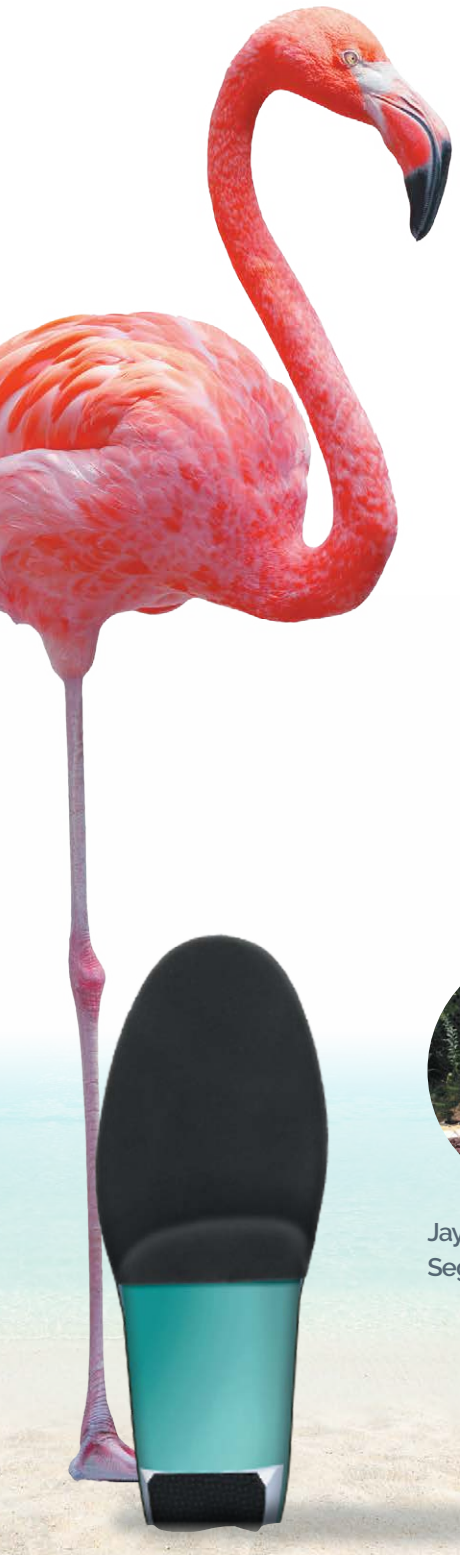
of lower extremities in the US annually, due to vascular disease

Market-Tested
Over One Million Tests Performed
Market-Trusted

Biomedix is a market leader in PAD diagnostics, delivering products and services that feature a cloud-based platform enabling community-based collaborative care.

Visit **biomedix.com** to discover more about how we can help you cost-effectively save limbs and save lives.

PATIENTS LOVE US.
DOCTORS LOVE US.
But don't take our word for it...



"I've been in practice 20 years and sports medicine/ orthotics is the mainstay of my practice. I have never seen a lab produce such a great product with such fast turnaround time. Their app is amazing for submitting and tracking orders. Most importantly, my patients LOVE them and many request a 2nd pair.

If you want a lab that actually makes your life easier...Orthotica is it!"

Misty McNeill, DPM,
Weil Foot & Ankle

Jay Segel, DPM
Segel Podiatry

"For over four decades, I have been in private practice on Martha's Vineyard, specializing in biomechanics, orthotics, and rehabilitative podiatric medicine. Orthotica's app scanning, ordering, and tracking modules are intuitive and easy to use for myself and my staff, and the patients find it fascinating.

I have found the products, personnel and practices at Orthotica to be exceptional!"

ORTHOTICA Labs

YOU CAN LOVE US TOO!

To open your Orthotica account or for more information, call:

888.895.1305

orthotica.com

Can Biofeedback Improve Biomechanical Factors Associated with CAI?

By Seyed Hamed Mousavi, Fateme Khorramroo, Hooman Minoonejad, and Johannes Zwerver

Restoring correct ankle biomechanics is essential for maintaining long-term joint health of the ankle in patients with chronic ankle instability.

Lateral ankle sprain (LAS) is 1 of the most common musculoskeletal injuries in athletes and the general public. Incomplete recovery and inadequate restoring of function due to lack of appropriate rehabilitation can lead to chronic ankle instability (CAI). Loss of passive ligamentous stability and deficits in neuromuscular control and strength reduce the ability to protect the joint from sudden perturbation, further exacerbating the risk of re-injury. CAI alters normal biomechanics to a greater ankle inversion and laterally deviated center of pressure (COP), thus increases risk of recurrent giving-way of the ankle, ligament sprains, and back pain through changes in the kinematic chain over time. This can also result in abnormal stresses across the talar cartilage (post-traumatic osteoarthritis development). Therefore, restoring correct ankle biomechanics is essential for maintaining long-term joint health of the ankle in patients with CAI.

Biofeedback may alter the biomechanics of lower extremities in patients with CAI. However, no systematic review with meta-analysis reviewing the studies investigating the effect of biofeedback on biomechanical factors associated with CAI has been published. Therefore, this study aimed to systematically review the literature on the effect of gait training and biofeedback on biomechanical parameters in individuals with CAI and conduct a meta-analysis. The research question of this study was: can biofeedback improve biomechanical factors associated with CAI?

Methods

The study authors searched 4 databases including PubMed, Web of Science, Scopus, and Embase from their inception through June 30, 2022. The Downs and Black appraisal scale was applied to assess quality of included studies. Two reviewers screened studies to identify those reporting the effect of biofeedback on biomechanical factors associated with CAI. Outcomes of interest were kinetics and kinematics. Two authors separately extracted data from included studies. Data of interest were study design, number of sessions, intervention, tools, outcomes, number, sex, age, height, and body mass of participants.

This article has been excerpted from "Effects of biofeedback on biomechanical factors associated with chronic ankle instability: a systematic review with meta-analysis." BMC Sports Sci Med Rehabil 15, 168 (2023). https://doi.org/10.1186/s13102-023-00780-7. Editing has occurred, including the renumbering or removal of tables and figures, and references have been removed for brevity.

Continued on page 50

Continued from page 49

leading to a total of 13 included studies.

Results

Thirteen studies with a total of 226 participants were included. Biofeedback was capable of shifting COP and lateral plantar pressure medially and reducing foot inversion, adduction, propulsive vertical ground reaction force (vGRF), ankle joint contact force, peak pressure, and pressure time integral in the lateral midfoot and forefoot. Auditory biofeedback had a greater impact on modifying plantar pressure in individuals with CAI. The meta-analyses revealed that visual biofeedback reduces peak pressure in lateral midfoot and pressure time integral at lateral and medial heel and pressure increases under the hallux.

