Collaborative Care for Better Outcomes

15 YEAR ANNIVERSARY

LOWER EXTREMITY REVIEW

July 25 / volume 17 / number 7v

First MPJ Arthrodesis–Techniques to Reduce Non-Union Risk

NOW OPEN

lerMARKETPLACE

A New Kind of Exhibit Hall

Available 24/7/365

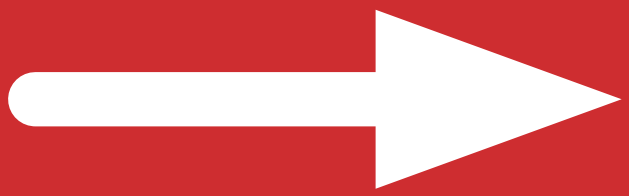
IerMARKETPLACE.com is THE place to learn about the products you need now from the names you trust.

*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 17 NUMBER 7 LERMAGAZINE.COM

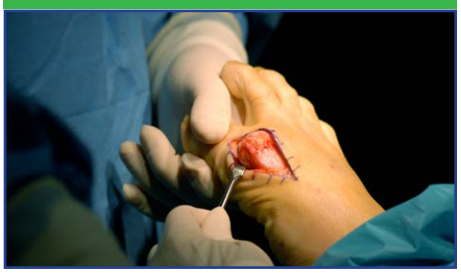
July 2025 contents

SHORTTAKES FROM THE LITERATURE

AD INDEX

NEW & NOTEWORTHY

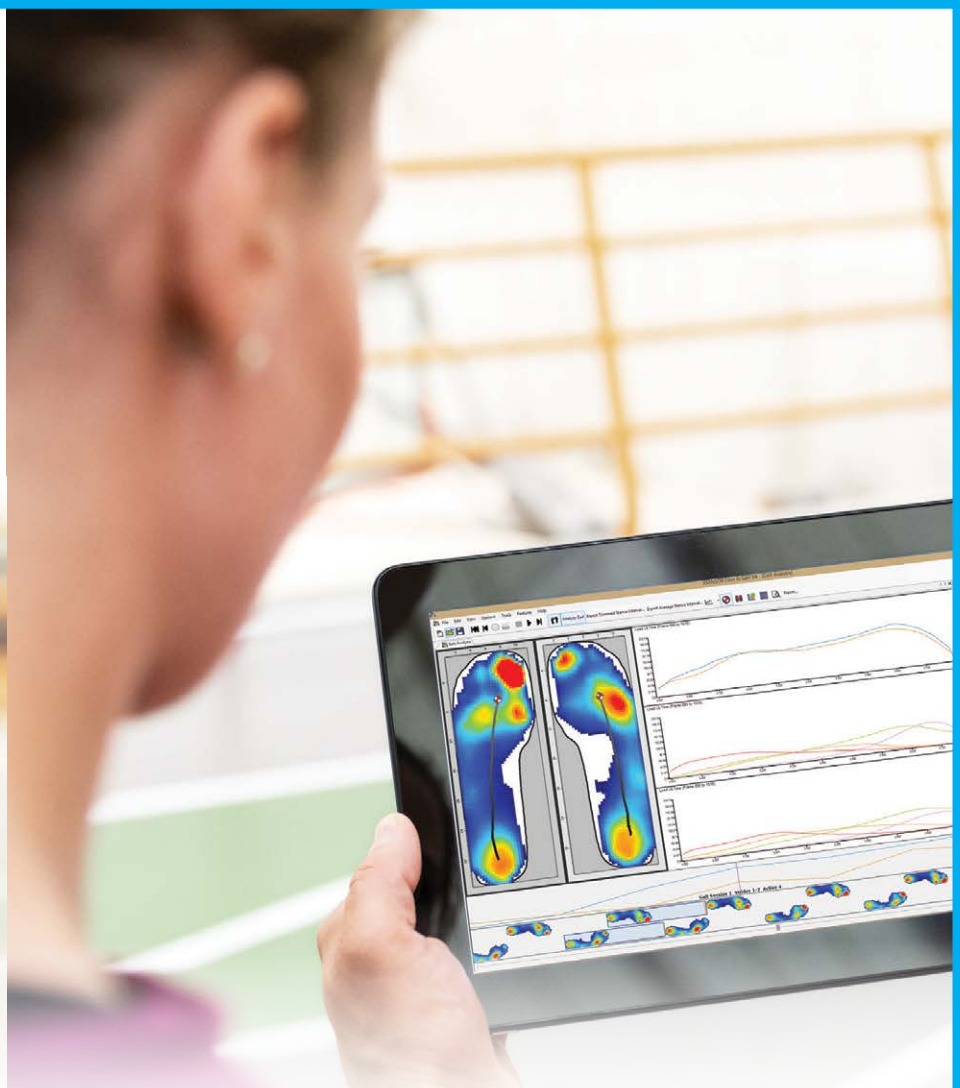
COVER STORY



THE LAST WORD

Designed by @YLMSportScience

FEATURE ARTICLES



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

LOWER EXTREMITY REVIEW

ler

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

STAFF

Editor Emeritus
Janice T. Radak | janice@lermagazine.com

Editor
January Shoaf | january@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

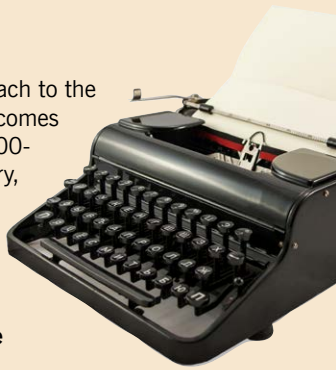
Showcasing evidence and expertise across multiple medical disciplines to build, preserve, and restore function of the lower extremity from pediatrics to geriatrics.

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: **january@lermagazine.com**

POSTOPERATIVE SHOES OR WALKER BOOTS: STUDY COMPARES 2 TYPES OF ORTHOSES

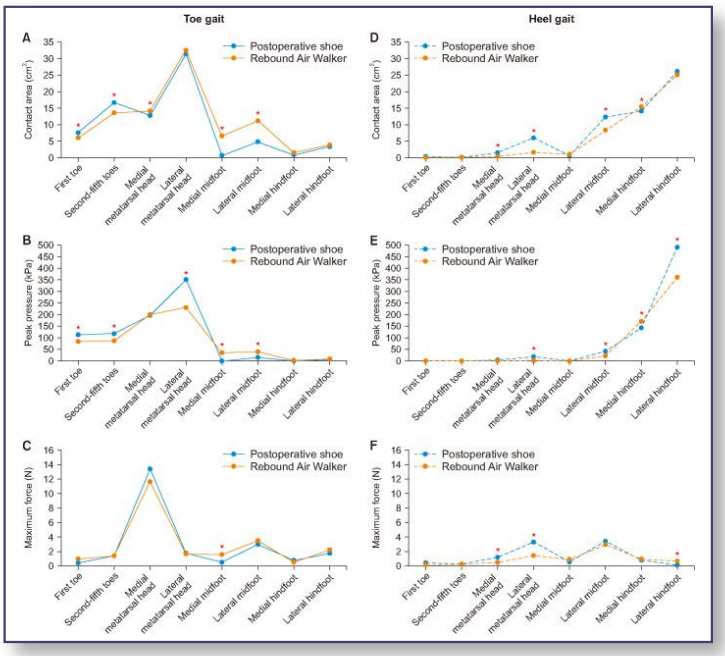


Figure: Comparison of contact area, peak pressure, and maximum force between 2 orthoses during toe gait (A-C) and heel gait (D-F). *Significant differences between groups.

The choice of an appropriate type of orthosis depends on the patient's specific condition and needs. Different types of orthoses can affect plantar pressure distribution during certain gait patterns. Toe and heel gaits are common patterns of gait assigned for optimal recovery in patients with foot or ankle injuries. This study aimed to evaluate differences in plantar pressure between postoperative shoes and walker boots during toe and heel gaits in healthy individuals. The researchers hypothesized that differences exist in contact area, peak pressure, and maximum force pattern owing to the characteristics of each orthosis.

A total of 30 healthy individuals with a mean age of 21.7 ± 1.2 years were included in this study. Two types of gaits, toe and heel, were performed while wearing each orthosis on the right foot. A standardized running shoe was worn on the left foot. Plantar pressure variables including contact area, peak pressure, and maximum force were collected using the Pedar-X in-shoe pressure measuring system.

During toe gait, while both orthoses demonstrated similar offloading in the hindfoot areas, walker boots were superior in reducing the peak pressure (first toe, $P = 0.003$; second to fifth toes, $P < 0.001$) and contact area (first toe, $P = 0.003$; second to fifth toes, $P = 0.003$) in the forefoot areas. During heel gait, both orthoses demonstrated similar offloading in the toe areas; however, the walker boots were superior in reducing the peak pressure in the lateral hindfoot ($P < 0.001$).

The results of this study can serve as a guideline for orthopedic physicians in prescribing an appropriate type of orthosis during specific types of gait for patients following foot and ankle injury and postoperative recovery. ler

Source: *Kyung MG, Seo HS, Yoon YS, Kim DY, Lee SM, Lee DY. Comparison of in-shoe pedobarographic variables between 2 orthoses during toe and heel gaits. Clin Orthop Surg. 2024;16(6):987-993. doi: 10.4055/cios24106. Use is per Creative Commons Attribution 4.0 International License.*

EFFECTS OF FES ON COGNITION RATE & GAIT IN NEUROLOGICAL PATIENTS

People with neurological disorders and foot drop may suffer from cognitive-motor interference during walking. Functional Electrical Stimulation (FES) targets foot drop during gait but its effects on cognition remain underexplored.

Fifteen individuals (4 males, 11 females; mean age 35.5 ± 12.5 years) with various neurological disorders, who had been using FES for at least three months, were recruited from the outpatient clinic. Patients were assessed during walking with and without FES (FES CONDITION) and under single- and dual-task walking (TASK). The dual-task consisted of counting backwards from a number near 100 in steps of seven while walking. Cognition rate served as outcome parameter, with high values indicating subjects could efficiently maintain both cognitive task performance and walking speed.

A linear mixed model analysis was conducted with FES CONDITION

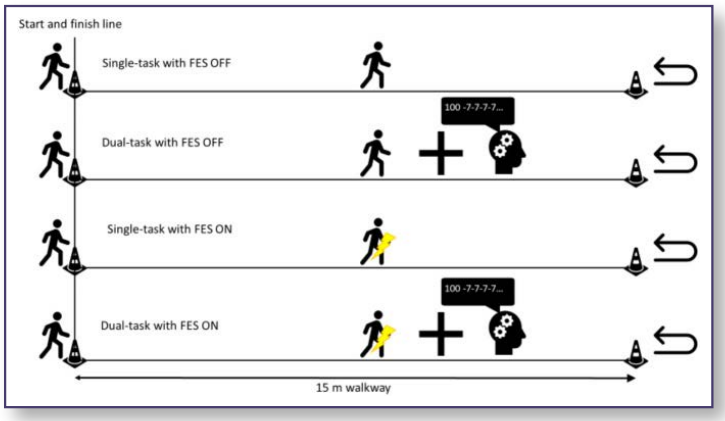


Figure: The four walking conditions: without FES during single- and dual-task walking, followed by with FES during single- and dual-task walking. The cognitive task required counting backward from near 100 in steps of seven. (FES: functional electrical stimulation).

and TASK as fixed and PATIENTS as random effects. The cognition rate during dual-task walking was significantly better with FES vs. without. FES showed minor effects on dorsiflexion in swing but larger effects on overall gait, as reflected in walking speed, step length and step width.

