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LOWER EXTREMITY REVIEW
May 26 / volume 18 / number 5

# The Swelling Secret: *Lymphedema*

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## NEW & NOTEWORTHY



## THE LAST WORD



## COVER STORY

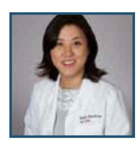


Discover the hidden science behind swelling and why all edema starts with the lymphatic system, how to spot it early and take control. Hear from 2 experts in the field and one man living with lymphedema..

By Dr. Windy Cole, DPM, CWSP, FACCWS, FFPM RCPS (Glasg) with Dr. Loan Lam and guest Cam Ayala

## LEREXPO HIGHLIGHTS





As diabetes grows worldwide in astounding numbers, so does limb loss due to the disease. This doctor gives us a glimpse of how AI can help to identify issues before they start and decrease limb loss.

By Dr. Laura Shin

## FOOT FORWARD



This month our author responds to questions and comments on the past articles and shares deeper insight into her methods.

By Dr. Jennifaye V. Brown

## FEATURE ARTICLES



Human feet evolved from flexible, grasping structures into stiff, arched platforms for walking. This piece dives into that transformation that enables efficient movement for forward propulsion.

By Tom Michaud, DC, and Nicolas Haelewijn, Ph.D.



One expert clinician gives insight into the ripple affects technology has on the clinician themselves, the perception of their knowledge and ability and the practice itself.

By Mikel D. Daniels, DPM, MBA



A continuation of this series about computer aided gait analysis, our expert gets real about the desire for fashion at the cost of foot health.

By Jay Segel, DPM; Sally Crawford, MS



A special report about the application of transcranial pulse stim in rehab for pain management in knee osteoarthritis.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LOWER EXTREMITY REVIEW

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## Lower Extremity Review

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



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# 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

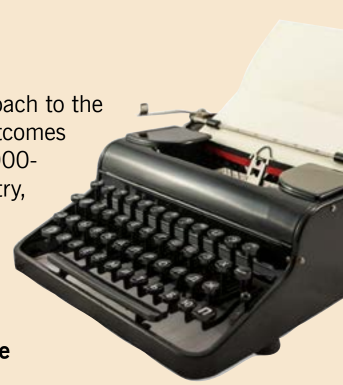
- Biomechanics matter
- Movement is essential
- Injury prevention is possible
- Diabetic foot ulcers can be prevented
- Collaborative care leads to better outcomes

## 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.



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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**

# ShortTakes From the LITERATURE

## THE RELATIONSHIP BETWEEN CLINICAL OUTCOMES AND GAIT BIOMECHANICS IN PF

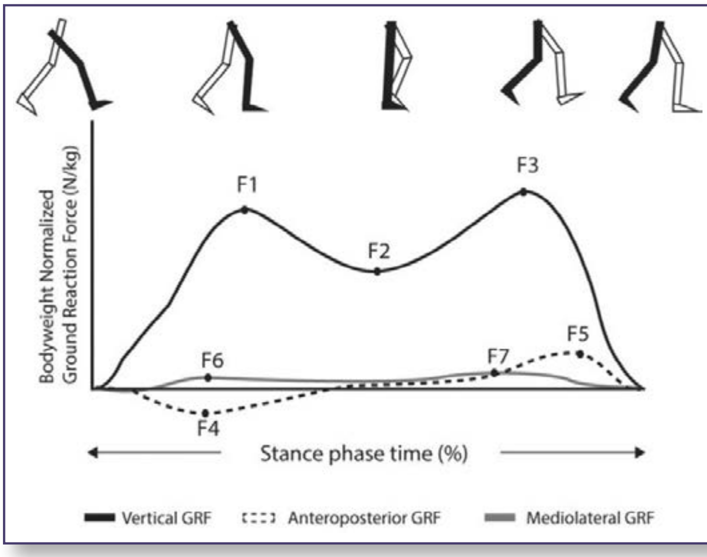



**Figure.** Ground reaction force (GRF)-time variables during gait.

Plantar fasciitis (PF) is a common musculoskeletal disorder characterized by heel pain that disrupts gait and daily function. This study examined relationships between clinical outcomes and gait biomechanics, determined whether these relationships differ between recent- and chronic-onset cases, and identified key clinical predictors of gait speed.

A cross-sectional study was conducted with 42 individuals with PF. Clinical outcomes included worst pain, normalized gastrocnemius and soleus muscle length, normalized lower limb muscle strength, and normalized dynamic balance. Gait biomechanics during barefoot walking were captured using a motion analysis system and force plates, focusing on spatiotemporal parameters and ground reaction forces (GRFs). Correlation coefficients were used to assess relationships across the overall cohort, as well as in recent- and chronic-onset PF, while multiple linear regression identified clinical predictors of gait speed.

Clinical outcomes related differently to spatiotemporal parameters and GRFs depending on symptom duration, with the recent-onset PF showing widespread correlations and chronic-onset PF showing more selective links with ankle strength and dynamic balance. Regression analysis identified gastrocnemius muscle length and anterior reach distance on the Y-Balance Test (YBT) as significant predictors of gait speed, explaining 28% of the variance ($P$ = 0.002).

Symptom duration influences gait biomechanics in PF, with recent onset showing broad adaptations and chronic onset exhibiting more specific strength- and balance-related changes. Gastrocnemius muscle length and dynamic balance in the anterior direction were identified as significant contributors to gait performance. Targeting these factors, with consideration of symptom duration, may improve gait in individuals with PF.

***Source:*** *Boonchum H, Vachalathiti R, Smith R, Muraki S, Bovonsunthonchai S. The relationship between clinical outcomes and gait biomechanics in individuals with plantar fasciitis. Arch Physiother. 2026 13;16:23-33. doi: 10.33393/aop.2026.3626*

## TREATMENT AND COST OF ATHLETIC TRAINING IN HIGH SCHOOLS FOR KNEE AND ANKLE


The monetary costs of sport-related injuries are significant, but complexity in public and private payers and disparate injury-reporting systems create challenges in accurately estimating their economic impact. Few researchers have characterized the cost of athletic training services for sport-related injuries. Treatment and costs characteristics of athletic training services provided to high school student-athletes for knee and ankle cases, including comparison of total cost of care by gender, sport, and injury severity outcome was researched. Between 2014 and 2019, 219 knee and 400 ankle cases and their associated treatments were documented by athletic trainers in the National Athletic Treatment, Injury and Outcomes Network Surveillance Program. Therapeutic exercises and ankle strapping were the most commonly documented services. The median estimated total cost of care was $124.20 (interquartile range, $75.44-$231.64) per knee case and $148.58 (interquartile range, $27.00-$287.10) per ankle case. Median total cost of care varied across injury severity.This study provides insights into the cost characteristics of high school athletic training services. Although costs were generally lower than previously reported, the findings highlight the value of athletic training services in managing knee and ankle cases and underscore the need for improved documentation and cost data collection to further demonstrate the economic value of athletic training services.

***Source:*** *Sniffen K, Collins C, Rozier M, Stamatakis K, Buchanan P, Hinyard L. Treatment and cost characteristics of athletic training services in secondary schools for knee and ankle cases. J Athl Train. 2026 16;61(1):51-58. doi: 10.4085/1062-6050-0587.24*

## FOOT TO FATALITY: ALARMING OUTCOMES FOLLOWING ACUTE DIABETIC FOOT INFECTIONS


Acute, deep infections of diabetes-related foot ulcers can present as surgical emergencies. The term diabetic foot attacks (DFAs) was introduced to emphasize the urgency of these infections and need for immediate intervention. DFAs are characterized by deep infection of the foot that spread rapidly to the rest of the foot and limb. It can be limb- and even life-threatening. Although DFAs are relatively common, the literature on the outcomes is scarce. We evaluated the outcomes and postoperative course of patients with DFA. This was a single-center, retrospective observational study. All patients who underwent emergency surgery for DFA between 2017 and 2023 were included. The primary outcome was time to wound closure. Secondary outcomes included amputation rate, mortality, amputation-free survival, hospital readmissions and surgeries of the limb. Amputation-free survival was calculated using Kaplan-Meier methods. A total of 104 DFAs in 97 patients were included. Wound closure was achieved in only 48.5% of DFAs with a median time to closure of 153.0 (IQR 147.0) days. The amputation rate during the initial hospital admission was 31.7%. The in-hospital mortality rate was 6.7% and 1-year mortality rate was 26%. Amputation-free survival at 12 months was 39.7% (95% CI 31.3-50.4%). DFAs are associated with a high risk of major amputations, high mortality rate, non-healing of the wound, frequent hospital readmissions and multiple surgeries of the limb. DFAs are associated with devastating outcomes. Increased awareness is necessary and may support earlier recognition and appropriate management.

***Source:*** *Ghijsen SC, Lenssen HH, Coert JH, et al. From foot to fatality: The alarming outcomes following acute diabetic foot infections ("diabetic foot attacks"). J Plast Reconstr Aesthet Surg. 2026 25;116:168-176. doi: 10.1016/j.bjps.2026.03.041.*

## EWING SARCOMA OF THE GREAT TOE: A RARE CASE REPORT


Ewing sarcoma (ES) rarely arises in the toes, where nonspecific pain and swelling can mimic benign conditions, delaying diagnosis. Early recognition is critical because modern multimodal therapy can achieve limb preservation and high rates of disease control. A case of a healthy 22-year-old man developed progressive pain and swelling of the left hallux after partial nail excision for a presumed ingrown toenail. The wound failed to heal, evolving into a friable 3 × 3 cm dorsal mass. Radiography and MRI demonstrated an aggressive lytic lesion destroying the distal phalanx with soft-tissue extension. Incisional biopsy revealed small round blue cells strongly positive for CD99, and fluorescence in situ hybridization confirmed an EWSR1 rearrangement consistent with ES. Staging PET-CT showed no metastases. The patient received 6 cycles of vincristine-doxorubicin-cyclophosphamide alternating with ifosfamide-etoposide, followed by partial amputation of the distal phalanx with clear margins. Histology showed 98% tumor necrosis. Adjuvant chemotherapy was completed uneventfully. At 12-month surveillance, MRI and PET-CT showed no local recurrence or distant spread, and the patient had painless, functional ambulation. It should be noted that persistent or atypical digital lesions warrant oncologic evaluation. Soft-tissue masses that do not resolve after routine care should prompt advanced imaging and biopsy. Molecular confirmation is pivotal. Detection of an EWSR1-FLI1 family fusion secures the diagno-

*Continued on page 12*

*Continued from page 11*

sis and guides therapy. Neoadjuvant chemotherapy enables limb-sparing surgery. Ewing sarcoma of the great toe is exceptionally rare but can be successfully treated when identified early and managed with coordinated multimodal therapy.