Discussion

The study authors aimed to systematically review the effect of gait training and biofeedback on biomechanical parameters in individuals with CAI. Thirteen studies were included. Three studies assessed visual, 2 assessed auditory, and 1 study assessed both visual and auditory feedback. Two studies assessed a novel device and 5 investigated vibration feedback. The following biomechanical variables were assessed in the included studies: ankle, knee and hip kinematics, plantar pressure, COP, vGRF, joint contact force (JCF), and maximum Force. Moderate evidence suggests that visual biofeedback results in a significant decrease in pressure time integral in lateral and medial heel and significant increase in hallux and decreased peak pressure in total foot and lateral mid-foot. There was no significant difference in pressure contact time and pressure contact area.

There is moderate evidence that visual biofeedback to individuals with CAI is effective in reducing pressure time integral in medial and lateral heel, reducing peak pressure, and in increasing pressure time integral in hallux. All included studies support the use of visual, auditory, haptic, and the novel devices biofeedback during gait and different tasks on lower limb biomechanics in individuals with CAI.

Effect of a gait-training device

Gait training with the novel device decreased pressure on the lateral column of the foot and shifted the COP medially during the stance phase and increased peroneus longus muscle activity with large effect sizes for all comparisons. In comparison, a systematic review assessing the effect of kinesio-taping in individuals with CAI, concluded that kinesio-taping reduces muscle activity of the peroneus longus and range of motion on inversion and eversion. Due to the small sample size and short follow-up, the study authors stated that they cannot speculate on the long-term effects or utility of the gait training device in a clinical setting.

Effect of vibration biofeedback

None of the 5 studies investigated the long-term effect of vibration feedback in individuals with CAI. COP shifted medially in 1 study, but the study was laboratory-based and had a small sample size. Two laboratory-based studies showed significant decrease in joint and ground forces and real-world showed no difference in vGRF loading rate. Vibration feedback can improve gait mechanics in this small sample size after laboratory training but not real-world training. A single session of real-world gait retraining with vibration feedback decreased lateral COP during gait and excessive inversion and adduction during loading response, that are 2 risk factors for recurrent ankle sprains. However, real-world training probably has better frontal plane alterations although a longer training time is required due to practice variability such as changing speed, walking surfaces which improves immediate motor learning outcomes.

Effect of visual biofeedback

Using external biofeedback (the use of laser for feedback comparing to video or mirror) during early phases of task learning and especially when manipulating an automated skill such as walking leads to greater motor learning, retention, and longer lasting improvements. Further refinement for cues or low-cost gait training interventions might be required to modify plantar pressure measures. The results regarding the medial shift of plantar pressure and COP measures in the shoe-mounted laser study are compatible with the suggestions to alleviate lateral COP during walking. Visual feedback with the use of laser is clinically available. In previous studies, 4 weeks of balance training was ineffective at improving inversion/eversion. Kinematics and comprehensive rehabilitation were also incapable of restoring normal gait and specifically targeting the gait is required. The study by Koldenhoven et al proposes that to immediately alter gait biomechanics, a specific training program that addresses the kinematics and kinetics outcomes should be included in standard rehabilitation procedures. It is unclear how long-lasting the effects of visual feedback on ankle inversion angle would be, as the study is lab-based. The shoe-mounted laser technique is clinically available; however, its effectiveness was assessed in a single session of gait training. A previous study examined the effects of midfoot strike gait retraining in healthy individuals, used multiple sessions; no difference was observed in loading rate and in promoting a midfoot strike versus rearfoot strike after removing the visual feedback. In the study by Koldenhoven et al, 8 weeks of kinematic feedback during walking resulted in decreased inversion at initial contact and decreased peak inversion across the entire stance phase. While the Koldenhoven results showed no significant differences in initial contact, these differences can be explained by the timing of the feedback. The visual kinematic feedback was given simultaneously with initial contact, requiring participants to actively adjust their contact for successful outcome. In contrast, the vibration feedback was given later in the gait cycle, allowing participants to make changes only during the loading phase. Changing initial contact with vibration feedback would require transferring the new kinematic pattern without feedback. This transfer likely did not occur after 1 session. Thus, the timing of feedback during the gait phase may affect immediate results, but more research is needed to confirm. However, these changes were not clinically meaningful considering their small percentage changes and effect sizes for the real-time video feedback.

Effect of auditory biofeedback

The auditory biofeedback was effective in reducing plantar pressure on the lateral part of foot and changing the COP medially. The device is available to clinicians but a longer follow-up period is required to support the potential effects on

treating patients with CAI. According to evidence, postural control continuously improves when balance training is used along with an external focus of attention. Individuals with CAI relied more on visual stimulus and traditional balance-training programs are not capable of altering the visual reliance.

After evaluating the findings of included studies, it is evident that various forms of biofeedback are able to correct lower limb biomechanics. However, when comparing the different types of biofeedback, it is notable that external feedback achieved better effects on outcomes than internal biofeedback and auditory biofeedback achieved better results in plantar pressure; further investigation is required to determine which mode of external feedback or a multimodal biofeedback is most appropriate in individuals with CAI.

All included studies investigated the young population and many were strongly lab-based. Moreover, according to the results of this study, assessing muscle activity is required in future investigations. Investigations in muscle performance is required in future studies in order to alter gait mechanics in individuals with CAI. To be able to apply results to geriatric practice, future studies should focus on biofeedback systems that facilitate implementation in everyday clinical practice and enable for practicing of tasks that resemble everyday life challenges. Recent progress in technology for wearable, wireless systems to monitor human motion can ease the development of biofeedback systems used in the everyday home environment.

Since all of the assessed biomechanical factors contribute to CAI, investigation on other factors leading to recurrent LAS is recommended.

Conclusion

This systematic review with meta-analysis shows that biofeedback-gait-training has a positive effect on CAI and results in improvement of biomechanical outcomes (ie, plantar pressure, vGRF, JCF, COP, ankle inversion) and leads to a more normal gait pattern. However, more studies are required to support these results and assess long-term effects and clinical consequences of biofeedback or a combination of feedback on CAI in different age groups. Clinicians should consider using low-cost, user-friendly biofeedback devices in order to implement these findings in real-world conditions. By using appropriate feedback interventions, ultimately LAS and CAI can be prevented and/or treated in a more specific way by reducing plantar pressure and ankle inversion angle and improving function of the foot. ler

Seyed Hamed Mousavi, PhD, is an assistant professor with the Department of Sport Injuries and Biomechanics, Faculty of Sport Sciences and Health, University of Tehran, Iran.