While dual-task led to inferior results in gait, FES counteracted this effect and improved cognition rate. These findings suggest that FES not only addresses gait pattern and stability but also frees cognitive resources for walking. This shift in focus may enhance environmental awareness, social interaction or multitasking and thereby improving overall independence and quality of life, which is particularly relevant for patients with neurological disorders and an increased risk of falls. ler

Source: *Bleichner N, Heitzmann DWW, Raynaud J, et al. Effects of functional electrical stimulation on cognition rate and gait in neurological patients during single- and dual-task walking. Sci Rep. 2025;15(1):13557. doi: 10.1038/s41598-025-98755-w.*

RISK & PROGRESSION OF HV ANGLE IN ELITE ADOLESCENT DANCERS

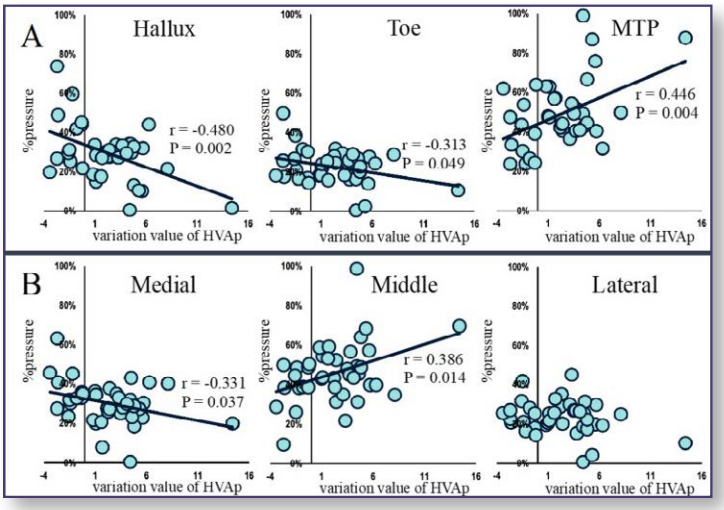


Figure: Significant correlations were observed between the variation value and %pressure in the hallux, toe, and MTP joint areas (A)and between the variation value and %pressure in the medial, middle, and lateral areas (B). MTP, Metatarsophalangeal, %pressure, Plantar pressure percentage.

No previous studies have linked the progression of hallux valgus (HV) with plantar pressure distribution, based on available information. This study aimed to determine the progression of HV angle in elite adolescent dancers and evaluate the risk factors associated with foot plantar pressure during demi-pointe movement.

For this cohort study, 40 adolescent dancesport dancers (age: 14.5 ± 1.3 years; height: 168.3 ± 8.3 cm; weight: 52.4 ± 8.1 kg) were recruited from a dancesport specialty school in Japan. All participants reported no foot or lower limb injuries or symptoms in the past year and were not undergoing any rehabilitation or medication treatment. The HV angle was measured by photography (HVAp). The HVAp survey included baseline and follow-up assessments after 1 year. Foot plantar pressures (kPa) were obtained using the F-Scan measurement system (Tekscan, Tokyo, Japan), and the data were divided into 2 categories based on the foot location (type 1: hallux, toe, and metatarsophalangeal [MTP] joint area and type 2: medial, middle, and lateral areas). Data were analyzed using the Pearson's chi-square test and multiple logistic regression.

The HVAp measurement demonstrated excellent reliability. A significant increase of 2.1° ± 3.5° in the HV angle of elite adolescent dancers was found at the 1–year follow-up assessment relative to that at baseline. There were significant correlations between the HVAp variation values and the hallux (r = –0.480, P = 0.002), toe (r = –0.313, P = 0.049), and MTP joint area (r = 0.446, P = 0.004) plantar pressure percentages in the type 1 category and medial area (r = –0.331, P = 0.037) and middle area (r = 0.386, P = 0.014) pressure percentages in the type 2 category. Based on the multivariate logistic regression analysis, the HVAp variation values were associated with foot plantar pressure in the hallux (odds ratio [OR]: –0.12, 95% confidence interval [CI]: –0.191 to –0.048, P = 0.002) and middle areas (OR: 0.09, 95% CI: 0.019 –0.161, and P = 0.014) from the 2 categories, respectively.

This study demonstrated significant progression of the HV angle in elite adolescent dancers over 1 year, which was significantly associated with increased foot plantar pressure in the middle area and decreased plantar pressure in the hallux area. These findings highlight the importance of monitoring and addressing foot plantar pressure in adolescent dancers. ler

Source: *Liu Z, Chen S, Okunuki T, et al. Progression and risk factors of hallux valgus angle in elite adolescent dancers: a cohort study. BMC Musculoskelet Disord. 2024;25(1):983. doi: 10.1186/s12891-024-08005-9.*

RESISTANCE TRAINING & HIGH PROTEIN DIET IMPACTS VASCULAR & MUSCLE HEALTH OF ELDERLY WOMEN

Resistance training is a well-known exercise therapy for preventing and improving lack of muscle mass, strength, and quality with advances in age; however, its effects on arterial stiffness are not beneficial. Additionally, a higher intake of protein, which is an effective nutrient for muscle health, results in lower arterial stiffness. Researchers hypothesized that the combination of resistance training and high protein intake would improve muscle mass, strength, and quality and cancel the resistance training-induced increase in arterial stiffness in elderly women. To test the hypothesis, they assessed the effects of resistance training combined with regular intake of steamed chicken breast, a high-protein food, on muscle mass, strength, quality, and arterial stiffness in elderly women.

Ninety-three elderly women (67.2 ± 5.3 years) were randomly divided into four groups; sedentary control (CON), higher dietary animal

Continued on page 12

Continued from page 13

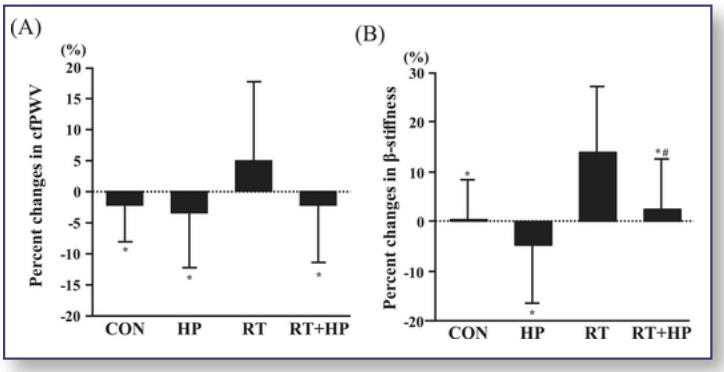


Figure: Comparison of percent changes in carotid-femoral pulse wave velocity (cfPWV; A) and carotid β–stiffness (B) before and after each intervention among the sedentary control (CON), high-protein intake (HP), resistance training (RT), and combination of RT + HP (RT + HP) groups. Data are expressed as means ± SD. *$P < 0.05$ vs. RT. #$P = 0.05$ vs. HP.

protein intake (HP), resistance training (RT), and combination of RT and HP (RT + HP) groups. Participants in the RT and RT + HP groups completed 12 weeks of resistance training (exercise intensity at 70% of 1 repetition maximum (1–RM), 3 sets with 10 repetitions of leg extension and curls, 3 days/week). In addition to the daily diet, the HP and RT + HP groups consumed steamed chicken breast as a high-protein diet.

Percentage changes in thickness (indices of muscle mass) and echo intensity (index of muscle quality) in the quadriceps muscle, 1–RM of leg extension and curls (index of muscle strength) and circulating C1q levels (a potential biomarker of muscle fibrosis) in the RT and RT + HP groups significantly improved after both RT and RT + HP interventions ($P < 0.05$). Percentage changes in carotid-femoral pulse wave velocity (cfPWV) and carotid β–stiffness (indices of arterial stiffness), and circulating angiotensin II (a vasoconstrictor peptide hormone) levels via each intervention were significantly higher in the RT group (4.9 ± 12.7%, 13.8 ± 13.5%, 94.9 ± 132.7%, respectively), as compared with the CON group (−2.5 ± 5.9%, 0.2 ± 8.1%, 21.2 ± 79.3%, respectively) ($P < 0.05$). Of note, no significant differences in the cfPWV, carotid β–stiffness and circulating angiotensin II levels between the RT + HP (−2.4 ± 9.3%, 2.4 ± 10.3%, −5.7 ± 29.6%, respectively) and CON groups were observed. Furthermore, significant positive relationships between the percentage changes in circulating angiotensin II levels, and cfPWV (r = 0.438, $P < 0.01$) and carotid β–stiffness (r = 0.328, $P < 0.01$) were observed.

The combination of moderate to high-intensity resistance training and regular intake of steamed chicken breast as a high-protein food could increase muscle mass, strength, and quality and could cancel resistance training-induced increases in arterial stiffness in elderly women.

Source: *Fujie S, Horii N, Kajimoto H et al. Impact of resistance training and chicken intake on vascular and muscle health in elderly women. J Cachexia Sarcopenia Muscle. 2025;16(1):10.1002/jcsm.13572. doi: 10.1002/jcsm.13572.*

SARCOPENIA COMMON IN OLDER PATIENTS WITH RLS

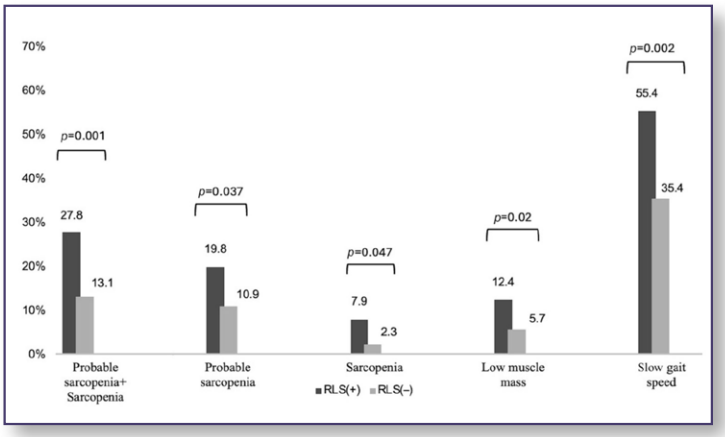


Figure. The frequency of probable sarcopenia, sarcopenia, low muscle mass and slow gait speed in all patients. $P < 0.05$, statistically significant.

Restless legs syndrome (RLS) is a disorder characterized by nocturnally exacerbating pain that leads to significant sleep disturbances. The hormonal and metabolic changes caused by sleep disruption may increase the incidence of muscle-related diseases like sarcopenia in older adults, which is defined by a progressive loss of muscle strength and mass. This study aimed to investigate the relationship between RLS and sarcopenia, which may affect each other through common pathophysiological pathways in older adults.

This was a cross-sectional study including 109 patients with RLS and 220 without RLS who applied to the geriatric clinic. RLS was assessed using the Turkish version of the International Restless Legs Syndrome Study Group (IRLSSG). Sarcopenia was diagnosed according to the European Working Group on Sarcopenia in Older People-2 criteria. All the demographics, comorbid conditions, medications and findings of comprehensive geriatric assessments were recorded. The association between RLS and sarcopenia was examined by logistic regression.

The mean age was 75 ± 7.4 and 73.8 ± 7 years for the RLS and the control groups, respectively ($P > 0.05$) and the ratio of females was higher in the RLS group (69.7% vs. 57.9%) ($P = 0.035$). The frequencies of coronary artery disease (CAD), hypertension (HT) and peripheral artery disease (PAD) were significantly higher in RLS patients ($P = 0.020$, $P = 0.047$, P = 0.010, respectively), while the prevalence of anemia was 41% and 25–OH Vitamin D levels (25[OH]D) were higher than in the control group ($P < 0.001$). The frequency of probable sarcopenia and sarcopenia was higher in patients with RLS than in controls (20% vs. 11%, $P = 0.037$ and 8% vs. 2.3%, $P = 0.047$, respectively). A significant association between RLS and an increased likelihood of probable sarcopenia, sarcopenia and slow gait speed (odds ratio [OR]: 2.621, 95% confidence interval [CI] [1.265, 5.431]; OR: 4.542, 95% CI [1.284, 16.071]; OR: 2.663, 95% CI [1.432, 4.951], respectively) was found after adjusting for factors such as gender, HT, CAD, PAD, serum 25(OH)D levels, anemia, chronic

kidney disease (CKD) and nutritional status. However, the significance of low muscle mass disappeared ($P > 0.05$).