***Source:*** *Alkhudhayri A, AlJohani HT, AlDakhil AM, Bobseit A, Alhamdan AA. Ewing sarcoma of the great toe: a rare case report. Int J Surg Case Rep. 2026 11;138(3):478-483. doi: 10.1097/RC9.0000000000000171*

## ELASTIC TAPING OF TOES AFTER PERCUTANEOUS FOREFOOT SURGERY: TECHNICAL TIP




**Figure 2.** The tape is applied centrally on the lateral aspect around the base of the proximal phalanx, then crossed medially in a manner similar to a charity ribbon. Rotational control can be adjusted by varying the tension of the 2 straps. Lateral (A), oblique (B), and dorsal-plantar view (C). Depending on the desired level of retention, 2 parallel overlapping strips may be applied (D).

**Figure 3.** Following resection of the bony eminence with a wedge burr, a lax joint capsule frequently can be observed. (A) Flaccid soft tissues (arrows) and the bone paste being manually expressed and subsequently thoroughly rinsed out. (B, C) Overlapping U-shaped tapes (white) used to press the capsule back onto the bone and reduce the risk of hematoma formation.

***Source:*** *Toepfer A, Potocnik P, Farei-Campagna J, et al. Elastic Taping of the toes after percutaneous forefoot surgery: a technical tip. Foot Ankle Orthop. 2026 7;11(2):24730114261433593. doi: 10.1177/24730114261433593.*

## HONEY DRESSING FOR DIABETIC FOOT ULCERS: A SYSTEMATIC REVIEW


Researchers conducted a systematic review and meta-analysis following PRISMA guidelines regarding the efficacy and safety of honey dressing compared to conventional dressings in the treatment of diabetic foot ulcers (DFUs). PubMed, BIOSIS, EMBASE, Cochrane Central Register of Controlled Trials (CENTRAL), and Google Scholar internet were searched from inception to Jan 31, 2026, for RCTs comparing honey dressing with conventional dressings in DFU patients. Primary outcomes were complete wound healing rate and time to complete healing. Risk of bias was assessed using the Cochrane RoB 2.0 tool. The quality of evidence was graded through the Grading of Recommendations Assessment Development and Evaluations (GRADE) approach. Sixteen RCTs involving 1423 participants were included. The sample sizes ranged from 23 to 348 participants. The follow-up duration varied from 4 to 24 weeks. Meta-analysis showed that honey dressing significantly improved the complete healing rate (OR 2.28, 95% CI 1.76 to 2.95) and reduced the time to complete healing (MD –4.38, 95% CI –8.06 to –0.71) compared to controls. According to the GRADE system, the overall quality of evidence for the outcomes of time to healing was rated as 'low', and the quality of evidence for the outcomes of healing rate was rated as 'moderate'. Honey dressing is a safe and more effective intervention for DFUs than conventional dressings, associated with significantly improved healing rates and faster healing time.

***Source:*** *Yao L, Dai J, Mei S. Honey dressing for diabetic foot ulcers: a systematic review and meta-analysis of randomized controlled trials. Front Endocrinol (Lausanne). 2026 18;17:1759703. doi: 10.3389/fendo.2026.1759703.*

# INFLAMMATION AND NUTRITION-BASED INDICATORS FOR PREDICTING DFUS

Inflammation and nutritional status are increasingly recognized as key contributors to impaired wound healing in diabetes. However, the relationship between inflammation- and nutrition-based indicators and diabetic foot ulcer (DFU) has not been well established. This study investigated these associations.

The cross-sectional analysis included 1,644 participants, including 129 with DFU and 1,515 without. Several biomarkers-neutrophil-to-albumin ratio (NAR), monocyte-to-albumin ratio (MAR), red blood cell distribution width-to-albumin ratio (RAR), hemoglobin-albumin-lymphocyte-platelet (HALP) score, and prognostic nutritional index (PNI)–were significantly associated with DFU prevalence. After adjusting for covariates, individuals in the highest tertile showed increased odds of DFU for NAR (OR = 1.73; 95% CI: 1.09–2.74), MAR (OR = 1.71; 95% CI: 1.05–2.79), and RAR (OR = 4.47; 95% CI: 2.57–7.77) compared with the lowest tertile. Conversely, higher HALP (OR = 0.50; 95% CI: 0.31–0.80) and PNI (OR = 0.42; 95% CI: 0.26–0.67) were associated with lower DFU prevalence. Restricted cubic spline analysis revealed a nonlinear relationship between RAR and DFU prevalence, with an inflection point at 3.83.

Findings from the retrospective clinical study supported these results. Elevated NAR (OR = 4.71; 95% CI: 1.99–11.18), MAR (OR = 2.56; 95% CI: 1.23–5.31), and RAR (OR = 6.15; 95% CI: 2.31–16.41) were positively associated with DFU prevalence, while HALP (OR = 0.93; 95% CI: 0.90–0.97) and PNI (OR = 0.85; 95% CI: 0.78–0.93) showed protective associations.

Overall, higher NAR, MAR, and RAR were linked to increased DFU prevalence, whereas higher HALP and PNI were associated with reduced risk. Among these indicators, RAR demonstrated the strongest predictive ability. ler

***Source:** Chen H, Zhou Y, Dai J. Association of inflammation and nutrition-based indicators and diabetic foot ulcers: a cross-sectional study and a retrospective study. Front Endocrinol (Lausanne). 2025 16;16:1654831. doi: 10.3389/fendo.2025.1654831*


# CLAI PATIENTS WITH SUBTLE CAVUS FOOT: IS CALCANEAL OSTEOTOMY AN ESSENTIAL PROCEDURE?


**Figure 1.** Imaging indicators for patients with chronic lateral ankle instability with subtle cavus foot.

Chronic lateral ankle instability (CLAI), frequently resulting from ankle sprains, is often associated with undiagnosed hindfoot varus deformities, specifically subtle cavus foot (SCF). While ligament reconstruction remains the standard treatment for CLAI with SCF, there is ongoing debate regarding the need for adjunctive calcaneal osteotomy to correct the underlying malalignment. A retrospective analysis of 102 patients with CLAI and SCF was conducted from November 2016 to November 2022. Patients undergoing arthroscopic modified Broström procedure were assigned to the control group, while those receiving arthroscopic modified Broström procedure with minimally invasive calcaneal osteotomy were placed in the experimental group. Preoperative and postoperative imaging included calcaneal pitch angle, Meary's angle, arch height, and calcaneus valgus angle. A total of 81 patients with 2-year follow-up were included. Significant differences in imaging indicators were observed in the experimental group ($P < 0.001$), while no significant changes were noted in the control group ($P > 0.05$). Both groups demonstrated improvements in AOFAS and VAS scores ($P < 0.001$), with differences between 3- and 24-month follow-up ($P < 0.001$). Significant differences in imaging indicators and AOFAS scores were found between groups at both follow-up intervals ($P< 0.01$). The complication rate was 6.52% in the experimental group and 11.43% in the control group. For patients with CLAI with SCF, arthroscopic modified Broström procedure with minimally invasive calcaneal osteotomy is an effective treatment that minimizes bone and soft tissue damage. This study suggests that it is necessary to correct hindfoot alignment while stabilizing the ankle joint to enhance function and reduce recurrence of chronic ankle instability. ler

***Source:** Fu S, Wang C, Wang J, Wu C, Shi Z. Comparison of treatment outcomes for patients with chronic lateral ankle instability with subtle cavus foot: is calcaneal osteotomy an essential procedure? J Orthop Traumatol. 2025 26;26(1):61. doi: 10.1186/s10195-025-00877-4.*

## WOUND TALK WITH DR. WINDY COLE

# Giving Lymphedema the Squeeze: All Things Compression

By Dr. Windy Cole, DPM, CWSP, FACCWS, FFPM RCPS (Glasg) with Dr. Loan Lam DPM, FAWPHc, FAPWCA, CWSP, CHWS, CLWT and guest Cam Ayala

## 1. Introduction: The Body's Hidden Homeostasis

In traditional medicine, we often treat the vascular, integumentary, and lymphatic systems as separate silos. However, the "Veil Theory," championed by Dr. Heather Hettrick, reveals that these systems are inextricably linked. At the center of this connection is the endothelial glycocalyx, a microscopic, sieve-like layer within our blood vessels that regulates the movement of fluid and proteins.

When this delicate "sieve" or the vessels themselves are compromised by disease or injury, the burden falls entirely on the lymphatic system. This leads to a paradigm-shifting realization for clinicians and patients alike: All edema is lymphedema. Whether the root cause is venous insufficiency, diabetes, or trauma, the resulting swelling is evidence of an overburdened lymphatic system.

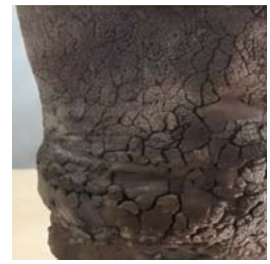
"Think of the lymphatic system as the sewer system of inflammation. It is responsible for clearing the 'junk'—infection, metabolic waste, and excess fluid. When the sewer system backs up, the entire biological environment suffers."

When this system fails, it follows a predictable, visible progression. For the "Lymphie" community, understanding this continuum is the first step toward reclaiming their health.

### Diagnosing Lymphedema: Clinical Exam

**Kaposis – Stemmer's Sign:** assesses the ability to pinch a fold of skin, classically done at the base of the second toe.