Fateme Khorramroo, MSc sports biomechanics, is associated with the Department of Sport Injuries and Biomechanics, Faculty of Sport Sciences and Health, University of Tehran, Iran.

Hooman Minoonejad, is an associate professor of sport injuries and corrective exercises with the Department of Sport Injuries and Biomechanics, Faculty of Sport Sciences and Health, University of Tehran, Iran.

Johannes Zwerver, MD, PhD, is associated with the Center for Human Movement Sciences, University of Groningen, University Medical Center Groningen, The Netherlands, and with the Sports Valley, Sports Medicine, Gelderse Vallei Hospital, Ede, The Netherlands.

Wound Care Game Changer

Help More Patients Relieve Plantar Pathologies — Offload In Their Shoes!

Introducing New PressureOFF™ Customizable Offloading Insoles from PediFix®

Reduce Pressure, Friction & Pain in Everyday Footwear

*With the proven 'removable pegs' offloading design you know, PressureOFF™ insoles help prevent, relieve and promote healing of common plantar pathologies — **in ordinary shoes** — for higher compliance and better outcomes.*

If pressure and friction offloading will benefit your patients, get them onto PressureOFF™ Insoles. Order today, request a free Sample Pack, or get more information. This is an offloading innovation with instant benefits for you, your patients and your practice.

Offload —

- Calluses
- Bursitis
- Capsulitis
- Sesamoiditis
- Warts
- Prominences
- Lesions
- IPKs
- Fat Pad Atrophy
- Bone Spurs
- Metatarsalgia
- Sensitive Areas
- Friction Zones
- Diabetic Hot Spots
- Diabetic Ulcers
- Ulcers in Remission
- Wounds
- Surgical Sites
- More

PediFix® Medical Footcare

Introductory Trial Sample Pack Offer!

Yes, I'm interested in PressureOFF™ Insoles for Offloading in patient footwear. Please send me:

☐ More information

☐ FREE Sample Trial Pack (while supplies last)

Your Name _____

Practice Name _____

Shipping Address _____

City _____ State _____ Zip _____

Phone _____

Fax _____

Email _____

In our practice, we see approximately _____ (#) patients each week.

My favorite supplier is _____

I prefer: ☐ to Dispense ☐ to Prescribe ☐ Patient Direct Order

Mail to: PediFix, Dept. LER822-P, 301 Fields Lane, Brewster, NY 10509

Fax to: 845-277-2851

Please provide all information requested.

*This offer is for healthcare professionals only. Limit one free sample per customer.

To order, get a free sample* or more information, mention code LER822-P

Call: 1-800-424-5561

Fax: 845-277-2851

E-mail: info@pedifix.com

Return this Coupon to:
PediFix, 301 Fields Lane, Dept. LER822-P, Brewster, NY 10509

Visit: www.pedifix.com/t-POIOffloading.aspx

Analysis of Ankle Instability and Posterior Malleolus Fractures

By Jichong Ying, Jianlei Liu, Hua Wang, Yunqiang Zhuang, Tianming Yu, Shuaiyi Wang, and Dichao Huang

Posterior malleolus fractures have been associated with ankle instability because the ligament pull that follows such fractures can lead to movement of the fracture fragment and consequently disrupt the weight-bearing surface's integrity.

Posterior malleolus fractures have a reported prevalence spanning 10% to 44% of all ankle fractures and are known to be associated with ankle instability and a heightened development of complications like traumatic arthritis. This adverse sequela is primarily attributed to the disrupted and intermittent contact of the articular surface, leading to degenerative changes over time. Such clinical observations have emphasized the acute intervention these fractures require and have accentuated the need to elucidate the underlying pathological mechanisms and biomechanical nuances driving their occurrence, comprehension of which holds the promise of paving the way for innovative, patient-specific treatment.

The complexities involved in obtaining precise laboratory-based spatial pressure measurements of the ankle highlight the significance of exploring the biomechanical implications of these fractures. Thus, this study aimed to identify stress concentration zones and understand the influence of sagittal angles on stress distribution in order to bridge the knowledge gap.

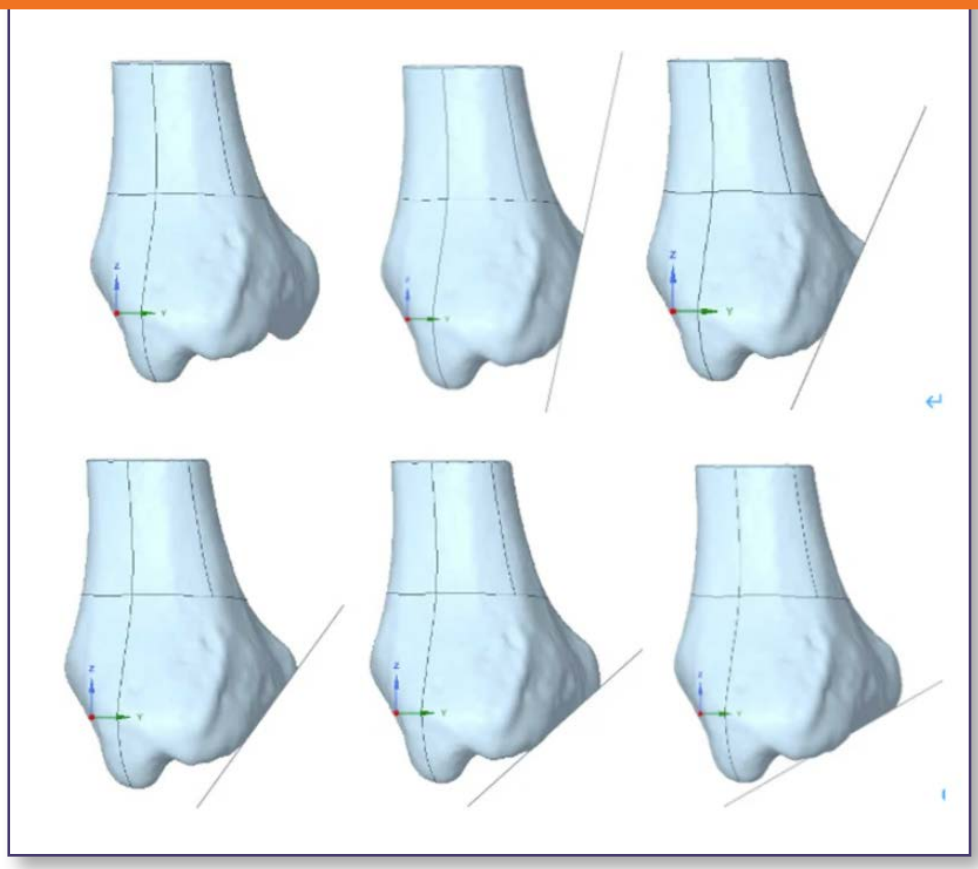


Figure 1: Comparison of the intact bone and 5 different fracture line locations. The top left image displays the intact bone, while the remaining images present varying sagittal angles from 12° to 60°

Methods

Data collection protocol began with the acquisition of 3D computed tomography (CT) scans from consenting, healthy volunteers. Special emphasis was placed on ensuring that the subjects maintained a neutral foot position throughout the scanning process, minimizing potential variations and artifacts. Spanning the length of the tibia to the depths of the foot, this rigorous scanning regimen produced a voluminous dataset of 380 high-resolution CT images of the right foot.