This study demonstrated that sarcopenia is prevalent among older patients with RLS, which seems to be associated with low muscle strength and slow gait speed. Given the negative health outcomes related to sarcopenia, interventions aimed at preventing its development could be significantly beneficial for patients with RLS in older adults as well.

Source: *Gokdeniz Yildirim A, Kaya D, Dost FS, Ontan MS, Isik AT. Sarcopenia seems to be common in older patients with restless legs syndrome. J Cachexia Sarcopenia Muscle. 2025;16(1):e13637. doi: 10.1002/jcsm.13637. Use is per CC BY.*

RISKS ASSOCIATED WITH ANKLE SPRAIN IN SOCCER PLAYERS

Soccer is associated with substantial injury risk, with reported between 13 to 35 injuries per 1000 player-hours of competitive play. Notably, approximately 77% of soccer-related ankle injuries are attributed to ankle sprain injuries (ASIs). ASI can lead to chronic ankle instability, obesity, and post-traumatic osteoarthritis. This study focuses on identifying factors such as gender, age, body mass index (BMI), and a history of ASIs, which contribute to the development of ASI in soccer players.

A systematic literature search was conducted in October 2023 across databases, including PubMed, Web of Science, Scopus, Cochrane Library, and ProQuest, without applying any filters. Keywords included ankle, ankle joint, sprain, risk factors, etc. Data extraction was performed on the included studies, with findings standardized and analyzed using Stata Statistical Software: Release 17 to determine a weighted treatment effect.

Researchers' systematic review included 26 studies. The meta-analysis revealed that a history of ankle sprain is the most significant risk factor for future ASIs. BMI emerged as a risk factor in 3 out of 7 studies, while age and height were significant in 1 out of 6 studies each. Gender and weight were not found to significantly affect ASI occurrence. Other factors identified but not subjected to a meta-analysis due to methodological heterogeneity or insufficient studies included playing surface, joint laxity, muscle weakness, match congestion, strength asymmetries, ground reaction forces, balance maintenance, skill level, and playing position.

This research contributes valuable insights into the prevention of ASIs in soccer, highlighting the importance of previous ankle sprains and playing surface quality. These findings assist sports professionals in developing optimal conditions and strategies for effective ankle sprain prevention.

Source: *Hoveidaei AH, Moradi AR, Nakhostin-Ansari A. Risk factors of ankle sprain in soccer players: a systematic review and meta-analysis. Sports (Basel). 2025;13(4):105. doi: 10.3390/sports13040105. Use is per CC BY 4.0 International License.*

PRIMATES AND RODENTS HEAL 3 TIMES FASTER THAN HUMANS

Skin wounds, which affect survival and biological functioning, are common in the animal kingdom. This study systematically investigated whether the slow wound healing observed in humans is a unique characteristic within the primate order.

First, researchers found no significant difference in wound-healing rates between baboons under experimental conditions and those in their natural environment (0.613 mm d^{-1}). Second, comparisons among 4 non-human primates (velvet monkeys, Sykes' monkeys, baboons and chimpanzees) revealed no significant differences in wound-healing rates.

Furthermore, these rates showed no significant differences compared to those observed in rodents, suggesting a potential commonality in wound-healing rates across diverse animal species. In contrast, human wound-healing rates were found to be markedly slower (0.25 mm d^{-1}), approximately 3 times slower than those observed in non-human primates. This finding indicates that the slow wound healing observed in humans is not a common characteristic among primate order and highlights the possibility of evolutionary adaptations in humans.

Understanding these inter-species differences in wound-healing rates may provide valuable insights into the evolutionary implications of wound healing. This study also underscores the need for further research into the biological processes underlying wound healing in various species.

Continued from page 15

Source: *Matsumoto-Oda A, Utsumi D, Takahashi K. Inter-species differences in wound-healing rate: a comparative study involving primates and rodents. Proc Biol Sci. 2025;292(2045):20250233. doi: 10.1098/rspb.2025.0233. Use Per CC BY.*

SUTURE METHOD MATTERS IN KNEE ARTHROSCOPY FOR MENISCUS REPAIR

The choice of meniscus repair technique has effects on long-term outcomes and recovery. A retrospective analysis was conducted on 120 patients with meniscus injuries who underwent surgical treatment at Yuhuan People's Hospital, Department of Joint Surgery, from January 2019 to March 2021. Based on the suturing method, patients were assigned into 2 groups: Group A (64 cases, all-inside suturing) and Group B (56 cases, outside-in suturing).

Surgical indicators and adverse events were recorded for both cohorts. The variances in proprioception before and after surgery, International Knee Documentation Committee (IKDC) scores, Lysholm scores, knee range of motion (ROM), and Visual Analogue Scale (VAS) pain scores were compared between the 2 groups. Group A had significantly shorter operative time, postoperative immobilization, and hospital stay compared to Group B ($P < 0.05$). The overall incidence of adverse events was 12.50% in Group A and 16.07% in Group B, with no significant difference between the groups ($P > 0.05$).

There were no substantial differences in preoperative knee proprioception difference values, IKDC scores, Lysholm scores, VAS scores, and knee ROM between the 2 groups ($P > 0.05$). At 3 months postoperatively, Group A exhibited lower proprioception difference values at 15°C, 45°C, and 75°C angles compared to Group B ($P < 0.05$). Additionally, at 3 months and 3 years postoperatively, Group A showed higher IKDC scores, Lysholm scores, and ROM and lower VAS scores compared to Group B ($P < 0.05$). Compared to the outside-in suturing approach, the all-inside suturing method for treating meniscus damage is more effective. It attenuates operative time, postoperative immobilization time, and hospital stay, ameliorates knee proprioception, promotes knee function recovery, alleviates pain, and is safe and reliable.

Source: *Jin W, Cai J. The effect and long-term prognosis of different suturing methods for meniscus repair under knee arthroscopy. Ann Ital Chir. 2024;95(5):909-917. doi: 10.62713/aic.3607. Use is per CC BY.*

COMPARISON OF ESWT AND HILT FOR CALCANEAL SPURS

Calcaneal spur (CS), a prevalent cause of localized heel pain, can significantly impact daily activities by causing discomfort and functional limitations. Symptoms typically include heel pain, especially during walking or after prolonged periods of inactivity, such as getting out of bed in the morning. This study aimed to evaluate the effectiveness of extracorporeal shock wave therapy (ESWT) and high-intensity laser therapy (HILT) in managing calcaneal spur-related symptoms. These non-invasive modalities were compared in terms of their ability to reduce pain and improve functional outcomes.

In this randomized clinical trial, patients diagnosed with calcaneal spur based on clinical and radiographic findings were randomly assigned to receive extracorporeal shock wave therapy (ESWT) or high-intensity laser therapy (HILT). Participants were randomized into 2 groups to receive either ESWT or HILT, complemented by standardized exercise regimens. Pain intensity was measured using the Visual Analog Scale (VAS), and functional outcomes were assessed with the Foot Function Index (FFI) at baseline, post-treatment, and 3 months post-treatment.

Both groups showed significant improvements in pain and functional outcomes. In the ESWT group, VAS scores for initial step pain decreased from 7.8 ± 1.0 to 4.0 ± 1.0 post-treatment and further to 3.4 ± 1.0 at 3 months ($P = 0.002$). The HILT group demonstrated a similar trend, with scores reducing from 7.5 ± 1.2 to 4.2 ± 1.1 post-treatment and 3.5 ± 0.9 at follow-up ($P = 0.001$). Total FFI scores improved significantly in both groups, with the ESWT group showing a larger reduction (58.8 to 19.7; $P = 0.033$) compared to the HILT group (57.4 to 35.4; $P = 0.046$). No significant adverse events were reported in either group.

ESWT and HILT are effective non-invasive options for treating calcaneal spur with ESWT providing slightly greater functional benefits.

Source: *Karakuzu Güngör Z. Comparison of extracorporeal shock wave therapy and high-intensity laser therapy in the treatment of calcaneal spur-related symptoms: clinical outcomes and functional improvement. J Orthop Surg Res. 2025;20(1):393. doi: 10.1186/s13018-025-05812-1. Use is per CC BY.*

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

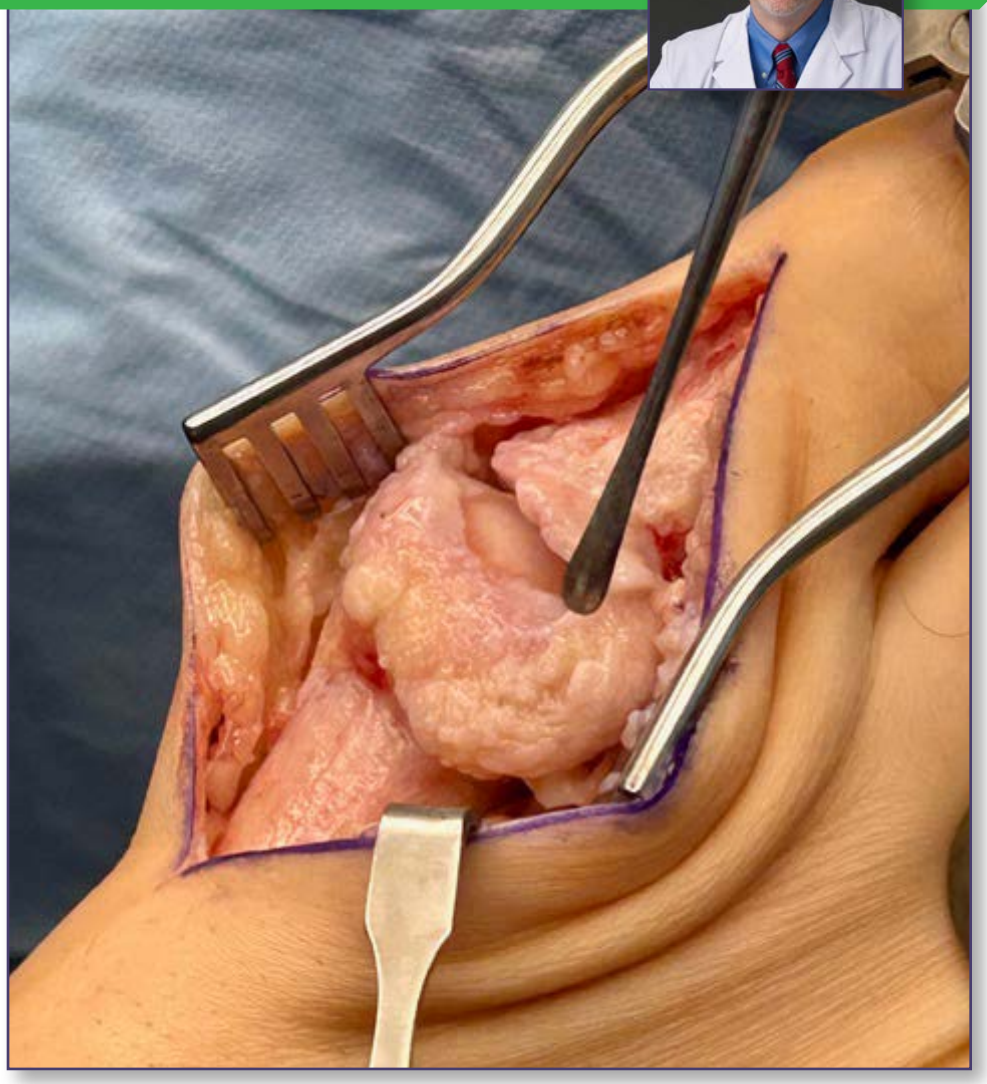
Call to order or for more information.