**Lipdermatosclerotic Skin Changes:** hyperkeratosis, woody skin changes, papules, pappilomas, pustules, verruca-like lesions



**"Sausage Toes":** Dorsal foot swelling or "dorsum hump" with toe involvement

**Lymphedema Rubra:** Acute Lipodermatosclerosis - often misdiagnosed as cellulitis

## 2. The Continuum of Lymphedema: From Stage 0 to Elephantiasis

Lymphedema is a chronic, progressive condition, but it is not a death sentence for your lifestyle. The clinical stages help us determine the level of intervention needed. (see Table 1)

**The "So What?" of Empowerment:** Do not let a Stage 3 diagnosis steal your hope. While the body replaces fluid with fibrosis (permanent scar tissue), Dr. Lam and other experts emphasize that specialized therapy can reverse many late-stage skin changes. The goal is to move backward on the continuum—from Stage 3 to Stage 2, and eventually to a stable Stage 0.

## 3. The Clinical Detective: Avoiding the "Antibiotic Trap"

Accurate diagnosis is often delayed because lymphedema is frequently mistaken for infection. This leads to the "antibiotic trap," where patients are prescribed cycles of drugs that do nothing for the underlying lymphatic failure. (see Table 2)

**Red Flags for Diagnosis**

- **Sausage Toes and Dorsal Humps:** Swelling often begins in the distal extremities. Look for sausage-like toes and a hump on the midfoot where fluid traps, unable to pass the ankle's lymph nodes.

This article is a summary of Dr. Cole's presentation, "Giving Lymphedema the Squeeze" from Wound Talk with Dr. Windy Cole on January 8, 2026. To view the full presentation with questions and answers–and see the agenda for the program, visit https://woundtalk.lerexpo.com/ . Continuing education credits are available for this and many of the lerEXPO programs

## Table 1. The Continuum of Lymphedema: From Stage 0 to Elephantiasis

| STAGE | CLINICAL PRESENTATION | REVERSIBILITY STATUS |
|---|---|---|
| **Stage 0 (Latent)** | Impaired transport with no visible swelling. | Highly manageable; focuses on preventing onset. |
| **Stage 1 (Spontaneously Reversible)** | Early fluid accumulation; pitting edema that may subside with limb elevation. | Reversible with consistent compression and therapy. |
| **Stage 2 (Spontaneously Irreversible)** | Tissue becomes fibrotic (scarred); pitting is harder to elicit; elevation no longer reduces swelling. | Partially reversible; requires active intervention to soften tissue. |
| **Stage 3 (Elephantiasis Nostras Verrucosa)** | Significant volume changes, skin thickening, and lesions (papillomas). | Actually Reversible: With proper therapy, even late-stage skin changes can be significantly improved. |

- **Kaposi-Stemmer Sign:** A gold-standard test. If you cannot pinch and lift the skin at the base of the second toe, the test is positive, indicating significant tissue thickening.
- **Lymphorrhea (The Weeping Pore):** This occurs when lymphatic vessels essentially burst under pressure. Patients often describe it as milky perspiration that appears after a workout, as if fluid is seeping directly through the skin.

**The Medication Warning:** Empowerment means checking your med list. Common drugs like Amlodipine (for blood pressure), Gabapentin (for nerve pain), and Prednisone (steroids) are notorious for inducing or worsening edema. If you notice a sudden increase in swelling after starting a new script, advocate for a review with your physician.

## 4. The Patient Journey: From Pain to Purpose

The lived reality of a "Lymphie" is defined by the battle between discipline and motivation. Cam Ayala's story serves as a powerful testament to the grit required for long-term management.

1. **The Trigger:** For Cam, primary lymphedema was dormant until puberty. A bone biopsy for a suspected tumor acted as the triggering event, causing his lymphatic system to fail post-operatively.
2. **The Surgical Odyssey:** Cam endured 24 surgeries in 7 years, including a botched knee replacement. This cycle of infection (osteomyelitis) and surgical fatigue led to a pivotal moment of clarity.
3. **The Pivot:** In 2022, Cam chose an elective transfemoral amputation. Far from a failure, this was a proactive choice to regain

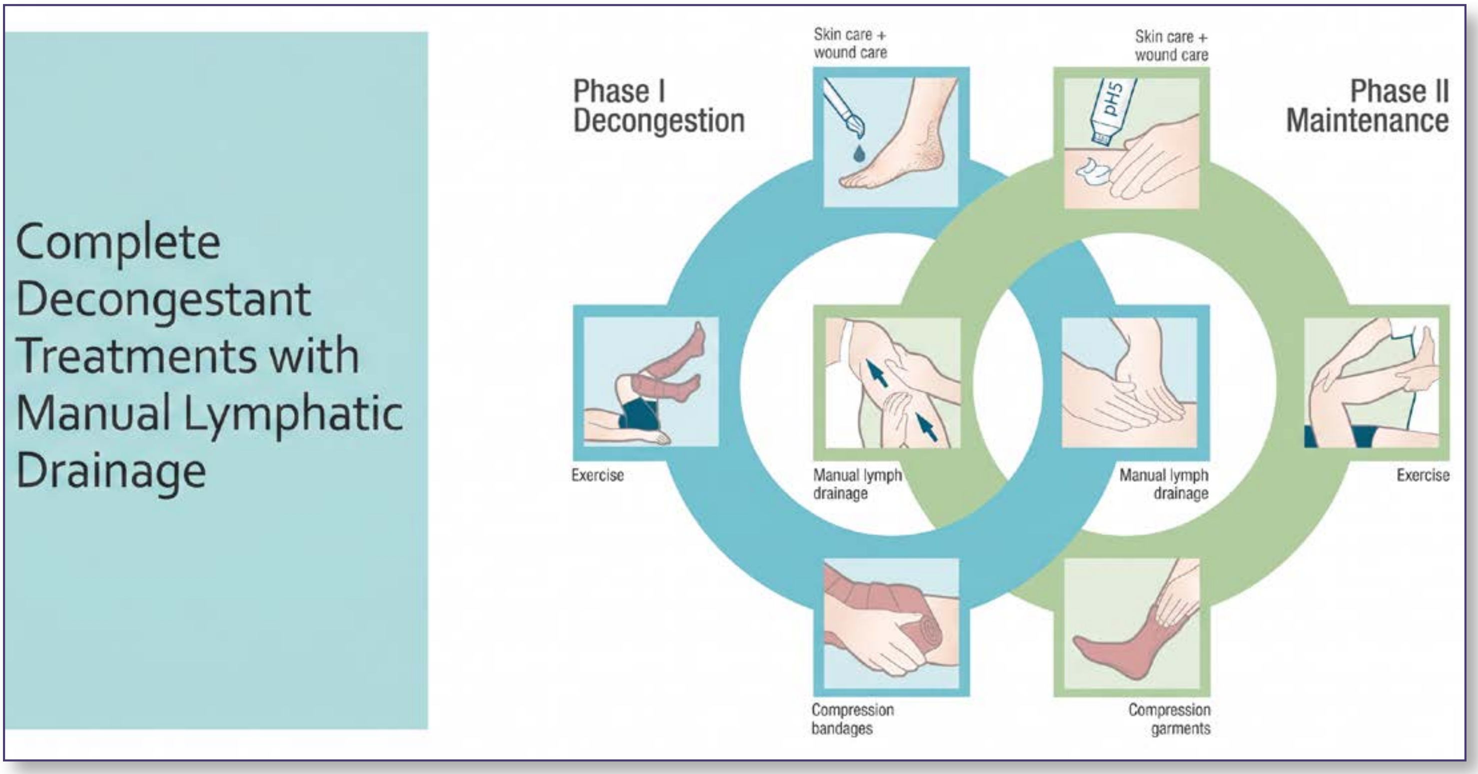



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**Table 2. Cellulitis vs. Acute Lipodermatosclerosis**

Clinicians must distinguish between infection and the "Lymphedema Rubra" (inflammation) associated with Acute Lipodermatosclerosis:

| FEATURE | CELLULITIS (INFECTION) | ACUTE LIPODERMATOSCLEROSIS |
|---|---|---|
| **Symmetry** | Almost always one side (unilateral). | Frequently affects both sides (bilateral). |
| **Blanching** | Redness is often non-blanchable. | Redness is blanchable (turns white when pressed). |
| **Shape** | Diffuse swelling. | Distinctive inverted champagne bottle shape. |
| **Systemic Signs** | High WBC count and fever. | Normal WBC count; no systemic fever. |

mobility. Even as an amputee, he continues lymphedema protocols daily because the condition is systemic.

**The Mantra:** "Lymphedema and gravity do not take days off." Cam teaches that while motivation is fleeting, discipline—doing the compression and therapy when you don't want to—is what prevents the disease from progressing.

## 5. Building the Integrated Care Team

You cannot manage lymphedema alone. You need a specialized circle of care that understands the complexities of the lymphatic system. (see Table 3)

**Clinical Resource:** Every care team should utilize the Stride Guide by Susie Ehmann and Robin Bhork, an essential algorithm for choosing the right compression based on patient-specific tissue texture and mobility.

## 6. The Modern Toolkit: Management, Technology, and the Law

The gold standard of treatment is Complete Decongestive Therapy (CDT). This includes Manual Lymphatic Drainage (MLD)—a light, skin-stretching technique (not deep tissue)—combined with compression and exercise.

The Lymphedema Treatment Act is a landmark legislation that changed the landscape of care. The most empowering change? Medicare and private insurers now provide coverage for compression with or without a wound.

- **Daytime Garments:** Coverage for 3 garments per affected limb every 6 months.
- **Nighttime Garments:** Coverage for 2 garments per affected limb every 2 years.

**Next-Gen Technology**

Management has evolved beyond the hot and itchy elastic stockings of the past:

- **Inelastic Compression:** Modern tools like the AeroWrap provide stiff support that is 250% more effective at pumping fluid during movement than traditional elastics.
- **The Arrow Gauge:** This allows for patient-controlled precision. It features a built-in safety valve that automatically blows off excess air, ensuring the patient never over-compresses the limb.
- **Pneumatic Pumps:** Advanced home pumps now feature zoned chambers that can be deactivated to avoid pressure on painful wounds or sensitive areas.