Within the study authors' finite element analysis (FEA) project, they mapped the intricate contact interfaces between the articular cartilage and the underlying bone. Bridging different skeletal components, they synthesized a comprehensive static analysis model, which represented the full biomechanical gamut of the ankle joint. FEA was utilized to examine the stress distribution across the contact surface of the ankle joint, both in its natural state and under varied sagittal fracture line angles. (Figure 1)

This article has been excerpted from "Biomechanical insights into ankle instability: a finite element analysis of posterior malleolus fractures." Journal of Orthopedic Surgery and Research. 2023;18(1):957. https://doi.org/10.1186/s13018-023-04432-x. Editing has occurred, including the renumbering or removal of tables and figures, and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

Continued on page 54

Continued from page 53

Results

Three distinct stress concentration zones were identified on the ankle's contact surface: the anterolateral tibia, the anteromedial tibia, and the fracture line (Figure 2).

The most significant stress was observed at the fracture line when a fracture occurs. Stress at the fracture line notably spikes as the sagittal angle decreases, which can potentially compromise ankle stability. Larger sagittal angles exhibited only minor stress variations at the contact surface's 3 vertices. It was inferred that sagittal angles below 60° might pose risks to ankle stability. (Figure 3)

Discussion

FEA was employed in this study to provide insights into the stress distribution across the contact surface of the ankle joint, both in its natural state and under varied sagittal fracture line angles. Historically, posterior malleolus fractures have been associated with ankle instability. This is because the ligament pull that follows such fractures can lead to movement of the fracture fragment and consequently disrupt the weight-bearing surface's integrity. Given the intrinsic difficulties associated with obtaining precise laboratory-based spatial pressure measurements of the ankle, this research offers a contribution.

The study authors indicated that the alignment of their model's stress predictions with those reported in empirical studies underscores its potential utility in a clinical setting. The maximum contact stress identified is particularly significant given its proximity to the values reported in cadaveric studies, which are often considered the gold standard for biomechanical analysis. This suggests that the model can reliably approximate in vivo conditions, providing a valuable tool for presurgical planning and postoperative evaluation. However, it is critical to note that while the model's contact stress predictions are within the range of those found in the literature, the exact values may vary due to differences in methodology, sample size, and the biomechanical properties assigned to the tissues in different studies. Despite these potential variations, the consistency of the results herein with those of Kimizuka et al and Guan et al reinforces the robustness of this modeling approach.

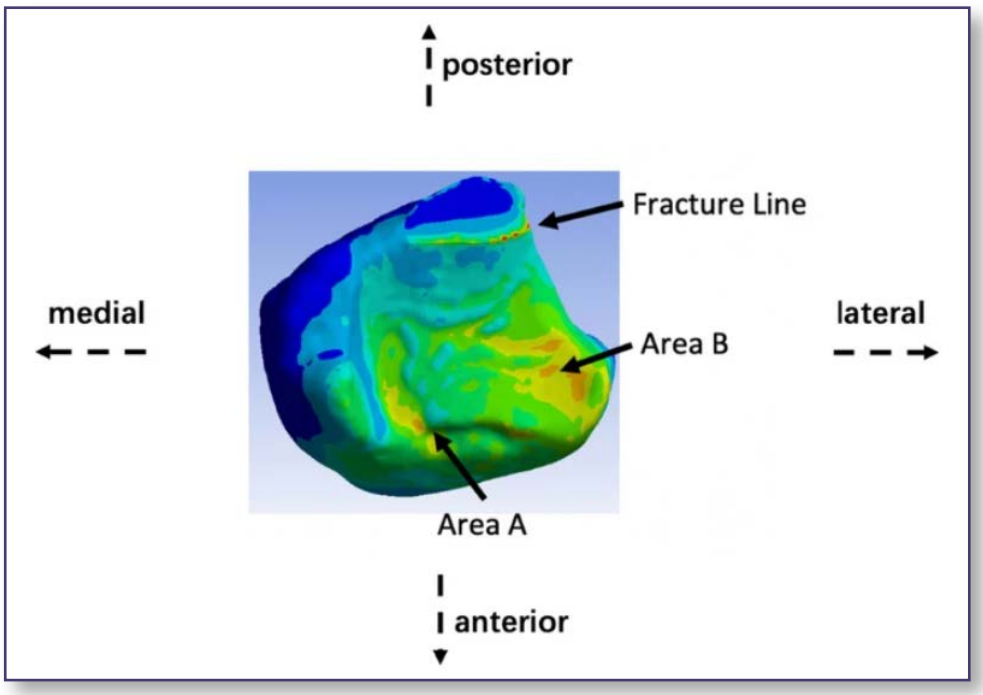


Figure 2: Area A is situated in the anteromedial quadrant of the tibia, while Area B is localized to the depressed contour of the anterolateral tibial surface.

Through meticulous modeling, this study has brought to light 3 distinct stress concentration zones on the ankle's contact surface, namely the anterolateral tibia, the anteromedial tibia, and the fracture line itself. Notably, any fractures can potentially shift the apex of this stress triad, paving the way for possible ankle instability.

While past studies have often generalized the stress distribution, the findings herein underscore the nuanced alterations that fractures introduce to the stress landscape. Moreover, these stress hotspots also align with frequently observed clinical fracture sites, shedding light on the interplay between stress redistribution and the biomechanical consequences of fractures.