888.895.1305

orthotica.com/learn-more

First MPJ Arthrodesis – Techniques, Non-Union Management & Key Considerations

By Patrick DeHeer, DPM FACFAS, FFPM RCPS (Glasg)



First metatarsophalangeal joint (MPJ) arthrodesis has been studied extensively since its inception in 1852. The procedure primarily aims to relieve pain, restore length, and stabilize the medial column of the foot. This in turn helps re-establish the foot's weight-bearing pattern, contributing to a balanced foot tripod. Despite its long history and effectiveness, MPJ arthrodesis is not without complications, the most notable of which is non-union.

The prevalence of non-union varies with rates ranging from 6.5% to 9.2%. Key strategies to minimize this risk include appropriate plate selection—favoring longer plates—and careful consideration of the dorsiflexion angle, with a 5-degree angle often recommended. Non-union management might involve both medical approaches, such as teriparatide to boost bone healing, and surgical revisions, using techniques such as orthogonal plating and bone grafting to restore proper alignment and length of the first ray.

Benefits of First MPJ Arthrodesis

First MPJ arthrodesis is a well-established procedure with a track record of providing significant benefits for patients. Its primary aim is to alleviate pain and provide stability to the foot. Beyond pain relief, it plays an integral role in correcting foot mechanics and restoring the correct alignment of the medial column of the foot. This procedure helps reestablish a balanced weight-bearing pattern, which in turn contributes to the stabilization of the foot structure.

The primary benefit of the first MPJ arthrodesis is pain relief. Patients suffering from severe pain in the first MPJ can find significant relief after undergoing this procedure. Along with mitigating pain, it enhances the stability of the medial longitudinal column, which is essential for the overall balance and functionality of the foot. By providing a stable base, patients can experience improved mobility and function.

One of the critical goals of this procedure is to restore the original length of the medial column. Maintaining the proper length is vital for effective weight distribution across the foot, promoting a healthier and more balanced walking pattern. This restoration can alleviate transfer metatarsalgia, an issue stemming from uneven weight-bearing across the foot.

Non-Union Rates and Risk Factors

Non-union is a potential complication follow-

This article is a summary of Dr. DeHeer's presentation, "Non-union after a 1st MPJ arthrodesis, now what and how I can reduce the odds of this happening again?," from the APMA Surgical Complications Virtual Seminar held January 28, 2025. To view the full presentation with questions and answers—and see the agenda for the daylong program, visit https://apmasurgical.lerexpo.com/en/login. Continuing education credits are available for this and many of the lerEXPO programs.

ing first MPJ arthrodesis, although it occurs in a minority of cases. Understanding the rates and risk factors associated with non-union is crucial for surgical planning and patient education.

Studies indicate that the non-union rate for first MPJ arthrodesis is approximately 6.5%, meaning these patients did not achieve a complete fusion of the bones post-surgery. Practitioners are advised to speak with patients realistically about potential outcomes, including a 5% to 10% chance of non-union.

Key risk factors contributing to non-union include male gender, multiple comorbidities, and severe arthritis. These factors, alongside surgical technique and hardware choice, can influence union success rates. Patients should be informed about these risks to maintain realistic expectations and enable proactive management.

The degree of dorsiflexion applied during the fusion significantly impacts the likelihood of a successful union. A dorsiflexion angle of around 5 degrees is often recommended, as it is found to reduce the load applied distally and promote better bone fusion. Conversely, zero-degree plates can increase the risk of non-union due to less optimal load distribution. Achieving the proper angle not only aids in the fusion process but also benefits foot biomechanics by enhancing arch support and promoting a proper gait. Proper angle alignment also avoids transfer metatarsalgia, which is always a potential about which patients need to be advised.

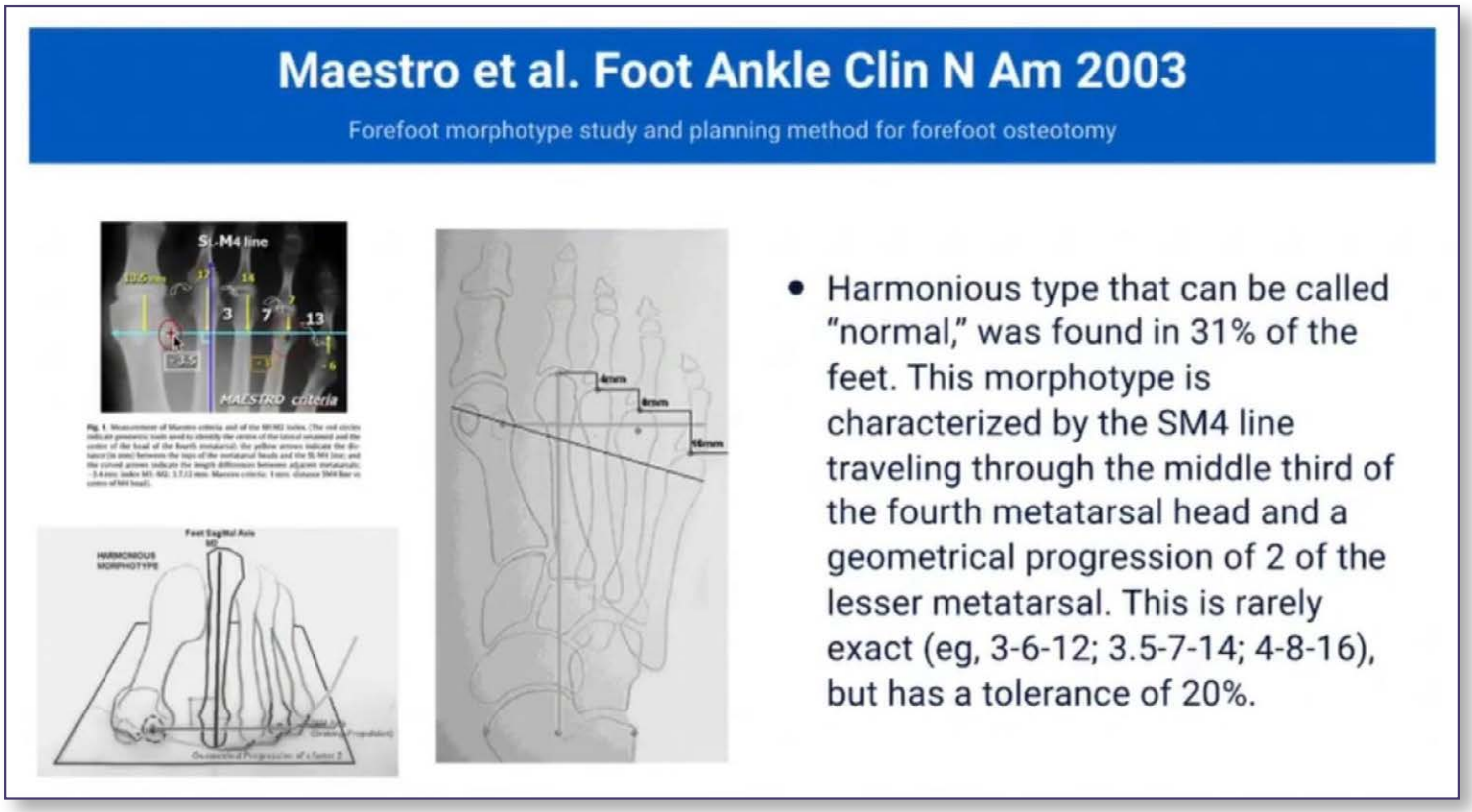
> Utilizing longer plates is advocated to gain additional purchase in the diaphyseal bone.

Surgical Technique Considerations

A pivotal component in first MPJ arthrodesis is the adequate preparation of the joint. Properly releasing the joint ensures successful fusion by minimizing non-union risks. Essential steps include the thorough release of the adductor hallucis and sesamoidal-phalangeal ligament. By accessing these structures, surgeons can effectively prepare the joint, ensuring the best chance for a successful outcome. This preparation also plays a crucial role in achieving correct alignment and function of the foot post-surgery.

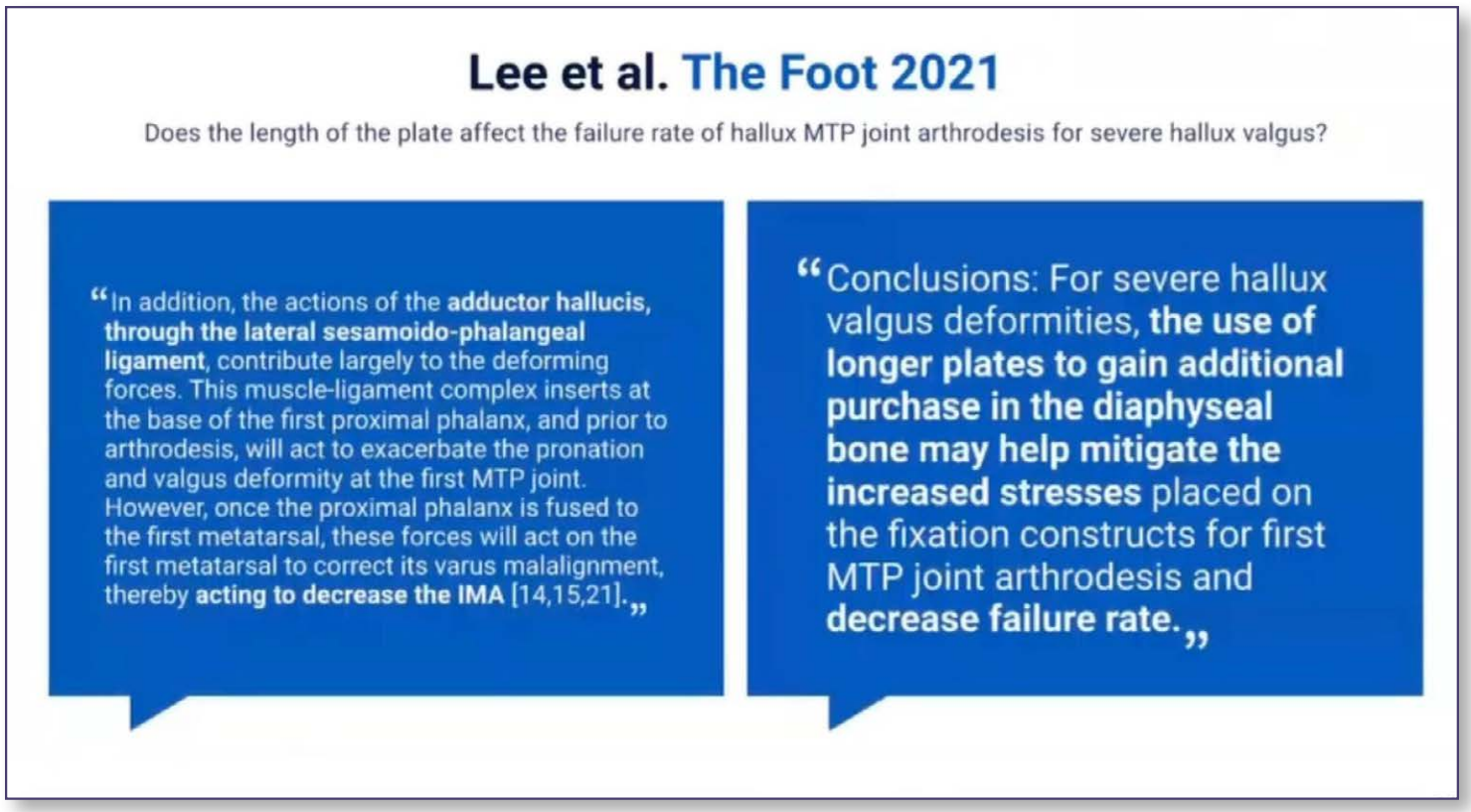
Another consideration during surgery is the length of the plate used. Research indicates a notable increase in failure rates with shorter plates, with failure defined as incomplete bony union or implant breakage. Hence, utilizing longer plates is advocated to gain additional purchase in the diaphyseal bone. This strategy not only helps to reduce the mechanical stress on the fixation construct but also enhances stability, which is crucial for a durable surgical outcome.