## 7. Conclusion: Thriving with Lymphedema

While lymphedema is chronic, it is no longer a barrier to a full, active life. By combining the right technology with personal discipline and legislative

**Table 3. Building the Integrated Care Team**

| ROLE | PRIMARY VALUE ADD |
|---|---|
| **Certified Lymphedema Therapist (CLT)** | Crucial: Must be a CLT. General massage can trigger flare-ups. CLTs use specialized techniques to move fluid safely. |
| **Super-microsurgeons** | Plastic surgeons who perform advanced procedures like lymph node transfers or bypasses. |
| **DME Suppliers** | Providers of the tools (pumps and garments) who navigate insurance requirements. |
| **Mental Health Professionals** | Vital for addressing body dysmorphia and the psychological weight of chronic disease. |

support, you can move from pain to purpose.

**Empowerment Resources:**

- **NLN (National Lymphedema Network):** For patient conferences and support.
- **LEARN Network:** For instructional videos on self-MLD and skin care.
- **Amputee Coalition:** Support for those whose journey includes limb loss.
- **Lymphedema Patient Roundtable (YouTube):** Monthly discussions on the psychological elements of thriving.

Stay mobile, stay disciplined, and remember you are not just a patient; you are a "Lymphie" with a community and a toolkit designed for your success.

*Dr. Windy Cole is a double board-certified podiatric physician and internationally recognized wound care expert with more than 24 years of clinical experience in limb preservation and advanced wound management. She serves as Adjunct Professor and Director of Wound Care Research at Kent State University College of Podiatric Medicine and is Chief Research Officer for Capsicure Clinical Research Organization.*

*As the founder of Cole Collaborative Consulting, Dr. Cole partners with biotech and medical device companies to develop evidence-generation strategies, strengthen market access pathways, and deliver high-quality scientific and medical communications.*

*A leader in the integration of emerging technologies into wound care, Dr. Cole has directed numerous clinical trials and contributes her expertise to advisory boards across the biotech and device sectors, providing insight on FDA strategy, clinical trial oversight, medical monitoring and protocol development with real-world implementation.*

*A sought-after speaker at national and international symposia, she is dedicated to advancing patient outcomes through evidence-based practice, interdisciplinary collaboration, and innovation in the management of complex, hard-to-heal wounds.*

*Dr. Loan Lam is Medical Director of wound services at United Vein and Vascular Centers. She earned her medical degree from Barry University and completed a podiatric surgical residency at Yale New Haven Health System. Board-certified in wound care, hyperbaric medicine and lymphedema therapy, Dr. Lam has published in peer-reviewed journals, presented at national and international conferences, and serves as PL for multiple clinical trials. She is active in professional societies including AVLS, NLN, WHS, and APWCA, and serves on boards for the American Cancer Society and Save a Leg, Save a Life Foundation.*

*Cam Ayala is widely recognized for his appearances on ABC's The Bachelorette and Bachelor in Paradise, brings more than celebrity to this webinar of surgeries before a life-changing above-knee amputation in 2022. His journey from pain to purpose now fuels his work as a product specialist with the U.S. Department of Veterans Affairs, where he supports fellow amputees and patients with chronic wounds.*

## LEREXPO HIGHLIGHTS

# AI-Assisted Risk Stratification and Management in Diabetic Limb Salvage

By Dr. Laura Shin

The global prevalence of diabetes is increasing and is projected to affect 642 million people by 2040, highlighting the growing need for effective prevention, management, and supportive care. Diabetes can be associated with a range of health complications that require ongoing medical attention. Among these, diabetic foot conditions–particularly ulcerations and infections–are leading contributors to non-traumatic lower-limb amputations. As a result, a substantial portion of healthcare resources is dedicated to supporting individuals living with diabetes and managing related complication.

The integration of artificial intelligence (AI) and advanced monitoring technology offers a transformative shift from reactive "catch-up" medicine to proactive, preventive care. By utilizing AI-assisted risk stratification, clinicians can identify high-risk patients before tissue loss occurs. Key technological interventions include remote thermal imaging, smart wearable devices (socks, mats, and boots), and machine learning algorithms designed to predict ulceration risk and improve diagnostic accuracy. Success in limb salvage requires an integrated "Toe and Flow" multidisciplinary model that breaks down clinical silos and empowers patients through real-time feedback and self-management.

## The Scale of the Diabetic Foot Crisis

The diabetic foot is a complex clinical challenge that often serves as a marker for systemic disease severity. The clinical and economic impacts of these complications are profound:

- **Prevalence and Projections:** By 2040, an estimated 642 million people worldwide will be diagnosed with diabetes. In the United States, 30 million people currently have the disease, while another 84 million are classified as prediabetic, a population that often goes unmonitored despite significant risks of neuropathy.
- **The Pathway to Amputation:** Approximately 25% of patients with diabetes will develop a foot ulceration. Critically, 85% of nontraumatic amputations are preceded by a diabetic foot ulcer.
- **Mortality Rates:** The mortality rate following diabetic foot ulceration or amputation is extremely high, often exceeding that of many cancers. Even when a limb is salvaged, more than 50% of patients may die within 5 years due to related systemic complications.
- **Economic Impact:** Diabetes and its complications account for trillions of dollars in healthcare spending. Addressing the diabetic foot is essential for reducing this burden, as preventative care has the potential to save billions.

## Clinical Challenges in Current Practice

Standard treatments often suffer from fragmented care and a reactive approach to complications.

## The "First-Line" Amputation Problem

Even in technologically advanced regions, over 50% of transtibial amputations for diabetic wounds are performed as a first-line intervention. Patients are frequently offered amputation without undergoing:

- Non-invasive vascular studies
- Comprehensive diagnostic workups
- Offloading trials
- Surgical reconstruction attempts

## The Loss of the "Gift of Pain"

Peripheral neuropathy deprives patients of the "gift of pain," meaning they do not feel the trauma or pressure causing tissue loss. This leads to noncompliance with offloading and delayed presentation of wounds.

## Clinical Triad of Complications

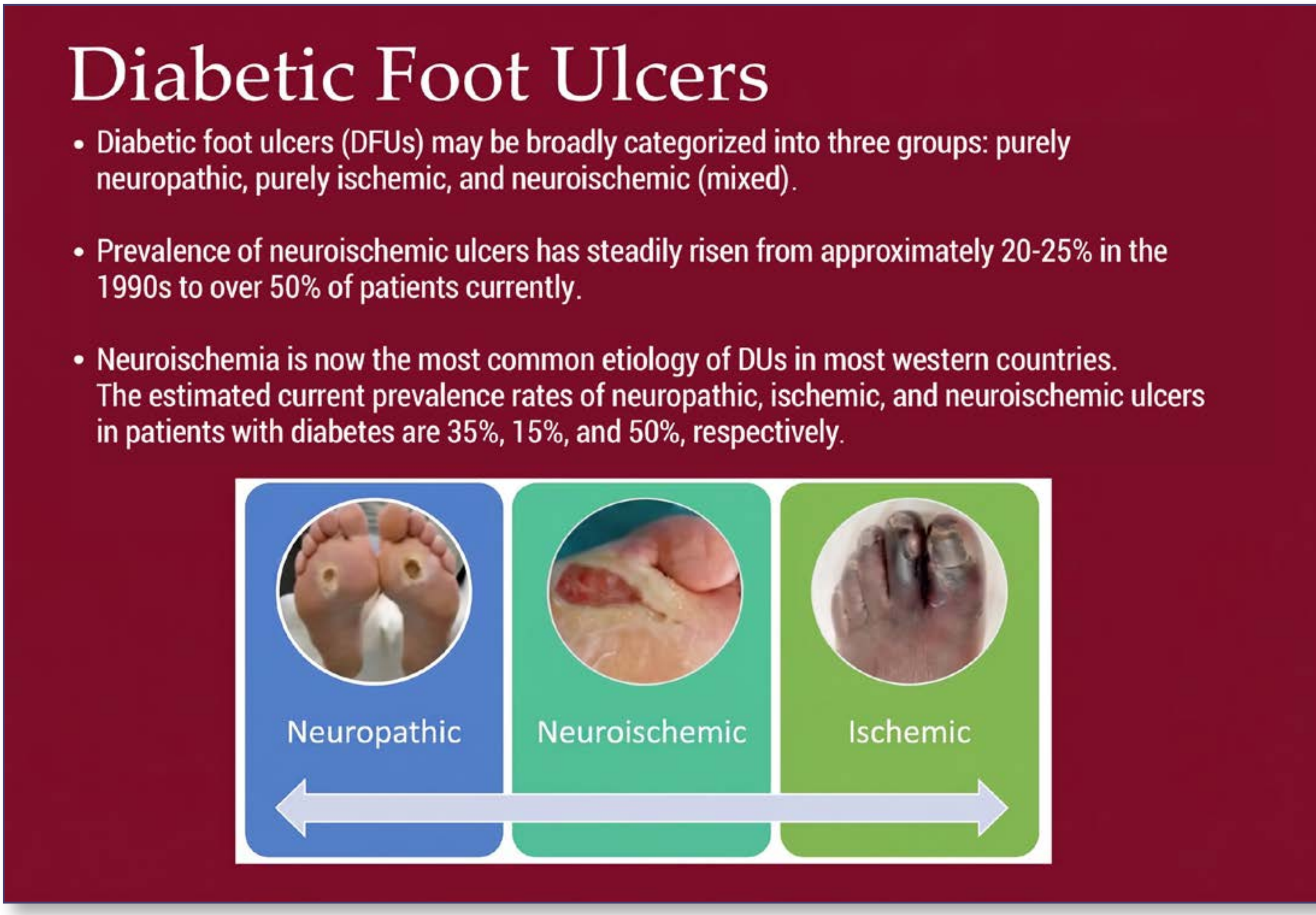
Effective treatment requires navigating a triad of factors:

1. **Wound**: Managing tissue loss and healing
2. **Vascular:** Ensuring proper perfusion and revascularization
3. **Infection:** Identifying and treating bacterial loads or osteomyelitis

## AI and Technological Interventions

AI and machine learning are being utilized to

This article is a summary of Dr. Shin's presentation, "AI-Assisted Risk Stratification: Identifying High-Risk Patients Before Problems Start", from the Diabetes Technology and Prevention Summit November 15, 2025. To view the full presentation with questions and answers—and see the agenda for the program, visit https://diabetestech.lerexpo.com/. Continuing education credits are available for this and many of the lerEXPO programs.




enhance diagnosis, treatment optimization, and prognosis.