One of the standout revelations of this investigation is that the most significant stress

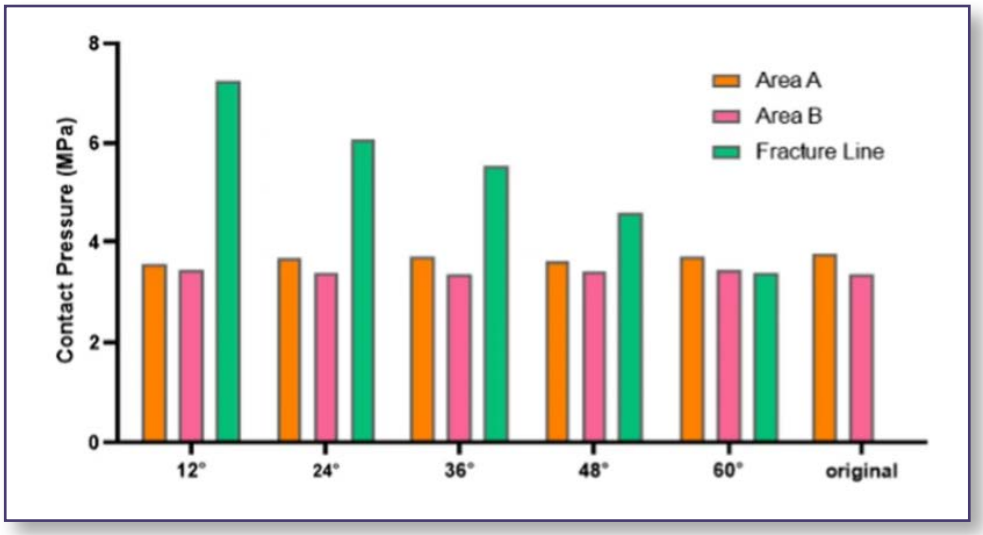


Figure 4: Contact pressure peaks at different fracture angles. Area A is situated in the anteromedial quadrant of the tibia, while Area B is localized to the depressed contour of the anterolateral tibial surface.

is exerted at the fracture line when a fracture occurs. Delving into the data presented in Figure 4, it becomes evident that larger sagittal angles (relating to smaller fracture fragments) see the stress points at the contact surface's 3 vertices exhibit only slight variations. In contrast, as the sagittal angle diminishes, stresses at both the posterolateral and posteromedial tibia largely remain static, but there is a notable spike in stress at the fracture line. Such stress escalation can compromise ankle stability. Past research endeavors have pointed out that an increase in joint contact stress, caused by fracture fragments, is a crucial factor influencing the onset of post-traumatic arthritis. The study presented here suggests that sagittal angles below 60° might pose considerable risks to ankle stability. Thus, careful evaluation of the sagittal fracture angle can be pivotal for informed therapeutic decision making. Prolonged stress exertion on the soft tissues at the fracture site might also hasten the onset of traumatic arthritis. Earlier works have identified a robust link between extensive ankle fracture fragments and the emergence of traumatic arthritis, emphasizing the need for internal fixation in cases where the fractured articular surface area of the posterior malleolus exceeds 25%. The present study reinforces these viewpoints.

The inclusion of average contact pressure data in this analysis provides a more nuanced understanding of the stress distribution across the contact surface of the ankle joint. As observed, the average contact pressure slightly diminishes with larger sagittal angles. This observation suggests that while peak stress concentrations are critical for assessing the risk of acute damage at specific points, the average stress distribution also has implications for the overall biomechanical integrity of the joint. Specifically, the reduction in average contact pressure at larger angles may reflect a distribution of force that could mitigate the risk of concentrated stress leading to fracture propagation or joint degeneration.

Heralding the merits of FEA, this research showcases its potential as an indispensable tool for a deeper understanding of posterior malleolus fractures. It provides clinicians with granular

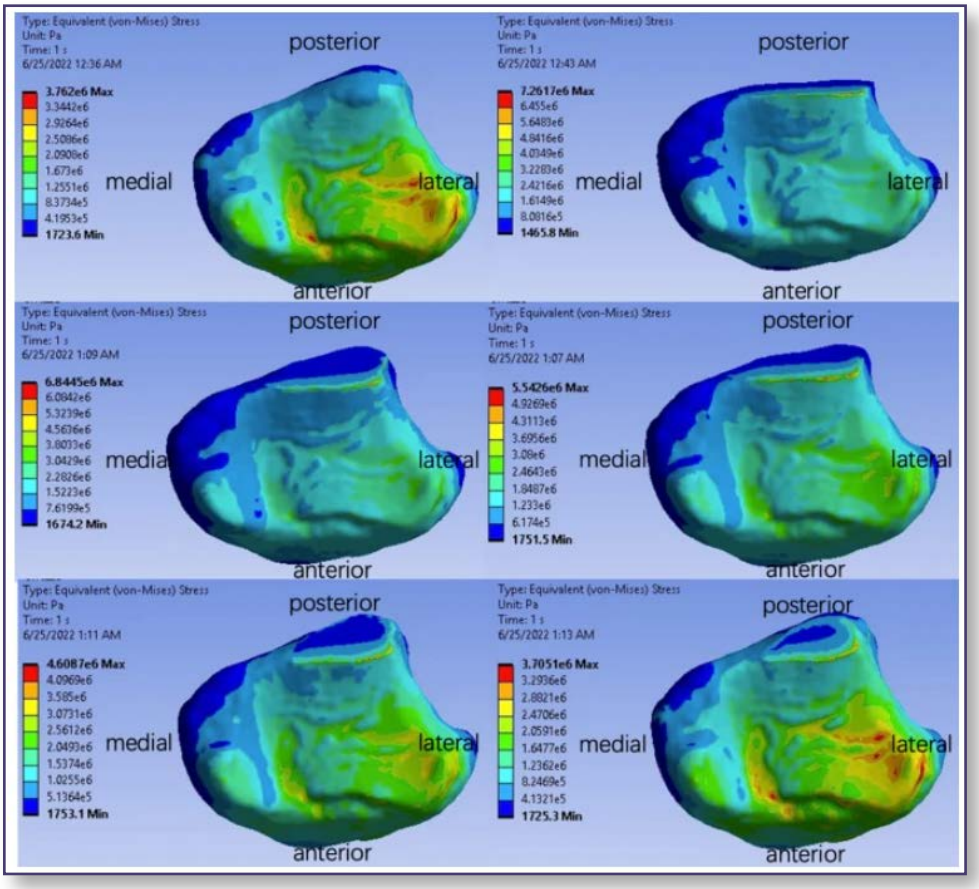


Figure 3: Stress distribution of the contact surface for different models.

data about stress distribution alterations across various sagittal angles, thus enriching the decision-making process, especially concerning treatment interventions. The inferences drawn from this study hint that surgical procedures might be essential for fractures with reduced sagittal angles to prevent joint instability and the possible complications that may ensue.