Correct positioning during surgery significantly influences the success of first MPJ arthrodesis. Utilizing an axial K-wire during the procedure helps simulate the weight-bearing surface and achieves the desired dorsiflexion angle of 5 – 10 degrees. Furthermore, maintaining the appropriate length of the first ray is vital to prevent complications, such as transfer metatarsalgia. The alignment and positioning substantially



Continued on page 18

Continued from page 17



affect foot biomechanics, reinforcing the need for meticulous attention during surgery.

Management of Non-Unions

In cases where non-union occurs, medical treatment options such as teriparatide can be beneficial. This synthetic parathyroid hormone, typically used for osteoporosis, boosts osteoblastic activity, accelerating fracture healing. Studies demonstrate that patients using teriparatide experienced quicker union times, making it a promising treatment adjunct for non-unions in first MPJ arthrodesis cases.

For more severe non-union cases, surgical revision using orthogonal plate fixation is a preferred approach. This method involves placing 2 plates at approximately 90 degrees to each other, offering significantly enhanced structural stability over unilateral plating. The increased strength and stability of orthogonal plating have been supported in studies involving femur and Lapidus fusions, making it an effective strategy for managing non-unions.

Bone grafting plays a crucial role in revision surgeries, as it facilitates the healing process by providing a scaffold for new bone growth. Pre-cut allografts soaked in bone marrow concentrate are often used to ensure healthy, bleeding surfaces and to maintain the length during revision procedures. This technique is essential for creating a conducive environment for fusion and restoring the length and stability of the medial column of the foot.

Conclusion

Meticulous surgical techniques, such as adequate joint preparation and the use of longer dorsal plates, play a critical role in minimizing the occurrence of non-unions. When it does occur, orthogonal plating and teriparatide as proven options as advanced strategies in non-union management. These approaches not only enhance healing outcomes but also improve the overall structural integrity and alignment of the foot, making them vital considerations for optimizing patient results in foot surgery. ler

Studies demonstrate that patients using teriparatide experienced quicker union times

Patrick DeHeer, DPM FACFAS, FFPM RCPS (Glasg) is now Medical Director at Upperline – Indiana and Podiatric Residency Director at Ascension St. Vincent Hospital in Indianapolis.

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

WOUND CARE UPDATE

I Thought I Was Doing Everything Right…Until the Denials Came In

By Cassandre Voltaire, DO, ABWMS

I used to think documentation was the easy part. Write what you saw, describe what you did, keep it clear and detailed. I was trained well. I took pride in good notes—organized, clinical, complete. The kind you'd feel confident handing off to a colleague.

So when I started seeing denials for wound care visits, I was confused. Not for lack of improvement. Not for gaps in treatment. But because the notes—my notes—didn't check the right boxes. It caught me off guard.

I had always thought of Medicare and other insurance reimbursement as a backend process, something for billing to figure out. It was a function of codes and clerical work, not something I needed to worry about as a clinician doing solid, evidence-based care. But when the same visit got flagged twice, and then a third time for a skin substitute denial, I knew I had to dig deeper.

The first time I looked at a Local Coverage Determination (LCD) closely—really looked at it—it wasn't love at first sight.The language was dense. The formatting was dry. But in between the lines, I saw something important: They were telling me what they needed to see. And I hadn't been showing it. Things like:

- Precise measurements at every visit
- Description of the tissue removed, not just "debrided as needed"
- Documentation that explained why the treatment was still medically necessary

I'd been doing all of that. But I hadn't been saying it in the way the system recognizes. And it turns out, that language matters more than I realized.

Good Medicine Vs Approved Medicine

This is what I've come to understand: You can provide excellent care and still be denied. Denied not because what you did was wrong, but because how you documented what you did did not match the language of reimbursement.[1,2]

I always thought "medical necessity" would be obvious from the clinical picture. But medical necessity, at least on paper, is a formula. It's not enough to be right. You have to write it right. And the difference between "wound improved with debridement" and "continued presence of devitalized tissue, 20%, requiring selective sharp debridement per CPT 97597" can mean approval—or denial. This isn't about gaming the system. It's about understanding how the system reads what we write.

I expected to feel frustrated—and I did. But what I didn't expect was how much clarity came from reading the LCDs and linking them back to my own notes.[3] The denials weren't random. They were following a playbook. I just hadn't read the playbook yet. And once I did, it felt less like fighting an invisible enemy and more like learning a new language. Still medicine, just written with a different accent.

This Isn't a Compliance Lecture

I'm not writing this to give advice. Honestly, I'm still learning. I still overthink my phrasing. I still wonder if I've included enough detail. But here's what I can say from the trenches of figuring this out:

- LCDs aren't just policy—they're prompts. If you follow the logic, you can reverse-engineer what your documentation needs to show.[1,4]
- Coders can only code what we, the clinicians, document. If we're vague, we tie their hands. If we're precise, we give them the keys.
- "Medical necessity" isn't assumed. It has to be spelled out, sometimes sentence by sentence.[2,5]

There's a strange kind of power in realizing that.

The Part I Never Learned in Training

I've had years of clinical education. I've practiced in hospitals, skilled nursing facilities, and wound clinics. I've memorized pressure ulcer stages, venous protocols and biofilm management strategies. But not once—not once—did anyone walk me through how documentation links to reimbursement denial risk. Or how Medicare's language shapes the care our patients are allowed to receive.That knowledge wasn't framed as part of my job.

And yet now I can see it clearly: If I don't know how to document for coverage, I might unintentionally block access to care. That makes it my job whether I like it or not.

So where am I now?

I'm still working through it. I've started reviewing LCDs when new denials come in. I've rewritten templates and added prompts. I've asked coders questions I never used to ask. I've also become less embarrassed about not knowing these things sooner. Because here's the truth: A lot of us don't know. Not because we're careless, but because this system is complicated and no one teaches us how to speak its language.

But I'm learning. Slowly. Deliberately. And sharing what I find, in case it makes someone else's road a little less frustrating. Because in the end, the goal isn't to be perfect. It's to make sure the care we give actually reaches the patient. And if that means writing one extra sentence in the note, then that sentence might be the most important thing we do that day.

Cassandre Voltaire, DO, is a wound care physician specializing in advanced wound management and chronic wound healing. Based in Massachusetts, she combines her background in family medicine with holistic and evidence-based wound care. She is also the founder of WoundFit, dedicated to empowering healthcare providers with accessible wound care education and resources.

References

1. Centers for Medicare & Medicaid Services (CMS). Billing and Coding: Wound and Ulcer Care (A58567). Updated Jan 2024. Available at https://www.cms.gov/medicare-coverage-database/view/article.aspx?articleId=58567. Accessed June 25, 2025
2. Thomas Hess CT. Diagnosis and Documentation Drive Medical Necessity. Advances in Skin & Wound Care. 2016;29(12):546-547. https://pubmed.ncbi.nlm.nih.gov/27846031
3. CMS Local Coverage Determination (LCD) L37228. Debridement of Wounds. Noridian Healthcare Solutions. https://www.cms.gov/medicare-coverage-database/view/lcd.aspx?lcdid=37228
4. AHIMA. Clinical Documentation Integrity Toolkit, 2023. https://www.ahima.org (requires membership access, citation verified via summary)
5. Schaum KD. Can physicians use CPT 97597/97598 to bill Medicare? Ostomy Wound Management. 2010;56(9):10–12. https://pubmed.ncbi.nlm.nih.gov/20859073

Unique Biomechanical Challenges of the Diabetic Foot

By James McGuire, DPM, LPT, LPed, FAPWHc

"Variability is the law of life, and as no two faces are the same, so no two bodies are alike, and no two individuals react alike and behave alike under the abnormal conditions we know as disease."

Sir William Osler, FRS, FRCP

The biomechanics of the diabetic foot are an intricate interplay of physiological and mechanical challenges that necessitate specialized care strategies. Diabetes often triggers changes in foot structure and function as a result of complications including peripheral neuropathy, vascular issues, and obesity. Additionally, tissue glycosylation adds rigidity to muscles and joints, exacerbating biomechanical imbalances. These changes lead to increased plantar pressure, impaired balance, and heightened ulceration risk, especially in areas such as the metatarsal heads. The underpinning forces of gravity further contribute to alignment difficulties, pushing the foot toward a more stable, yet problematic, plantar grade position. Understanding and addressing these biomechanical challenges are crucial for effective diabetic foot care, aiming to mitigate risks and enhance patient outcomes.

Why such a focus on diabetes? Numbers tell the story: 38.4 million people in the United States have diabetes, that's 11.6% of the US population. Only 29.7 million are diagnosed. That leaves 8.7 million people undiagnosed, meaning 22.8% of adults with diabetes are undiagnosed. These are the patients we need to be watching for.

Tissue glycosylation is a prevalent issue in diabetic patients, resulting from the binding of glucose to amino acids, impacting joints, connective tissues, muscles, and nerves throughout the body. This process leads to increased stiffness in tissues, ultimately affecting the biomechanics of the diabetic foot. Understanding the implications of tissue glycosylation is crucial in managing the associated challenges.

Glycosylation results in the stiffening of joints and connective tissues, reducing their flexibility. This decreased range of motion impacts various joints in the foot, including the subtalar and midtarsal joints, contributing to a loss of eversion mobility. Consequently, the rigidity in joints places additional stress on the forefoot, altering load distribution and exacerbating biomechanical inefficiencies.

Reduced tissue flexibility from glycosylation affects overall biomechanical function. The limited joint movement leads to compromised propulsion during walking, where people with diabetes push off with a pronated foot due to the inability to effectively resupinate. This lack of dynamic stability impairs normal gait function, increasing the likelihood of stress-related injuries and ulcerations.

The windlass mechanism, essential for arch stabilization and efficient propulsion, is significantly affected by glycosylation. The stiffening of the plantar fascia disrupts this

This article is a summary of Dr. McGuire's presentation titled, "Biomechanics of the Diabetic Foot; Unique Challenges of the Neuropathic Lower Extremity," from the 2025 No-Nonsense Seminar, March 7-9, 2025, hosted by the North Central Ohio Academy of Podiatric Medicine. To view the 60-minute slide presentation with questions and answers, visit https://nononsense2025.lerexpo.com/. Continuing education credits are available for many lerEXPO programs.

Tissue Glycosylation

OVERLAPPING COMPLICATING FACTORS ASSOCIATED WITH DIABETIC BIOMECHANICAL AND OFFLOADING CHALLENGES	
Peripheral Vascular Disease / Arterial	Obesity
Fluctuating Edema from Chronic Venous Insufficiency	Tissue Glycosylation
Peripheral Vascular Disease / Lymphatic	Biomechanics
Peripheral Neuropathy	Deconditioning Balance
Skin Disease	Motivation
Tissue Infection/Necrosis	Social Factors

mechanism, leading to a locked, pronated foot position. This altered foot function transfers excessive force to the forefoot and particularly the interphalangeal joints, commonly resulting in ulceration sites for diabetics.

Challenges of Neuropathic Lower Extremities

Patients with diabetes often face neuropathic complications which can profoundly influence the biomechanics and health of the lower extremities. These issues arise from both sensory and motor neuropathies, adding to the complexity of diabetic foot care.