## Remote Monitoring and Diagnostics

- **Smartphone-Assisted Surveillance:** Utilizing high-resolution cameras and thermal imaging on smartphones allows patients or family members to monitor wounds. AI can process these images to predict healing trajectories or signal the need for immediate intervention.
- **Thermal Imaging:** Increases in skin temperature can predict ulceration before it is visible. Sensors in smart socks or mats can detect these changes and alert the patient to modify their activity.
- **Enhanced Radiography:** AI programs are being trained to identify early signs of osteomyelitis and medial arterial calcification (MAC) on plain radiographs, improving detection thresholds beyond human inspection.

## Wearable Technology and Compliance

- **Smart Boots:** Devices that monitor patient

**Table 1. Predictive Risk Stratification**

Clinicians use a categorical system (0–3) to determine the frequency of care and the necessity of specialized equipment.

| RISK CATEGORY | CLINICAL INDICATORS | RECOMMENDED ACTION/FOLLOW-UP |
|---|---|---|
| **0** | No neuropathy | Annual follow-up; primary care management |
| **1** | Neuropathy present | Evaluation every 3–6 months; specialized footwear |
| **2** | Neuropathy + Deformity or PAD | Evaluation every 2–3 months; prescriptive inserts |
| **3** | History of Ulcer or Amputation | Evaluation every 1–2 months; high-intensity monitoring |

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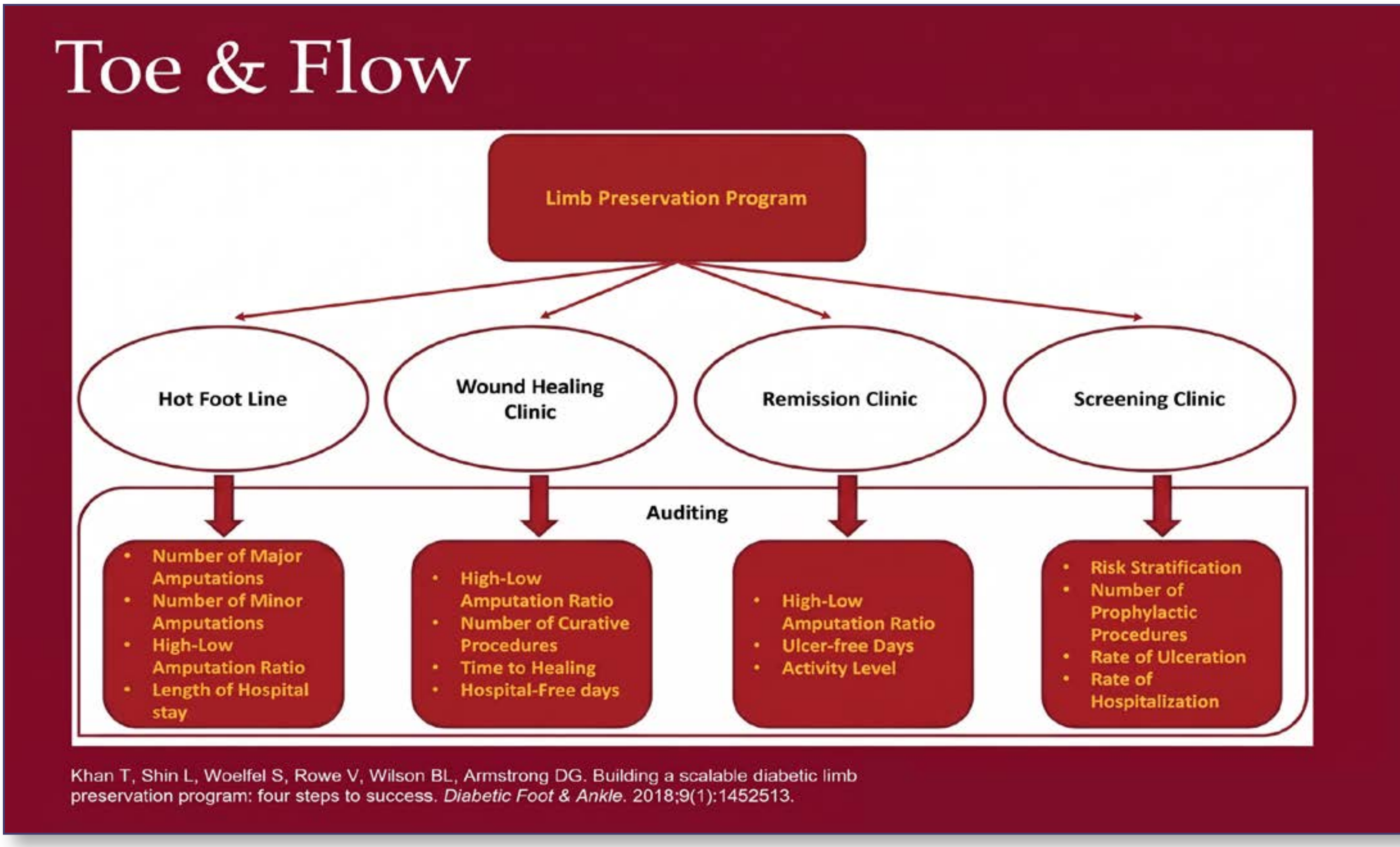


compliance with offloading requirements. These boots can provide real-time reminders to patients who lack sensation in their feet.

- **Continuous Glucose Monitoring (CGM):** Integrating CGM data with foot health monitoring allows clinicians to see the direct correlation between glycemic control (eg, A1C levels) and wound healing risks.

## Integrated Care Pathways: The "Toe and Flow" Model

To prevent amputations, healthcare systems must move away from clinical silos. The limb preservation program at University of Southern California emphasizes a multidisciplinary approach:

- **The "Hot Foot Line":** An acute care pathway is designed to fast-track patients with urgent infections or ulcerations from emergency rooms and primary care offices to specialists.
- **Limb Preservation Centers:** Integrated teams involving podiatric surgeons (the "Toe") and vascular surgeons (the "Flow"), work alongside physical therapists, orthotists, and nutritionists.
- **Remission Clinics:** Once a wound is healed, patients enter a "remission" phase rather than being discharged. This involves continuous surveillance to prevent recurrence, as diabetic wounds are prone to return.
- **Socioeconomic Integration:** Effective care plans must account for a patient's home environment, transportation access, and ability to offload based on their job or living situation.

The transition toward AI-assisted risk stratification represents a vital evolution in diabetic care. By empowering patients with self-management tools like smartwatches and sensors, and by providing clinicians with machine-learning-driven diagnostic data, the medical community can move toward a personalized care plan model. The ultimate goal is to identify risks in the pre-ulceration phase, thereby reducing the astronomical human and financial costs associated with diabetic foot complications. ler

*Laura Shin, DPM, PhD, is a reconstructive surgeon and physician-scientist who specializes in podiatry, including foot and ankle deformities, Charcot neuroarthropathy, limb salvage, wound care and diabetic feet and ankles.*

*Her interest in stem cell biology and the potential for using stem cells to repair diabetic wounds, along with her passion for patient care, led her to pursue a dual PhD and DPM degree. In her clinical and research pursuits, Dr. Shin is dedicated to preserving and restoring mobility, which she believes is crucial to quality of life. She has a special interest in patients with diabetes and other high-risk conditions.*

*Her research focuses on stem cell regeneration and the body's capacity for healing. In particular, she is examining tissue and stem cell repair in older adults, people with diabetes, and people whose immune systems are compromised. Away from Keck Medicine of USC, Dr. Shin loves spending time with her family, including her two children, sharing a taste for travel and exploring the outdoors. She also plays tennis and enjoys photography and reading.*

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# Rethinking the Role of the Plantar Fascia's Windlass Mechanism

By Tom Michaud, DC, and Nicolas Haelewijn, Ph. D.

Ever since *Sahelanthropus tchadensis* stood upright 7 million years ago, the feet of our common ancestors have undergone a series of important structural changes necessary to accommodate the functional requirements of bipedal locomotion. While the feet of arboreal primates were well-adapted for grasping branches during movement through tree canopies, their hypermobile midfoot and adducted great toe led to instability and buckling during the push-off phase of gait, limiting their effectiveness for upright walking and running. Over millions of years, evolutionary adaptations resulted in modern humans developing an arched foot that is 2 to 3 times stiffer than that of current flat-footed primates[1]. This increased rigidity facilitates efficient force transfer through the Achilles tendon, midfoot, forefoot, and ultimately into the ground. Although various anatomical factors have contributed to the increased rigidity of the arched foot, such as the development of a stable first ray and the establishment of the transverse tarsal arch[2], the windlass mechanism remains the predominant theory accounting for the human foot's capacity to effectively stiffen its arch during propulsion.

Originally described by Hicks in 1954[3], the underlying premise of the windlass mechanism is that because the plantar fascia is inherently stiff and unyielding, passive dorsiflexion of the toes during push-off tractions the plantar fascia around the metatarsal heads, which in turn creates a compressive force that locks the midfoot by tractioning the forefoot and rearfoot together (Fig. 1). Because the first metatarsal head has a larger diameter, the medial band of the plantar fascia is especially effective at increasing arch height. According to Hicks[3], the windlass mechanism is passive in that no muscle activity is necessary to raise the arch. The beauty of this theory is that because the plantar fascia does not consume calories as the windlass mechanism stabilizes the arch, the metabolic cost of locomotion is greatly reduced.