Conclusion

The present study, utilizing FEA, has illuminated the intricacies of stress distribution across the ankle joint's contact surface, both in its natural state and when subjected to different sagittal angles of fracture lines. The findings accentuate the pivotal role of the contact surface in ensuring ankle stability and the subsequent alterations that fractures can introduce to its stress profile. This research has identified 3 specific zones of stress concentration, with fractures having the potential to shift the peak stress, which may lead to ankle instability. Furthermore, the study highlights the significance of sagittal angles in determining the stability of the ankle post-fracture. A sagittal angle below 60° is identified as a potential risk factor for compromised ankle stability. This provides a crucial reference point for clinicians, assisting in the decision-making process for therapeutic interventions. ler

The study presented here suggests that sagittal angles below 60° might pose considerable risks to ankle stability.

Jichong Ying, Jianlei Liu, Hua Wang, Yunqiang Zhuang, Tianming Yu, Shuaiyi Wang, and Dichao Huang are affiliated with the Department of Orthopaedic Trauma, Ningbo No.6 Hospital, Ningbo, China.

GAITRite BASIC®

www.gaitrite.com

Clinical Reports tailored to your patient conditions

MOST AFFORDABLE GAIT ANALYSIS

SPECIFICALLY TAILORED FOR O&P

IMPROVE PATIENT OUTCOMES

OBJECTIVE MEASURES FOR REIMBURSMENT

sales@gaitrite.com

www.gaitrite.com

888-482-2362

FULLY PORTABLE
compact storage

QUICK SET UP
under 75 seconds

MINIMAL TRAINING
easy reporting features

ad index

Please Support our Advertisers…
Visit us online at lermagazine.com

Because of them, we are able to provide you with this unique, informative and invaluable magazine!

New & Noteworthy

Noteworthy products, association news, and market updates

FIZZING FOOT FOAM

Dermatonics Deodorising Fizzy Foot Foam is the perfect solution for anyone who wants to keep their feet cool, fresh, and comfortable throughout the day. This unique, fizzing foot foam provides an instant cooling and refreshing sensation, while also deodorizing and revitalizing the skin. The fizzing sensation produced by the foam helps revive and rejuvenate the skin. The formula features menthol and New Zealand manuka honey, which work together to provide a powerful exhilarating effect for your feet. This product is an innovative and refreshing formula that provides long-lasting comfort and freshness while soothing tired and sore feet.

Justin Blair & Company
800/566-0664
justinblairco.com

THERMAL NAIL FUNGUS TREATMENT

Patented ToeMate® Kits include a microwaveable soaking bowl, pretreatment and thermal chemistry, footrest, and instructions. Infected nails are pretreated with salicylic acid followed by soaking in warm bis (hydrogenated tallow alkyl) dimethyl quaternary chlorides (QAC) and poly (hexamethylenebiguanide) hydrochloride (PHMB) dissolved in water for 10 to 15 minutes once daily. Company data suggests that QAC and PHMB both penetrate the nail and exhibit antibacterial, virus, yeast, and mold activity, so additional conditions may also be treated including bacterial infections, onycholysis, paronychia, and psoriasis. The active ingredients in ToeMate Kits have been safely used in personal care products and public water treatments for over 60 years.

Innovation Biomedical Devices
650/200-8584 thetoematestore.com

TOTAL ANKLE REPLACEMENT SYSTEM

Enovis™ recently unveiled its Scandinavian Total Ankle Replacement (STAR® Ankle). Recent U.S. Food and Drug Administration approval makes this product the first and only mobile bearing ankle system in the United States produced with e+™ Polyethylene in the United States. The e+™ Polyethylene insert contains the free radical-neutralizing antioxidant vitamin E; as a result, the material resists oxidation and maintains consistent wear rates and stable mechanical properties over time, and will offer improved durability, stability, and longevity. In contrast, other highly crosslinked polyethylenes are remelted during manufacturing to neutralize free radicals, a process that can reduce their mechanical strength by up to 12%.

Enovis
800/336.6569
enovis.com

HANGER/AOPA ESTABLISH THE DR. JAMES H. CAMPBELL COMMITMENT TO OUTCOMES AWARD

Hanger, Inc., along with the American Orthotic and Prosthetic Association (AOPA), announced the creation of the Dr. James H. Campbell Commitment to Outcomes Award during the General Session at the annual AOPA National Assembly. The award was created to honor Hanger Senior Vice President and Chief Clinical Officer Jim Campbell, PhD, CO, FAAOP, for his exceptional contributions to the orthotic and prosthetic (O&P) field, and as part of Hanger's commitment to advance the science of care across the profession. The inaugural award is slated for presentation at the 2025 National Assembly.

"Jim's impact to the O&P profession has been transformative, driving a focus on the importance of clinical outcomes," said Hanger Chief Executive Officer Pete Stoy. "Because of his instrumental efforts, clinical success is measured by the quality of patient care and the outcomes that are delivered. There's no doubt the profession is better because of Jim's commitment to excellence."

As part of establishing the annual award, Hanger will donate $100,000 to AOPA, with the recipient being determined by AOPA's board of directors following a formal nomination process. The award will recognize an individual who has made significant and outstanding contributions to the field through exceptional dedication to achieving the best clinical outcomes for patients.

"AOPA is honored to partner with Hanger to award the Dr. James H. Campbell Commitment to Outcomes Award," said AOPA Executive Director, Eve Lee, MBA, CAE. "Dr. Campbell truly is a visionary and bestowing this award on others who make similar substantial contributions to the field will only further the profession and its impact on those it serves."

Every year, the award recipient will receive a $3,000 honorarium, in addition to fully paid airfare, accommodations and registration at the National Assembly. More information about the recognition will be available on AOPA's website in spring 2025, when the nomination process opens.

APPLICATION FOR WOUND CARE

Perceptive Solutions' WoundZoom PRO is an advanced application that gives healthcare providers a more intelligent and efficient way to manage wound care across a variety of care settings with its non-contact 3D wound measurement technology and intuitive workflow application that can all be accessed on a clinician's smart device. This Health Insurance Portability and Accountability Act–compliant digital wound management solution seamlessly integrates into the provider's electronic health records through a cloud-based portal, which produces practice analytics and census reports on demand. The WoundZoom system is valued to elevating clinical and business outcomes. It is available for download on the Apple App Store with application access granted with a user license.

Perceptive Solutions
888/237-0546
perceptivesol.com

SUBTLE GAIT IMPAIRMENTS DETECT EARLY COGNITIVE DECLINE

Gait analysis is emerging as a valuable, non-invasive complement to cognitive assessments that aid in early diagnosis and management. In clinical settings, gait and balance tests typically focus on a straight walking path. However, researchers at Florida Atlantic University (FAU) have ventured into a different realm—curved path walking—a more natural yet complex activity. Straight walking is a rhythmic and simpler activity, whereas walking on a curving path requires greater cognitive and motor skills such as a transition time to change directions and correct balance.