Muscle Atrophy and Gait Alterations: Chronic neuropathy in these patients contributes to muscle atrophy, particularly in the plantar muscles and larger leg muscles. This atrophy leads to delayed and weakened muscle firing, slowing walking speed and shortening step length. The changes in muscle function result in a more cautious and unstable gait, further increasing musculoskeletal strain.

Increased Fall Risk and Balance Issues: Patients with diabetic neuropathy often experience heightened fall risk due to a combination of muscle weakness, sensory deficits, visual impairments, and vestibular issues. Their compromised balance and proprioception make it difficult to recover from stumbles, increasing their susceptibility to falls. Regular assessments and targeted physical therapy focusing on balance and strength can mitigate these risks.

Importance of Early Sensory Screening: Preventative measures, such as early sensory screening, are invaluable in diabetic foot care. Screening with more sensitive tools, like 1- or 2-gram monofilaments, can detect sensory loss early, allowing for timely intervention and lifestyle changes to slow neuropathy progression. Addressing sensory changes before the complete loss of protective sensation is critical in reducing

GAIT AND BALANCE

Unsteadiness

- Somatosensory deficit
- Visual disturbances
- Vestibular deficit
- Motor control problems

Uncertainty

- Gait disturbances

Cavanagh PR, Simoneau GG, Ulbrecht JS. Ulceration, Unsteadiness and Uncertainty: The biomechanical consequences of diabetes mellitus. J Biomechanics. 1993;26(1):23-40.

THE DEADLY 10 LEADING TO AMPUTATION	
Bad biomechanics	Immune system abnormalities
Fat pad thinning	Delayed wound healing
Connective tissue stiffness	Infection
Vascular (arterial, venous and lymphatic) dysfunction	Resistance to Advice
Neuropathy (sensory and motor)	Practitioner delay

the risk of ulceration and further complications.

High Amputation Risk: When caring for this patient population, clinicians must be highly vigilant about the multitude of factors that elevate the risk of amputation. Known collectively as the "Deadly 10," these include bad biomechanics, fat pad thinning, increased connective tissue stiffness due to glycosylation, vascular (arterial, venous and lymphatic) dysfunction, and neuropathy affecting sensory and motor functions. Additional risk factors encompass immune system abnormalities, which impair infection response, and delayed wound healing. A significant risk arises from patient behaviors such as resistance to proper footwear, combined with practitioner delays in addressing these issues proactively.

Addressing Biomechanical Imbalance

Diabetes frequently exacerbates underlying skeletal deformities, such as hammer toes, pronation, equinus, and hallux abducto valgus. These malalignments pre-exist in many of these patients, worsening as the disease progresses due to increased glycosylation, leading to stiffer tissues and more diminished flexibility. This compounded misalignment increases focal pressure on joints and metatarsal heads, significantly contributing to ulcerations. Early recognition and corrective intervention for these skeletal issues are vital to mitigate further harm.

A major challenge in diabetic foot biomechanics is the thinning and stiffening of the metatarsal fat pad. Typically, these fat pads cushion the foot and distribute pressures seamlessly during activity. In people with diabetes, diminished thickness compromises this function, increasing the risk for plantar ulcers. The lowest required thickness thresholds are notably absent in diabetic patients, amplifying plantar pressures and ulcer sites. Emphasizing the maintenance or artificial support of fat pad thickness is crucial in managing these risks.

Addressing these biomechanical issues involves a multi-faceted approach. Incorporating targeted physical therapy programs encourages Achilles stretching to reduce pressure transferred to the forefoot. Custom orthotics can aid in redistributing pressure and correcting gait issues by providing adequate plantar support and realigning foot posture. Additionally, educating

FAT PAD THICKNESS

The minimum thicknesses of the metatarsal fat pad necessary to make sure that peak pressures under the metatarsal heads does not exceed 700 kPa:

- 1st — 11.05 mm
- 2nd — 7.85 mm
- 3rd — 6.65 mm
- 4th — 6.55 mm
- 5th — 5.05 mm

Abouaesha F, Van Schie CHM, Armstrong DG, Boulton AJM. Plantar soft-tissue thickness predicts high peak plantar pressure in the diabetic foot. J Am Podiatr Med Assoc. 2004;94(1):39-42

MECHANICAL CONSIDERATIONS	
Areas of excessive focal pressure	Loss of mid-foot stability
Shear calluses	Altered gait patterns
Dorsal digital displacement	Equinus
Excessive metatarsal head pressures	Select muscle weakness

Cavanagh PR, Simoneau GG, Ulbrecht JS. Ulceration, Unsteadiness and Uncertainty: The biomechanical consequences of diabetes mellitus. J Biomechanics. 1993;26(1):23-40.

patients on lifestyle changes, including diet and exercise, can slow down progressing symptoms and improve overall foot health.

Footwear & Orthotics/ Physical Therapy & Stretching

Footwear and orthotics play a pivotal role in diabetic foot management. Properly fitted shoes with adequate support can prevent pressure-induced injuries and complications. The use of rocker sole designs in diabetic footwear is particularly beneficial. Such designs help offload stress from the forefoot, facilitating smoother and safer gait by reducing peak plantar pressures. Orthotic devices, whether rigid or accommodative, support foot alignment, provide total contact for pressure distribution, and minimize high-pressure spots prone to calluses or ulcers. Engaging patients in the selection of appropriate footwear and overcoming vanity or resistance to recommended options is crucial. Educating patients on the long-term benefits of recommended footwear choices can help prevent re-ulceration and potential amputations, empowering them to actively participate in their care and management.

Physical therapy (PT) is greatly underutilized yet essential in managing diabetes-related foot complications. PT programs focusing on Achilles stretching can improve ankle range of motion and alleviate forefoot pressure. Balance and gait training enhance proprioceptive feedback, reduce the fall risk, and strengthen muscles weakened by neuropathy. Regular PT engagement can address the destabilizing impact of neuromuscular deficits in diabetic patients.

Conclusion

The biomechanics of the diabetic foot presents unique challenges in managing the neuropathic lower extremity. Addressing these complexities necessitates a multifaceted approach, involving proper footwear, orthotics, physical therapy, and patient education. Clinicians must be proactive in recognizing risk factors and intervening early. Factors like peripheral vascular disease, tissue glycosylation, and fat pad atrophy significantly impact the foot's health. By adopting comprehensive strategies, including frequent monitoring and employing tools like rocker sole shoes and specialized orthotics, healthcare providers can reduce the risk of ulceration and amputation, enhancing overall diabetes care and foot health.

James McGuire, DPM, LPT, LPed, FAPWHc, is Director of the Leonard S. Abrams Center for Advanced Wound Healing and Professor at Temple University School of Podiatric Medicine.

Prototype AFO Focuses on Aesthetics, Comfort, Function

By Peter Dabnichki and Toh Yen Pang

This study highlights the importance of a user-centered design in enhancing adherence to and satisfaction with AFOs.

Ankle-foot orthoses (AFOs) are essential in pediatric rehabilitation particularly for children with conditions such as cerebral palsy, drop foot, or neuromuscular impairments. However, for this patient population, compliance is a common issue as functionality is secondary to appearance and peer perception. Discomfort, pain, and functional limitations have also been shown to lead to non-adherence to device usage. Thus, the aim of this study was to device a method that inverts this traditional approach and devises an attractive light design (Figure 1) that can be adapted to ensure structural soundness.

Figure 2: The 3D-printed AFO underwent user testing involving individuals that were representative of the intended population. The research team wore the AFO prototype for a pre-defined duration, during which key activities, such as standing, walking, ascending and descending stairs, and engagement in light physical activity, were observed. The AFO was fitted by the participants themselves or with assistance from caregivers to evaluate the ease of application and removal.

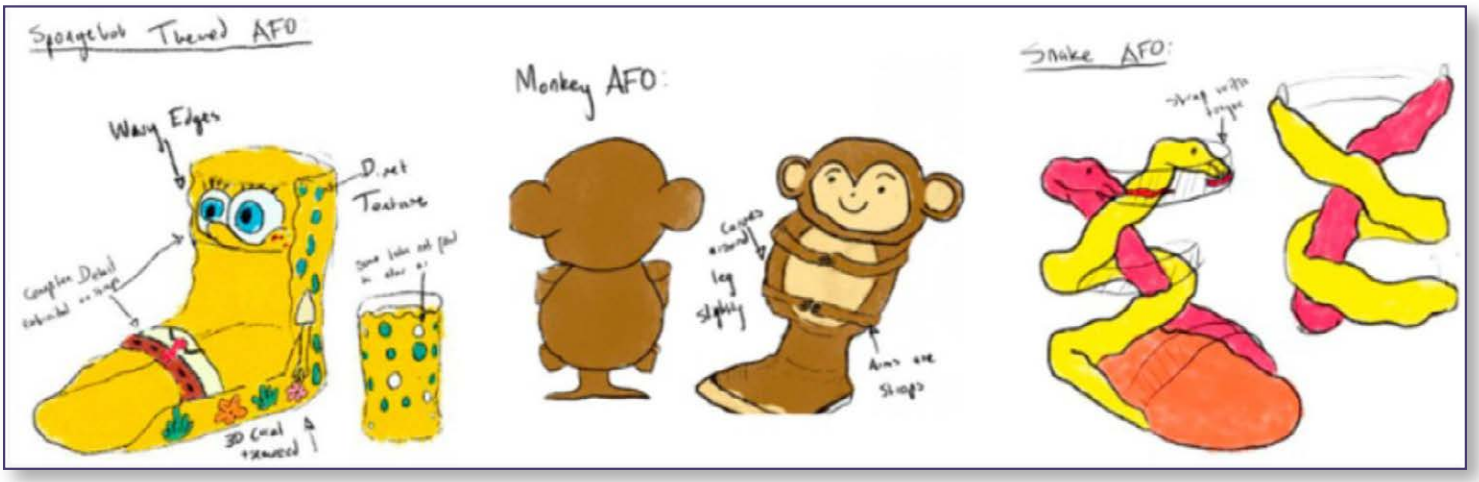
Methods

This study used a user-centered design process, adapted from established engineering design principles, to develop and evaluate an innovative AFO design. Specific design criteria were established—integrating advanced materials and fabrication methods, including additive manufacturing, as well as the specific requirements of individuals with conditions necessitating the use of AFOs—to encompass comfort, range of motion, ease of donning and doffing, and durability. Nylon PA12 was selected as the optimal material choice for pediatric AFOs due to its balance of mechanical performance, skin comfort, cost-effectiveness, and sustainable production, with minimal material waste. A prototype AFO was subsequently fabricated, incorporating features such as adjustable stiffness and a personalized fit (Figure 2).

Results and Discussion

By synthesizing insights garnered from user feedback, esthetic research, and engineering analysis, this study sought to create AFO designs that enhance both functional performance and the emotional well-being of users. Once anthropometric data were collected, they were integrated into Computer Aided Design (CAD) software to develop custom AFO designs tailored to individual users. The study authors used the "extrude" approach to modify the support's thickness to the desired height and then shape it by cutting away material to create a tree-like form. This approach met the esthetic design requirement. A filleting tool was used to create soft, rounded edges, ensuring comfort by preventing pinching or sharp transitions against the skin. The design also effectively distributed torque from the support down to the base by gradually connecting the 2 components. The current study prioritized user empowerment in the design by incorporating visually engaging elements that

This article has been excerpted from "User-Centered Design Framework for Personalized Ankle–Foot Orthoses" Prosthesis. 2025; 7(1):11. https://doi.org/10.3390/prosthesis7010011. Editing has occurred, including the renumbering or removal of tables and figures, and references have been removed for brevity.



promote compliance and self-expression. The designs integrated strategically placed ventilation features to improve breathability and overall comfort and also allowed for the AFO to remain integrated within a shoe, facilitating streamlined usability. The use of CAD-based approaches enables easy adjustments and iterative refinement, rendering the manufacturing process more flexible and efficient.