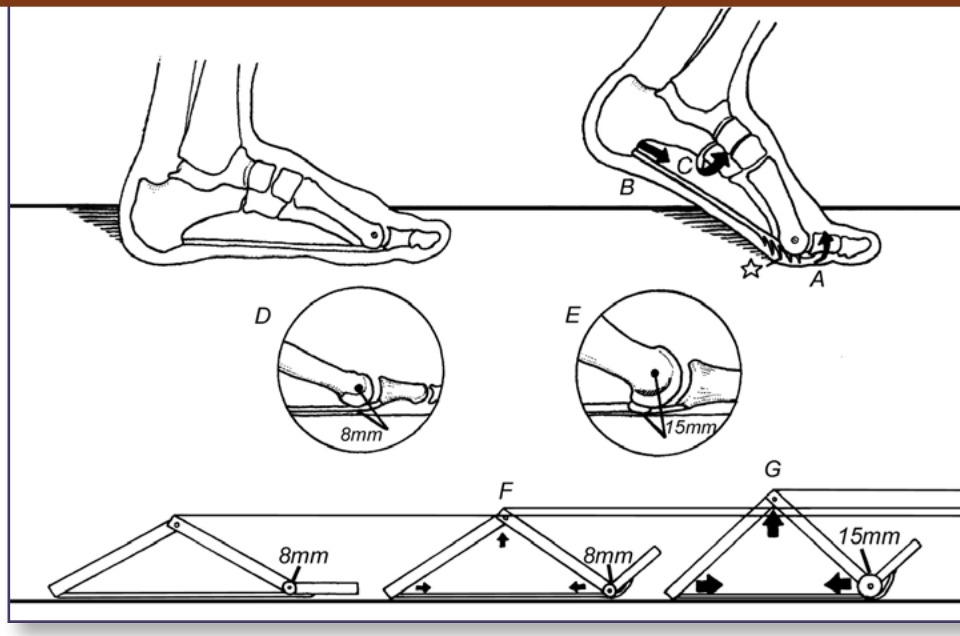


**Fig. 1. The Windlass Mechanism.** During the propulsive period, ground-reactive forces dorsiflex the toes, which pulls the plantar fascia around the metatarsal heads (A). This action results in the approximation of the rearfoot and forefoot (B) and allows for the increased arch height necessary for stability (C). The amount of pull generated by the plantar fascia is directly related to the distance between the transverse axis of the metatarsophalangeal joint and the passage of the plantar fascia: the greater the distance, the greater the pull placed upon the plantar fascia while the digit dorsiflexes. For example, the average lesser metatarsal has an average of 8 mm between its transverse axis and the passage of the plantar fascia (D) while the first metatarsal, with its larger head and the presence of sesamoid bones (which the plantar fascia invest) has a distance of nearly 15 mm between the transverse axis and the plantar fascia (E).

Although Hicks' model is widely accepted, some researchers challenge the passive role of the windlass mechanism, as cadaver studies show it produces only a third of the force needed for foot rigidity[4, 5]. While some studies show that dorsiflexion of the toes during propulsion does stiffen the plantar fascia[6,7], other studies prove that the plantar fascia actually undergoes appreciable elongation as the toes reach their peak range of dorsiflexion, which goes counter to the entire concept of the windlass mechanism[8,9]. Even more significant, some research shows that as the windlass mechanism elevates the arch, the arch actually becomes more compliant or flexible, rather than rigid and stiff. This was conclusively proven by Welte, et al.[10]. These researchers used linear actuators to compress the longitudinal arch as the toes were placed in a neutral, plantarflexed, or extended position. To their surprise, the authors found that the medial longitudinal arch was more flexible when the windlass mechanism was engaged. The authors theorized that engaging the windlass mechanism places the long and short plantar ligaments in a more midline position, allowing them to store and return energy as the arch compressed. Welte et al.[10] also observed that as the windlass mechanism reached peak tension, the axis of the midfoot shifted vertically, causing the forefoot to abduct. This sudden abduction allowed the abductor hallucis muscle to help stabilize the arch by decelerating forefoot abduction.

The ability of the intrinsic arch muscles to support the plantar fascia and improve stiffness of the midfoot was demonstrated in a partic-

*Continued on page 24*

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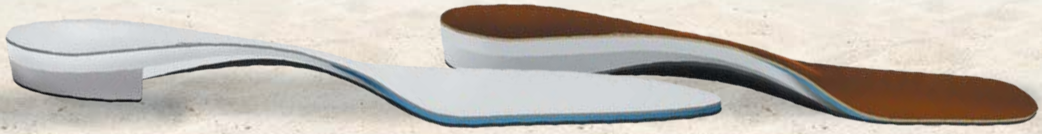

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ularly well-done study by Farris et al.[11]. These researchers used nerve blocks to temporarily paralyze the plantar intrinsic arch muscles before having the subjects walk and run on a treadmill. The authors noted that when the intrinsic arch muscles were paralyzed, the participants were unable to effectively generate power during propulsion, and they were forced to avoid the propulsive period by increasing their step frequency and prematurely lifting their feet off the ground via excessive hip flexion. Farris et al.[11] clearly demonstrate that active muscle contraction, not passive windlass action, creates midfoot rigidity during propulsion. Note that it is not just the intrinsic muscles that play a role in stiffening the arch. A previous cadaveric study demonstrated that when the long digital flexors contract, they create a compressive force in the metatarsal shafts, which helps stabilize the forefoot during propulsion and prevents the metatarsal shafts from bending[12] (Fig.2). According to Kevin Kirby[13], the intrinsic and extrinsic muscles are under direct control of the central nervous system and have the capacity to reinforce the passive ligamentous mechanisms necessary for arch stability as needed. Kirby[13] refers to the interaction between the muscular and ligamentous restraining mechanisms as the Longitudinal Arch Load-Sharing System (LALSS), which he claims allows the body to increase or decrease the stiffness of the medial arch depending upon the stresses the foot is being exposed to. Interestingly, recent research shows that when muscles are engaged to provide stability, the first fibers to be recruited are those with the longest lever arms responsible for limiting excessive articular motion[14]. Referred to as the principle of Neural Mechanical Matching, the central nervous system's ability to precisely recruit just the right muscle fibers at the right time would be invaluable for stabilizing the arch against the rapid, and often unpredictable motions associated with walking and running over uneven terrain.

Note the previously described mechanisms in which the plantar fascia and the supporting musculature work to stiffen the midfoot occurs primarily in people with well-formed medial longitudinal arches. As noted by DeSilva et al.[15], a small subset of the population presents with what is known as a "midtarsal break," in which the lateral midfoot maintains ground contact during propulsion as the lateral tarsometatarsal articulations buckle under the stresses of propulsion. The authors note that a midtarsal break is more likely to occur in someone with a convex-shaped base of the proximal fourth metatarsal, which allows the lateral forefoot to dorsiflex during propulsion (Fig. 3). DeSilva et al.[15] state that excessive pronation associated with the midtarsal break prevents the plantar fascia from engaging the windlass mechanism, which undermines the mechanical stability of the foot during propulsion. The authors also note that the excessive pronation associated with the midtarsal break can be countered by a strong abductor digiti minimi muscle and a stiff long plantar ligament. The authors claim the development of a midtarsal break may be "a function of increased foot mobility in western, shoed humans who do not always develop the musculature necessary to maintain a stiff midfoot." This is consistent with research by Rao and Josephs[16] showing that individuals who are barefoot during childhood are significantly more likely to develop well-formed arches than individuals who wear shoes. Along this same line of reasoning, Miller et al.[17] show that wearing minimalist shoes for 12 weeks produces significant hypertrophy of the abductor digiti minimi muscle, which DeSilva et al.[15] claims may play an important role in stabilizing the lateral midfoot in people presenting with a midtarsal break.

According to Aquino and Payne[18], people with excessive pronation presenting with a hypermobile flatfoot may receive some support for the medial longitudinal arch via what is known as the reverse windlass mechanism. According to these authors, excessive pronation increases strain in the plantar fascia, which in turn allows the plantar fascia to create a compressive force through the midfoot by approximating the rearfoot and forefoot. The increased tension in the plantar fascia is maintained as the proximal phalanx collides into the dorsal aspect of the first metatarsal head (Fig. 4). In this situation, the midfoot is made more stable as the plantar fascia becomes taut. Although potentially de-

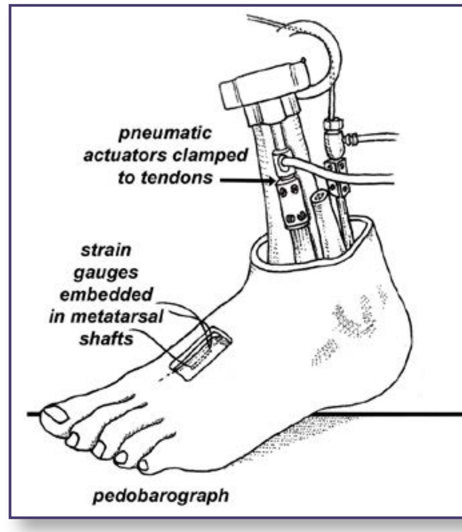


**Fig. 2.** Ferris et al.[12] mounted cadaveric feet in a heel rise position and measured pressure beneath the forefoot and bending strains in the metatarsal shafts before and after sequentially applying tension to a series of tendons clamped to pneumatic actuators. The authors also embedded strain gauges into the second metatarsal shafts in order to measure bending forces present in the bone with and without simulated muscle contraction. Using this elaborate technique, the authors determined that the primary role of the long digital flexors is to create a compressive force in the metatarsal shafts that protects them from buckling during propulsion. The authors emphasize that weakness of the long digital flexors can have a profound effect on forefoot stability and plantar pressures. Adapted from a photograph by Ferris et al.[12].

structive to the first metatarsophalangeal joint, tensioning the plantar fascia via the reverse windlass mechanism can reduce tension in some of the supporting musculature, explaining why the cross-sectional area of the abductor hallicus and flexor hallucis brevis muscle are frequently reduced in people with flat feet[19]. In contrast, people with low arches often have hypertrophy of other arch-supporting muscles, especially the flexor hallucis longus and flexor digitorum longus[20]. This latter finding explains recent findings by Haelewijn et al.[21], who note that it is possible to distinguish between symptomatic and asymptomatic flat-footed individuals by the volume of their flexor digitorum longus and quadratus plantae muscles.