College of Engineering and Computer Science researchers at FAU are the first to quantitatively compare the performance of healthy older adults versus older adults with mild cognitive impairment (MCI) in straight and curve walking. MCI is the early stage of cognitive decline and people with MCI have a much higher risk of transitioning to Alzheimer's disease (AD).

For the study, researchers used a depth camera, which can detect and track 25 joints of body movement, to record study participants' gait while performing the 2 different walking tests (straight versus curve). Signals from the 25 body joints were processed to extract 50 gait markers for each test, and these markers were compared between the 2 groups using descriptive statistical analyses.

Results showed curve walking resulted in greater challenges for the MCI group and outperformed straight walking in detecting MCI. Furthermore, several gait markers showed significant differences between healthy controls and MCI patients.

Gait markers included 2 macro markers (average velocity and cadence), 24 micro temporal markers (duration of feet for various sub-phases of the gait cycle, such as stance, swing, step, and stride phases), micro spatial markers (location changes of feet for various sub-phases of the gait cycle), and 6 micro spatiotemporal markers (velocity of feet for various sub-phases of the gait cycle). These markers provided detailed information on the functional performance of the participants during the gait tests.

Findings showed that 31 out of 50 gait markers were greater for the MCI group than healthy control older adults when the walking tests changed from straight walking to curve walking, and 13 markers showed significant differences between the 2 study groups.

Mahmoud Seifallahi (seated) and Ghoraani review the performance of straight walking using a depth camera, which can detect and track 25 joints of body movement. Image courtesy of FAU College of Engineering and Computer Science.

"The MCI group exhibited a markedly lower average step length and speed during curve walking, coupled with higher variability across most micro-gait markers," said Behnaz Ghoraani, PhD, an associate professor, FAU Department of Electrical Engineering and Computer Science, co-director of the FAU Center for SMART Health, and a fellow, FAU Institute for Sensing and Embedded Network Systems Engineering (I-SENSE). "The MCI group showed diminished symmetry and regularity in both step and stride lengths for curved walking. They also required extended double support time in various areas, especially while changing directions, which resulted in reduced step speed."

AD typically manifests as a decline in cognitive function with a gradual decline in an individual's ability to perform daily activities such as walking. Accurate and early clinical detection of AD remains a challenge. Typical clinical evaluations include a detailed history, comprehensive physical and neurological

examination, cognitive testing, blood work and brain imaging. However, depending on the clinical setting, these methods can be time-consuming, costly, and outside some clinicians' comfort level. These finding fill the gap by using a novel system to record gait in older adults employing a non-invasive, low-cost, non-wearable, and easy-setting depth camera, which is a crucial step in enhancing patient care and intervention strategies.

NEW MAGNETIC GEL HEALS DIABETIC WOUNDS 3 TIMES FASTER

Asst Prof Andy Tay (center) is holding a plaster pre-loaded with magnetic gel, which promises to accelerate the healing of diabetic wounds, while Dr. Shou Yufeng (right) is holding the device for magnetic stimulation. Dr. Le Zhicheng (left) is holding a sample of the magnetic gel in liquid form. Image courtesy of NUS.

A team of researchers from the National University of Singapore (NUS) engineered an innovative magnetic wound-healing gel that promises to accelerate the healing of diabetic wounds, reduce the rates of recurrence, and thus lower the incidents of limb amputations. Each treatment involves the application of a bandage preloaded with a hydrogel containing skin cells for healing and magnetic particles. To maximize therapeutic results, a wireless external magnetic device is used to activate skin cells and accelerate the wound healing process. The ideal duration of magnetic stimulation is about 1 to 2 hours. Lab tests showed the treatment coupled with magnetic stimulation healed diabetic wounds about 3 times faster than current conventional approaches. While the research has focused on healing diabetic foot ulcers, the technology has potential for treating a wide range of complex wounds such as burns.

The unique NUS invention takes a comprehensive all-in-one approach to wound healing, accelerating the process on several fronts. "Our technology addresses multiple critical factors associated with diabetic wounds, simultaneously managing elevated glucose levels in the wound area, activating dormant skin cells near the wound, restoring damaged blood vessels, and repairing the disrupted vascular network within the wound," said Assistant Professor Andy Tay, who leads the team comprising researchers from the Department of Biomedical Engineering at NUS College of Design and Engineering as well as the NUS Institute for Health Innovation & Technology.

The specially designed wound-healing gel is loaded with 2 types of US Food & Drug Administration–approved skin cells—keratinocytes (essential for skin repair) and fibroblast (for formation of connective tissue)—and tiny magnetic particles. When combined with a dynamic magnetic field generated by an external device, the mechanical stimulation of the gel encourages dermal fibroblasts to become more active. Lab tests showed that the increased fibroblast activity generated by the magnetic wound-healing gel increases the cells' growth rate by about 240% and more than doubles their production of collagen—a crucial protein for wound healing. It also improves communication with keratinocytes to promote the formation of new blood vessels.

"The approach we are taking not only accelerates wound healing but also promotes overall wound health and reduces the chances of recurrence," said Tay.

AI-POWERED EXOSKELETON ENHANCES HUMAN LOCOMOTION, HELPS RESTORE MOBILITY

A team of researchers from the New Jersey Institute of Technology (NJIT) have demonstrated a new method that leverages artificial intelligence (AI) and computer simulations to train robotic exoskeletons that can help users

Image courtesy of NJIT.

save energy while walking, running, and climbing stairs. The novel method rapidly develops exoskeleton controllers to assist locomotion without relying on lengthy human-involved experiments. Moreover, the method can apply to a wide variety of assistive devices beyond the hip exoskeleton demonstrated in this research.

"It can also apply to knee or ankle exoskeletons, or other multi-joint exoskeletons," said Xianlian Zhou, PhD, associate professor and director of NJIT's BioDynamics Lab. In addition, it can similarly be applied to transfemoral and transtibial prostheses, providing immediate benefits for millions of able-bodied and mobility-impaired individuals, he said.

This breakthrough holds promise for aiding individuals with mobility challenges, including the elderly or stroke survivors, without necessitating their presence in a laboratory or clinical setting for extensive testing. Ultimately, it paves the way for restoring mobility and enhancing accessibility for everyday in-home or community living.

"This work proposes and demonstrates a new method that uses physics-informed and data-driven reinforcement learning to control wearable robots in order to directly benefit humans," said Hao Su, PhD, an associate professor of mechanical and aerospace engineering at North Carolina State University.