The reliance on anthropometric measurement techniques makes this approach adaptable to regions where 3D scanning equipment is not feasible as well as providing a low-cost, scalable solution. However, in urban or resource-rich environments, 3D scanning could play a complementary role.

The results demonstrated that the proposed design displayed moderate deformation (12 mm) and low stress levels (1.8 MPa), with acceptable safety factors (FoS = 15) for nylon material. This material's properties align well with the requirements of lightweight yet durable AFOs.

The manufacturing flexibility provided by CAD modeling and the use of 3D printing technologies allowed for rapid prototyping and iterative refinement. This approach reduced the time and cost associated with traditional molding methods while enabling the creation of customizable designs tailored to individual users.

Physical testing was performed by using the printed AFOs on group members, with a focus on user experience, particularly in terms of comfort and fit.

Comfort and Fit: Discomfort was observed around the calf connection, primarily due to the unrounded edges of the 3D-printed material. This sharp geometry created localized pressure points, leading to skin irritation and discomfort during wear. Modifying the material's flexibility and further refining the edge geometry would likely alleviate these concerns.

Flexibility and Stiffness: The prototypes provided adequate alignment support; however, they exhibited excessive stiffness, which impeded natural gait and resulted in discomfort during prolonged use. Future iterations could focus on modifications to the 3D-printed materials. Design modifications, including integrating hinges or segmented components, could be potential solutions to enhance range of motion without compromising support.

Ease of Use: The integration of adjustable straps and compatibility with standard footwear significantly enhanced usability. This feature enables children to independently don and doff the AFO, which is essential for promoting compliance and fostering autonomy.

Esthetic and Psychological Impact: The visual appeal of the designs was positively received by the intended users, aligning with the objective of creating a device that fosters empowerment and self-expression. The actual design was an initial prototype that could be adapted to the body surface to increase the functional comfort.

Conclusions

This study highlights the importance of a user-centered design in enhancing adherence to and satisfaction with AFOs. By addressing key factors such as comfort, functionality, esthetics, weight, ease of use, and customization, the study authors propose design solutions that are tailored to the diverse needs and preferences of users. This research has established a framework for functionality, informed by prior studies, that focuses on principles such as user acceptance, comfort, wearability, and injury prevention. Incorporating user feedback was found to be a key strategy to address persistent issues, including poor fit, skin irritation, and psychological discomfort, which often lead to device rejection or inconsistent use.

The project also explored the potential of additive manufacturing to create more comfortable and engaging AFOs for children. This approach sought to mitigate non-compliance caused by discomfort and unappealing designs, while advancing functionality and esthetic appeal. Our methodology encompassed concept development, prototyping, testing, and iterative refinement. Beyond meeting functional requirements, these solutions must also address esthetic and psychological factors to enhance the overall user experience.

Future studies should expand on these findings by exploring advanced manufacturing methods and integrating emerging technologies to further personalize and optimize AFO performance. ler

Peter Dabnichki is affiliated with the Mechanical, Manufacturing and Mechatronic Engineering, School of Engineering, STEM College, RMIT University, Melbourne, Australia.

Toh Yen Pang is affiliated with the Biomedical Engineering, School of Engineering, STEM College, RMIT University, Melbourne, Australia.

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:**

PediFix® Medical Footcare

☐ 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:

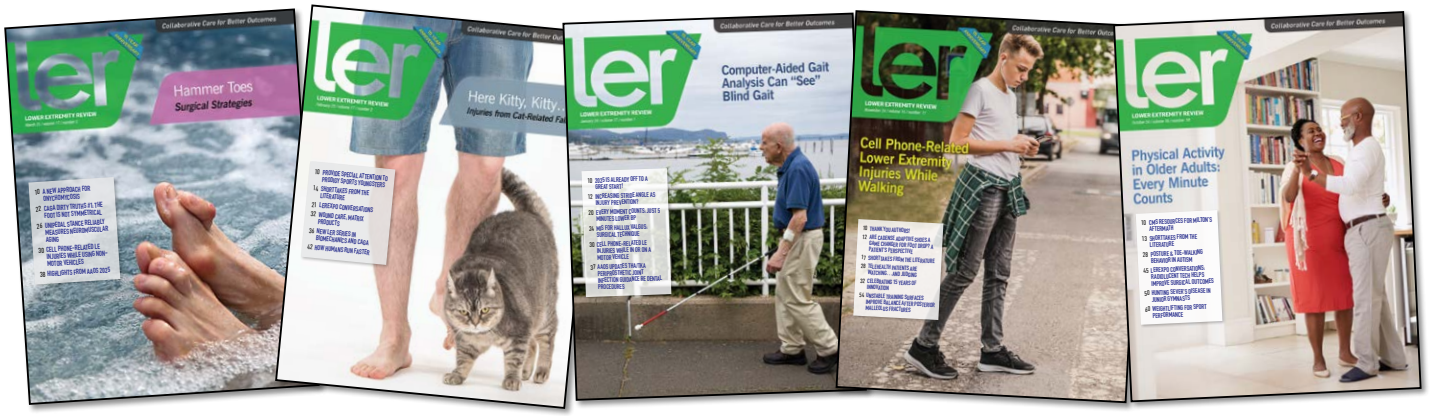
PediFix, 301 Fields Lane, Dept. LER822-P, Brewster, NY 10509

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

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

HYALURONIC ACID AND ALGINATE DEVICE FOR TENDON REPAIRS

VersaWrap® is a U.S. Food and Drug Administration–cleared medical device implant (not tissue), comprising hyaluronic acid (HA) and alginate, that provides a gelatinous encasement for peripheral nerves, tendons, and surrounding tissues such as ligaments and skeletal muscles. This bioresorbable, sutureless tendon protection device allows tissues to glide and to remain untethered, thereby reducing reoperations and improving patient outcomes. The device is nano-porous, allowing desired nutrients and healing molecules to permeate, preserving the healing microenvironment. VersaWrap offers unique surgical flexibility as the only tendon and nerve protector that can be delivered either as a sheet or as a flowable gel.

Alafair Biosciences
512/739-9510
alafairbiosciences.com

AAOS ANNOUNCES STRATEGIC TRANSITION OF FRACTURE & TRAUMA REGISTRY

The American Academy of Orthopaedic Surgeons (AAOS) announced the strategic evolution of the Fracture & Trauma Registry (FTR) as part of an initiative to modernize and streamline data capture across its Registry Program. Beginning January 1, 2026, key fracture data will be integrated into the American Joint Replacement Registry (AJRR) and the Shoulder & Elbow Registry (SER), allowing for broader clinical impact and improved participation.

Key benefits of the transition include the following:

- **Enhanced Efficiency:** Streamlined data submission reduces administrative burden on participating sites, particularly for Level 1 trauma centers.
- **Proven Technology:** Integration with established platforms that have demonstrated reliability and clinical value.
- **Broader Impact:** Access to larger participant networks and more robust datasets.
- **Sustained Insights:** Continuation of evidence-based practice tracking for the most clinically significant fracture types.

Under the new model, hip fracture data will transition to the AJRR, and proximal humerus fracture data will be incorporated into the SER. Distal femur, distal radius, and ankle fracture data will be securely archived. Participating sites will continue to have access to historical FTR reports and data through the end of 2025.

For more information or to enroll in the AJRR or SER, email RegistryEngagement@aaos.org or call 847/292-0530.

KNEE AND ANKLE COMPRESSION SLEEVES

FUTURO™ Brand's reengineered premium compression sleeves for muscle and joint support have a new sleek look, smooth low-profile construction, and ultra-soft fabric with 4-way stretch that delivers an unrestricted comfortable fit, flexibility, and range of motion. A

no-cutout construction helps reduce chafing and rubbing, and an innovative comfort band with silicone beading helps prevent slipping and rolling. The ankle sleeve, which features a low-profile design that fits comfortably in shoes, is recommended for mild tendonitis, swelling, soreness, sprains, and strains. The knee sleeve with stabilizers is recommended for mild arthritis, swelling, soreness, sprains, and strains. It is designed wider at the thigh for improved fit and with removable metal stabilizers, which adapt the support based on individual needs.

FUTURO Brand
800/537-2191
futuro-usa.com

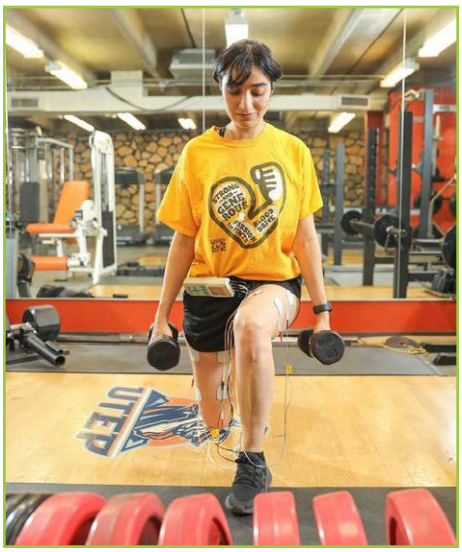
ENOVIS APPOINTS NEW CEO

Enovis™ Corporation, Wilmington, Delaware, has appointed Damien McDonald as chief executive officer (CEO), effective May 12, 2025. He also joined the company's board of directors following the conclusion of its 2025 Annual Meeting of Stockholders on May 21, 2025. McDonald succeeds Matt Trerotola

McDonald joins Enovis with over 35 years of experience in the medical device industry. Most recently, he served as CEO of LivaNova, a global business creating clinically differentiated medical devices for the head and heart to improve the lives of patients worldwide. In his 6 years there, he drove improved results in growth, profitability, and shareholder value. He also made a meaningful impact on company culture, centered on a "Patients First" mindset.

NMES COUPLED WITH RESISTANCE TRAINING LEADS TO GREATER MUSCLE MASS

Neuromuscular electrical stimulation (NMES) uses electrical currents to contract muscles. The stimulation devices are easy to use and widely available on the market, according to Sudip Bajpeyi, PhD, a professor in the Department of Kinesiology at The University of Texas at El Paso (UTEP), but he has often wondered, "Can these stimulators offer any benefits when used during resistance training? What does the research say?"



Zahra Fatahimeiabadi, a graduate student in Bajpeyi's lab, demonstrates a resistance workout while using NMES. Image courtesy of UTEP.

Well, the results are in–and they are promising. In a new meta-analysis study, Bajpeyi found that using NMES while doing resistance training leads to greater muscle mass and strength compared to resistance training alone.

Bajpeyi and his team conducted the meta-analysis, comprising more than a dozen studies that used NMES, and reviewed their results. The analysis focused on studies where participants performed traditional resistance exercises, such as bench presses or squats, while using NMES devices. The studies compared the results of participants using electrical stimulators while exercising to those who did the exercises with no electrical stimulation. Participants' muscle mass and strength were assessed at the beginning and the end of each study. Training periods for participants ranged from 2 to 16 weeks, with longer durations yielding better results.

"Under normal conditions, the brain activates muscles by sending signals through the nervous system." Bajpeyi said. "NMES mimics this process by delivering external electrical currents to the nerves, causing the muscles to contract, without input from the brain. Think of it as though your muscles are contracting involuntarily."

NITINOL IMPLANT SYSTEM FOR MTP FUSIONS, LAPIDUS PROCEDURES

REFLEX® HYBRID combines the compression of a nitinol staple with the stability of a locking plate, offering indication-specific implants designed for metatarsophalangeal (MTP) fusions and Lapidus procedures. When paired with a cannulated screw with a Dynamic Disc, or a REFLEX nitinol staple, the construct provides dynamic biplanar compression and fixation for a fully dynamic construct. The system includes an innovative inserter that allows the surgeon to expand the implant's legs for a streamlined technique. Because both of the implant's legs are on the same side of the joint, the surgeon has the flexibility to adjust the placement of the implant, which is not possible with other nitinol solutions on the market.