Given the key roles the foot and ankle muscles play in stabilizing the foot during propulsion, we suggest practitioners move away from Hicks' passive stability model to a functional approach that prioritizes foot strengthening exercises as a way to stiffen the arch during propulsion. Strength of flexor digitorum longus, flexor hallucis longus, and peroneus longus can easily be evaluated with a toe strength dynamometer (Fig. 5). Because this device has an interrater reliability of 0.95[22], it allows the practitioner to accurately monitor progress when performing foot strengthening protocols. Keep in mind that while many foot strengthening programs are commonly recommended, not all are equally effective. Osborne et al.[23] recently assessed EMG activity and torque generated at the metatarsophalangeal joints with 16 commonly prescribed foot and ankle exercises and discovered an intriguing paradox: certain exercises elicited substantial muscle activation, yet these EMG increases did not correspond to greater force output beneath the forefoot. Specifically, the short foot, squat, and toe spread exercises, which are frequently prescribed in foot strengthening programs, were relatively ineffective at increasing metatarsophalangeal joint torque. The authors state the mismatch between muscle activation and force output occurs because the muscles are exercised in their shortened positions, which greatly impairs force production. Following this logic, other commonly prescribed foot strengthening exercises, such as towel curl and marble pickup exercises, would also produce negligible changes in force output beneath the toes and should therefore be avoided. As demonstrated by Goldman et al.[24], optimal effectiveness in strengthening the toe muscles is achieved when exercises are performed with toe muscles in their lengthened positions, resulting in strength gains that are 4 times greater than those observed with conventional exercise methods.

One of the most effective foot strengthening routines is the ToePro exercise platform. A pilot study from Temple University[25] demonstrated that performing ToePro exercises 3 times a week for 6 weeks led to a 35% increase in force generated beneath the hallux and lesser toes. As strength improves, more challenging exercises can be introduced. Tourillon et al.[26]

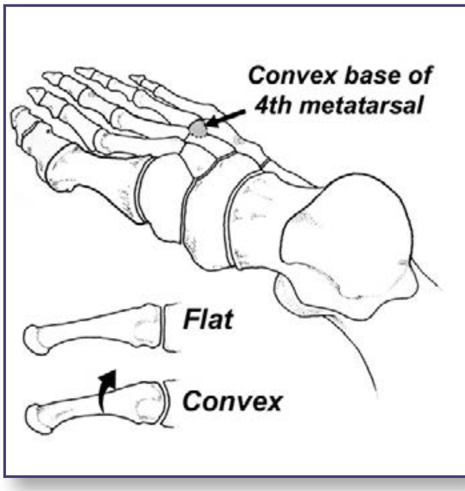


**Fig. 3.** As demonstrated by DeSilva[15], while the base of the fourth metatarsal in most individuals is flat, some people have a convex fourth metatarsal base, which allows the entire lateral forefoot to dorsiflex (arrow) under the stresses of propulsion. This sudden dorsiflexion causes the midfoot to buckle is vertical forces peak during pushoff.

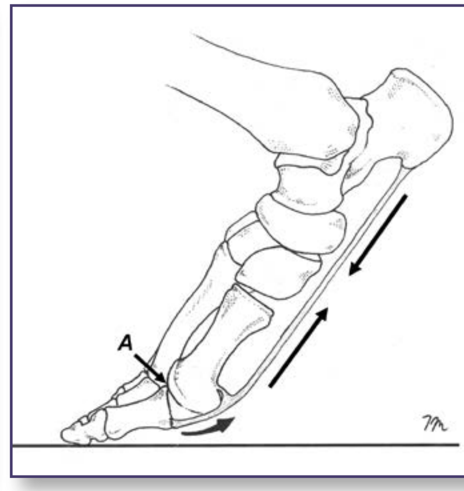


**Fig. 4. The reverse windlass mechanism.** As the midfoot collapses, increased tension in the plantar fascia prevents upward motion of the first MTP (**A**), but it also creates a stabilizing force by drawing the rearfoot and forefoot together (**arrows**). The reverse windlass mechanism essentially locks the midfoot during propulsion in people who pronate excessively.

recently conducted an 8-week strength program with 28 highly trained athletes. The authors discovered that these exercises, many of which are illustrated in figure 6, not only strengthen the intrinsic and extrinsic muscles of the arch but they also improve athletic performance. Specifically, the prescribed foot strengthening exercises enhanced cutting ability, improved side-to-side force transfer, and resulted in greater vertical propulsion at top running speeds. The improved athletic performance was probably due to both the intrinsic and extrinsic muscles' effectiveness in stabilizing the arch, which allowed accelerational forces created in the foot and leg to be transferred efficiently into the ground.

While historically healthcare professionals have attempted to reinforce the windlass mechanism by prescribing orthotics with varus posts that lock the midfoot, this treatment approach comes at a price. Several studies have shown that prolonged use of arch supports can cause atrophy of the intrinsic muscles of the foot[27,28]. Another important consideration is that arch supports have been proven to limit the storage and return of energy while running[29]. While orthotics have a long-term record of effectively reducing symptoms in people with hypermobile flat feet, they should always be prescribed specific foot strengthening exercises to prevent atrophy and maintain a strong arch. The upside of strengthening interventions is that they are easy to perform, inexpensive, and have been repeatedly proven to improve athletic performance, particularly horizontal jump distances, and medio/lateral cutting. By prescribing orthotics with foot strengthening exercises, you get the best of both worlds as the orthotics can enhance proprioception and decelerate the velocity of pronation, while strengthening exercises can reinforce the windlass mechanism, making the foot a more effective lever while walking and running.

*Since graduating from Western States Chiropractic College in the early 80s, Dr. Tom Michaud has published numerous book chapters and over 50 journal articles on subjects ranging from biomechanics of the first ray, to the pathomechanics of vertebral artery dissections. He has also served on the editorial review board of several chiropractic and podiatric journals.*

*In the early nineties, Williams and Wilkins published Dr. Michaud's first textbook, Foot Orthoses and Other Forms of Conservative Foot Care, which was eventually translated into 4 languages. His next book, Human Locomotion:*

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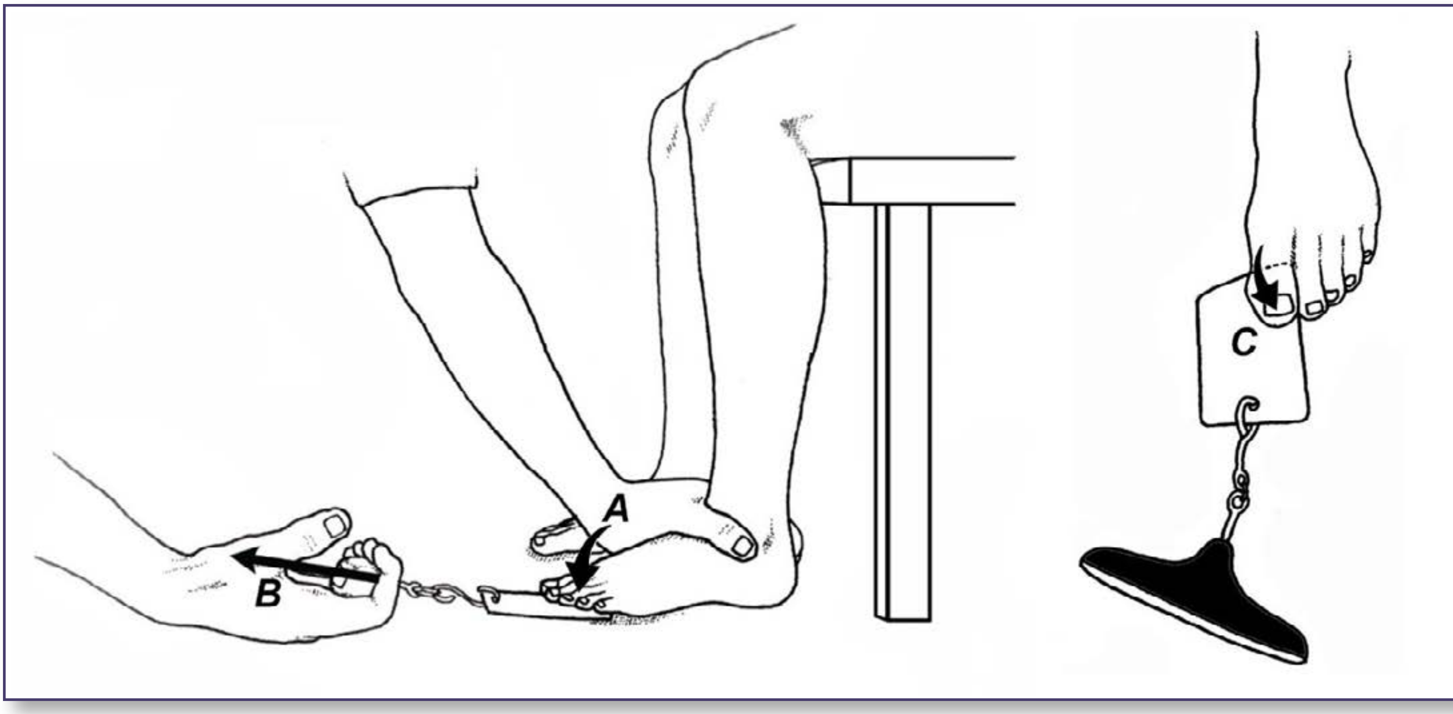


**Fig. 5. The toe strength dynamometer makes it possible to easily measure and record toe strength.** With the device placed beneath the second through fifth toes, the patient pushes down (A) as the examiner tries to pull the card out from beneath the toes (B). A digital score is recorded, and the test is repeated beneath the hallux (C). Ideally, the patient should generate 10% body weight beneath the hallux and 7% body weight beneath the lesser toes. Peroneus longus can be tested by placing the tip of the card beneath the first metatarsal head, and people should generate approximately 10% body weight with this test.