The researchers focused on improving autonomous control of embodied AI systems–which are systems where an AI program is integrated into a physical technology. This work focused on teaching robotic exoskeletons how to assist able-bodied people with a variety of movements, and expands on previous reinforcement learning based research for lower limb rehabilitation exoskeletons, also a collaborative

effort between Zhou, Su, and several others.

Normally, users have to spend hours "training" an exoskeleton so that the technology knows how much force is needed–and when to apply that force–to help users walk, run, or climb stairs. The new method allows users to utilize the exoskeletons immediately because the closed-loop simulation incorporates both exoskeleton controller and physics models of musculoskeletal dynamics, human-robot interaction, and muscle reactions, thereby generating efficient and realistic data and iteratively learning better control policy in simulation. The unit is preprogrammed to be ready to use right away, and it's also possible to update the controller on the hardware if researchers make improvements in the lab through expanded simulations. Future prospects for this project include developing individualized, custom-tailored controllers that assist users for various activities of daily living.

SEMI-CUSTOM ORTHOTIC INSOLES

Podiatrists, physical therapists, and other foot and ankle specialists are increasingly recommending Tread Labs' semi-custom orthotic insoles to their patients, citing impressive outcomes comparable to custom orthotics at a significantly lower cost to the patients. The company's innovative approach includes offering 4 distinct arch heights—low, medium, high, and extra high. This unique feature allows for a more tailored fit, addressing a wider range of foot types and conditions. The modular 2-part system further enhances affordability, as consumers can easily replace the foam top covers without the need to purchase entirely new insoles. Tread Labs' commitment to quality and affordability has positioned the company as a trusted name in the industry, and is making high-quality foot care accessible to a broader audience.

Tread Labs
781/435-0662
treadlabs.com

NANOMATERIAL QUICKLY HEALS WOUNDS IN DIABETIC ANIMAL MODEL

The researchers loaded a silk nanomaterial dressing with gold nanoparticles to seal and protect diabetic wounds in mice. Image courtesy of Jordan Yaron.

Arizona State University (ASU) bioengineers have developed a multistep strategy that applies different nanomaterials to diabetic wounds at different times to support both early- and late-stage healing. Their work showed this method outperformed a common wound dressing in a diabetic mouse model, closing wounds faster and producing more robust skin tissue. The researchers' analysis also suggests that their approach unexpectedly activated an immune cell population not normally seen in wounds that can resolve inflammation, which highlights a new potential avenue to accelerate healing.

For the first step, the team fabricated a silk nanomaterial dressing embedded with gold nanorods. Because gold nanoparticles readily convert light to heat, the team was able to direct a laser at dressings placed over fresh wounds in mice, producing heat that quickly sealed them in place and provided a high level of protection. The strategy, which the researchers previously found success with, creates something akin to an instantaneous scab, said Jordan Yaron, PhD, a bioengineering assistant research professor at ASU. This time around, the authors added histamine to the mix, a natural biochemical produced by the immune system that plays important roles in inflammation, blood vessel development, and allergic reactions.

Inflammation dominates the body's initial response to injuries, but eventually subsides to allow the body to rebuild. However, diabetic wounds can get stuck in first gear, maintaining persistent, low-grade inflammation, which can inhibit the healing process.

"Since the wound is stalled, we wanted to co-deliver histamine with the dressing, to give a push and bring the inflammation stage to a resolution," said Kaushal Rege, PhD, a chemical engineering professor at ASU. "Then we could introduce another strategy to take care of the subsequent phases of healing."

The authors monitored the wounded mice for 11 days and found that animals treated with a combination of the nanomaterial dressing and histamine healed at the fastest rate compared to those treated with the standard dressing with histamine or the nanomaterial dressing alone. The researchers mechanically tested the healed skin as well, finding that the tissue treated with both the nanomaterial and histamine was strongest and most similar to unwounded skin.

The investigators' next step in the study was to see if they could improve healing further by accelerating the post-inflammation phase wherein cells proliferate and remodel skin tissue. In a second set of mice, the authors followed up their initial treatment with a pair of nanoparticles they previously developed that were derived from 2 particular growth factors—proteins native to the body that promote the formation of skin tissue.

The team injected the nanoparticles at various time points into the nanomaterial-dressed wound bed, finding that delivery on day 6 had the best outcomes with regard to wound closure and tissue strength. This time point corresponds to a transitionary phase in which cells begin proliferating and remodeling tissue. With promising results in mice behind them, the researchers are now testing their strategy in larger animal models more relevant to human health, such as pigs.

Muscle Hypertrophy & Strength Gains

Vegan vs Omnivorous High Protein Diets

Reference : Monteyne et al. J Nutr 2023

Designed by @YLMSportScience

22 young adults completed a 10 week, high-volume (5 day/week), progressive resistance exercise program while consuming :

An omnivorous high-protein diet

~2 g/kg/day, meat, milk, yogurt, cheese & whey protein supplement

OR

A non-animal-derived high-protein diet

~2 g/kg/day, pulses, soy & vegan protein supplement

Images provided by PresenterMedia & Flaticon

WHAT DID THEY FIND?

Change after 10 weeks	Omnivorous vs Vegan
Lean mass	+2.6 ± 1.1 kg vs +3.1 ± 2.5 kg
Thigh muscle volume	+8.3 ± 3.6% vs +8.3 ± 4.1%
Thigh muscle fiber CSA*	+33 ± 24% vs +32 ± 48%
Squat (1-RM)	+18% vs +35%
Deadlift (1-RM)	+17% vs +26%
Bench press (1-RM)	+18% vs +28%**
Knee extension (1-RM)	+6% vs +6%

*CSA: cross-sectional area, ** significant difference

A carefully designed vegan diet can support optimal muscle adaptive responses to resistance training

Source: Monteyne AJ, Coelho MOC, Murton AJ, et al. Vegan and Omnivorous High Protein Diets Support Comparable Daily Myofibrillar Protein Synthesis Rates and Skeletal Muscle Hypertrophy in Young Adults. J Nutr. 2023;153(6):1680-1695. doi: 10.1016/j.tjnut.2023.02.023.

OrthoRite orthotics

always a step ahead

Children's Line

A classic shell manufactured from state-of-the-art acrylic. Ortho-Rite's functional acrylic offers full biomechanical control for patients requiring stability and support.


Dress-Rite


Sport-Rite


Walk-Rite


Graph-Rite


Leather Line

Ortho-Rite
INCORPORATED

65 Plain Ave.
New Rochelle, NY 10801
(800)473-6682
(914)235-9697 Fax
info@ortho-rite.com