Medline UNITE
844/626-8624
medlineunite.com

BIOINSPIRED ORIGAMI–BASED PROSTHETIC KNEE

This innovation represents a paradigm shift in lower-limb prostheses, offering a flexible, lightweight, and customizable solution for the development of soft robotics by integrating advanced materials, drives, and sensors. Image courtesy of Peking University.

A research team at Peking University, Beijing, China, has developed what they claim is the world's first soft prosthetic knee.

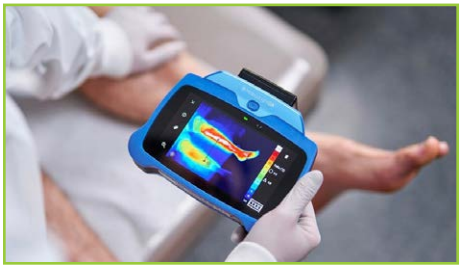
Compared to the rigid, high-density metallic mechanics of prosthetic knees, soft materials enable lighter, more flexible designs with better compliance and impact absorption. However, challenges such as inefficient deformation under load have hindered their application. The new design overcomes these limitations with an innovative solution: The soft prosthetic knee features an origami structure, reinforced with polymer blocks and a connection system for the thigh and calf. Weighing only 300 g and standing at 15 cm, the design of the prosthesis allows for a broad range of motion, meeting the dynamic movement needs of the knee.

The team introduced a fold structure that mimics the human knee's polycentric rotation. By adjusting design parameters, the prosthesis achieves highly accurate joint movement that replicates natural knee function. To enhance weight-bearing capacity, the back-fold structure creates a pneumatic chamber, simulating the hydraulic pressure of horsetail cells. Reinforced folds reduce unnecessary deformation, improving the accuracy of motion control. The prosthesis demonstrated precise movement under pneumatic control, with performance closely matching theoretical predictions. It also absorbed impact forces by 11.5% to 17.3%, held

weight of over 75 kg (250 times its weight) and generated more than 25Nm of torque.

In treadmill walking tasks, participants were able to walk at both normal and fast speeds with improved gait symmetry, experiencing less fatigue and lower impact. Additionally, the prosthesis performed well in multi-terrain and outdoor scenarios, such as walking on stairs and ramps, and crossing obstacles.

THERMAL IMAGING MODULE FOR MOLECULIGHTDX



MolecuLight recently announced the availability of its new Thermal Imaging Module for the MolecuLightDX™ fluorescence imaging platform. This innovative clip-on module allows clinicians using the DX device to capture informative thermal images simultaneously with the platform's established fluorescence images (for bacterial load assessment) and standard images (used for precise digital wound measurement), allowing clinicians to easily visualize, document, and quantify thermal changes directly at the bedside, complementing the DX's existing point of care capabilities. By seamlessly integrating thermal data with bacterial load information (via fluorescence) and precise digital wound measurements on the single DX platform, clinicians gain a more comprehensive, objective understanding of the wound environment. This combination supports better-informed treatment decisions and enhanced tracking of healing progress, all while improving workflow efficiency.

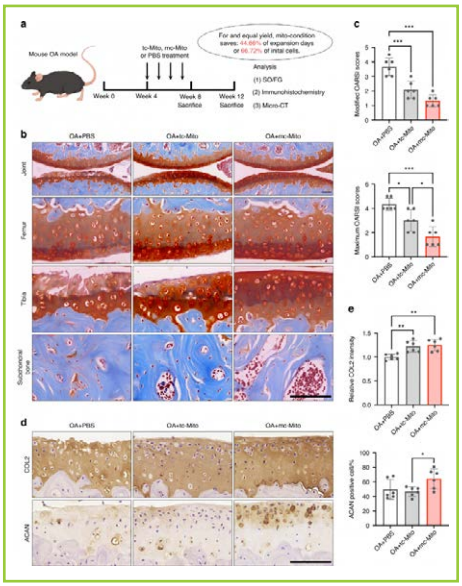
MolecuLight
877/818-4360
moleculight.com

NEW METHOD CREATES 854X MORE MITOCHONDRIA, OFFERING HOPE FOR CARTILAGE REGENERATION

Mitochondrial dysfunction is a common denominator in numerous diseases, including osteoarthritis (OA), heart failure, and metabolic disorders. While mitochondrial transplantation has emerged as a promising avenue for restoring tissue function, its clinical potential has been severely hampered by the scarcity of viable mitochondria. Thus, a team of researchers at Zhejiang University School of Medicine, Hangzhou, China, sought a sustainable and scalable solution for producing high-quality mitochondria suitable for clinical applications. The team has pioneered a stem cell–based system that functions as a "mitochondria factory." By leveraging human mesenchymal stem cells and a specially designed culture medium dubbed "mito-condition," the team achieved unparalleled increases in both mitochondrial quantity and quality. These mitochondria exhibited exceptional energy production and facilitated cartilage regeneration in OA models. This groundbreaking approach not only overcomes key barriers in mitochondrial transplantation but also deepens our understanding of cellular organelle regulation, opening new frontiers in regenerative medicine.

The innovative mito-condition culture medium integrates 9 essential components, including growth factors and human platelet lysate, to optimize mitochondrial production. Within just 15 days, this method generated 854 times more mitochondria than conventional approaches, all while preserving stem cell viability.

In OA models, transplantation of these enhanced mitochondria resulted in substantial cartilage repair over a 12-week period, surpassing the efficacy of traditional mitochondrial treatments. Furthermore, the mitochondria demonstrated impressive storage stability, retaining function for 24 hours at 4°C—a critical factor for real-world clinical



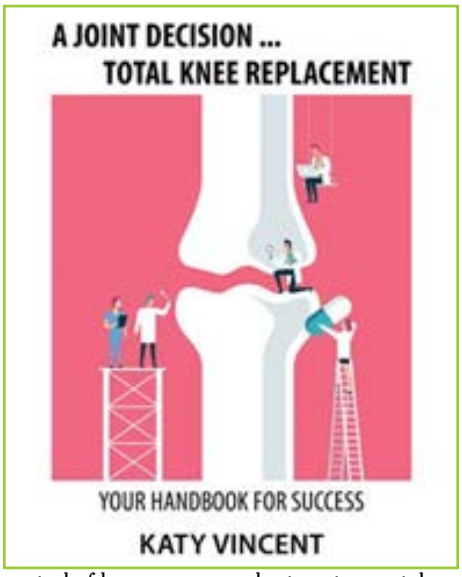
Mc—mitochondria exhibit superior performance for in vivo mitotherapy. (a) Schematic illustration of the establishment of the mouse OA model and the experimental design to evaluate the value of mitochondrial amplification for in vivo applications. (b) Safranin—O/Fast green staining of joint sections at 12 weeks. Scale bar, 50 μm. (c) Modified and maximum OARSI scoring system (sample = 6 for each group). (d) Immunohistochemical staining (COL2, ACAN) of joint sections at 12 weeks. Scale bar, 50 μm. (e) Quantification of COL2 and ACAN in cartilage tissues at 12 weeks (sample = 6 for each group). All data are presented as mean ± SEM. $^{*}P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$. P values were determined using one—way ANOVA (c, e).

applications. The concept of organelle tuning, as demonstrated in this study, could potentially be adapted to generate other cellular components, broadening the horizons of cell engineering and therapeutic applications.

The most immediate application of this technology lies in OA treatment, where it offers a promising regenerative solution. However, its impact extends far beyond joint disorders, with potential benefits for conditions such as heart disease, neurodegenerative disorders, and wound healing.

GUIDE TO HELP PATIENTS WITH RECOVERY AFTER KNEE REPLACEMENT

Katy Vincent, who underwent a total knee replacement at age 54, reveals how she took



control of her recovery and return to mental and physical fitness in *A Joint Decision ... Total Knee Replacement: Your Handbook for Success* (published by Balboa Press AU). This informative and interactive workbook is written to help readers prepare for, and recover from, a total knee replacement surgery. It documents everything the author has learned about knee replacements, and provides areas for planning and reviewing one's recovery activities on a daily, weekly, and monthly basis. It is the author's hope that the lessons and insights in this book will help others optimize their success and achieve a life of mobility and freedom after their surgery.

Balboa Press
balboapress.com/en-au

CARBON FIBER INSOLES

Overpowered Insoles, made from carbon fiber, feature unparalleled strength, an ultra-lightweight design, and cutting-edge technology, all to empower athletes of all levels to achieve new heights of speed, agility, and performance. Overpowered Insoles elevate the user's performance by maximizing speed, optimizing kinetic energy return, providing advanced shock absorption, enhancing balance and stability, and reducing the risk of injuries. With high-quality PU foam that is designed to mold to the foot contour over time, the user will experience a personalized, comfortable fit. They also offer optimal arch support tailored to the user's unique foot structure. The durability of the carbon fiber construction ensures that they can withstand the demands of intense athletic activities. Overpowered Insoles are available in a range of sizes to accommodate various shoe sizes.

Overpowered Insoles
overpoweredinsoles.com

UNIVERSITY STUDENTS DEVELOP PROSTHETIC FOOT

The team has applied for a patent for the Goldilocks Foot, which is now pending. And they have established a startup company, called Mediflex Prosthetics LLC, to attract venture funding that would allow them to further develop and eventually market their product.

When Colorado State University (CSU) engineering student Garrison Hayes was 6 years old, he underwent a transfemoral amputation due to pediatric osteosarcoma. After limb-salvage surgery, Hayes played soccer, then skied, cycled, and became a Paralympic athlete in the javelin throw. All the while, he found the prosthetic feet he used to be imperfect: Hayes has broken many of the devices through wear and tear, and he never walks—or even lounges around the house—without a shoe over his prosthetic foot for cushioning and flexibility.

So, when he became an engineering student, Hayes set out to create a better prosthetic foot. Last August, he teamed up with 4 other CSU undergraduates, all studying biomedical engineering. They invented a 3D-printed prosthetic foot fabricated from a type of nylon called polyamide. This material is applied layer by layer in a network of latticing. It costs less than other models of similar quality, may be customized for the needs of the wearer, is more comfortable, and because of its material and latticework design, returns energy to the body—putting a spring in the step of those who use it.

The students call their design the Goldilocks Foot because "this foot will fit just right," explained Eric Gutierrez-Camacho, who serves as the team's design engineer. He has printed prototypes of the Goldilocks Foot on his personal 3D printer; it takes 3 days to make each piece.

"It's not just some rubber shell over an insert. This is actively supporting your leg and your body," explained Hayes, who has tested each prototype his team has created. "When you apply pressure on it through gait cycles, the material wants to return to its shape, like a spring, and that supplies energy to assist you. It actively supports you and feels more natural."

"With the Goldilocks Foot, we can reach infinite markets to address very specific problems with very specific solutions," Gutierrez-Camacho said. "We can tailor each design to each person."

Source: Batista, NP, de Carvalho, FA, Machado, AF, Micheletti, JK, Pastre, CM. What parameters influence the effect of cold-water immersion on muscle soreness? an updated systematic review and meta-analysis. Clinical Journal of Sport Medicine 33(1):p 13-25, 2023. doi: 10.1097/JSM.0000000000001081

AZafo ARIZONA™
An OHI Company

ARIZONA BALANCE BRACE

OVER A DECADE

OF POSITIVE PATIENT OUTCOMES

Arizona Balance Brace: Podiatrists' top choice for treating balance issues

With over a decade of success, the **Arizona Balance Brace** is the **only** balance brace with a proven track record of impacting **tens of thousands of patients' lives.**

Scan to learn more about how to
Implement a Fall Prevention Program in your practice

AZafo ARIZONA
30 YEARS
OF INNOVATION

The OHI Family of Brands

APEX · AZafo ARIZONA™ · Langer Biomechanics · PedAlign · safestep™ PREVENTION PAYS · The Orthotic Group