*The Conservative Management of Gait-Related Disorders, which was published in 2012, is used in physical therapy, chiropractic, pedorthic, and podiatry schools around the world. In addition to technical books, Tom also published a book for recreational runners: Injury-Free Running: How to Build Strength, Improve Form, and Treat/Prevent Injuries, now in its second edition.*

*During his 40 years of clinical practice, Dr. Michaud designed and patented numerous diagnostic tools and exercise products to help with the evaluation and treatment of a wide range of sports injuries. Since his recent retirement from clinical practice, Tom is devoting his time to researching, writing, and designing new products in order to develop evidence-based evaluation and treatment protocols that can assist in not just the prevention of sports injuries, but also in ways to stay fit as we age.*

*Nicolas Haelewijn PT, Ph.D. is a postdoctoral researcher in musculoskeletal biomechanics at KU Leuven (Bruges, Belgium) and a clinical physiotherapist. His work focuses on foot function and pathology, with a particular interest in the biomechanical and morphological differences between asymptomatic and symptomatic flexible flatfoot. Integrating gait analysis with ultrasound imaging of intrinsic foot muscles, his research aims to advance assessment methods and inform evidence-based rehabilitation strategies.*

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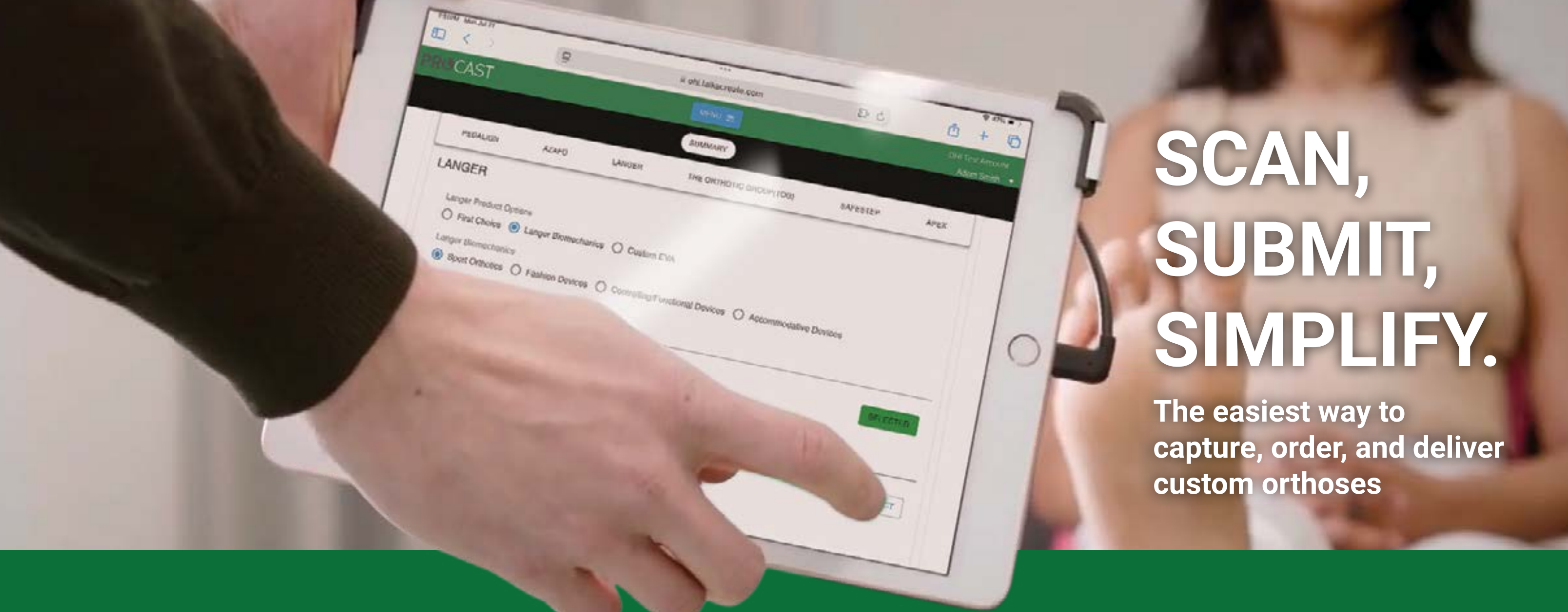

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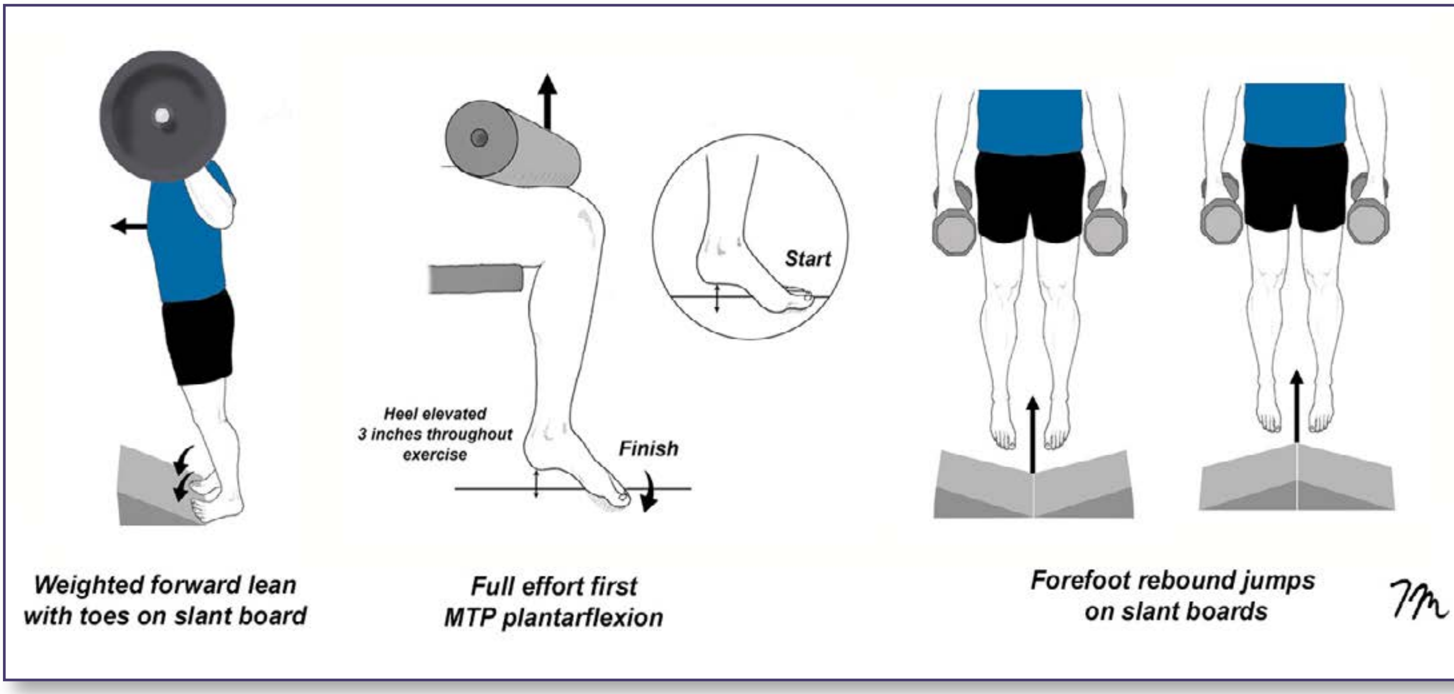


**Fig. 6. The foot strengthening routine recommended by Tourillon et al.**[26] Note that this is an open access journal and the entire training routine is available at the following website: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0313979

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# The Halo Effect of Technology in Podiatric Practice

By Mikel D. Daniels, DPM, MBA, President and Chief Medical Officer, WeTreatFeet Podiatry

When patients enter a podiatry office, their impressions begin forming immediately. Before any history is taken or exam performed, they are already processing what they see. Eyes are drawn to the physical space, the efficiency of the front desk, the demeanor of the staff. They enter the treatment room and notice the equipment in the room while waiting for the physician. These early signals shape expectations in ways that are both subtle and powerful. In many cases, they influence how patients interpret everything that follows.

Psychology describes this as the halo effect, a bias where 1 positive trait shapes how people see everything else about a person, product, or organization. This was originally coined by American psychologist Edward L. Thorndike, in a 1920 paper titled, "A Constant Error in Psychological Ratings". In his paper, he studied how military officers rated their subordinates. Today, we can use this to view our own practices. If patients see a modern, well-equipped environment, that single visible attribute often leads them to assume the physician is more skilled, more current, and more trustworthy across the board. While patients may not understand what each device does, people think they can recognize something as "up-to-date" when they see it. It is this perception that spills over into their beliefs about diagnosis, treatment, and outcomes.

In podiatry, this matters because so much of what we do depends on patient confidence and engagement. Patients come to us in pain, with impaired mobility, or fear of complications such as ulceration, infection, or amputation. When the environment and the tools signal that their problem is being taken seriously, and being evaluated with contemporary methods, they are more likely to trust our recommendations. The result is that the patient will follow treatment plans, return for follow-up, and speak positively about the practice to others. The halo effect of podiatry, when aligned with sound clinical judgment and clear communication, becomes more than just perception. It becomes a practical lever that influences adherence, outcomes, and the overall reputation of the practice.


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## Technology as a Signal of Quality

Patients rarely have the technical background to evaluate clinical decision-making. Instead, they rely on observational cues to form judgments about the care they are receiving. Modern equipment serves as one of the most immediate and tangible of these cues. Equipment such as a high-resolution imaging system, or a diagnostic ultrasound often communicates a commitment to staying current.

This perception aligns with broader findings in healthcare research. Studies on patient satisfaction consistently show that environmental and visual factors influence perceived quality of care. This is true even when clinical outcomes are equivalent. In this context, technology functions as a proxy for expertise. Patients may not fully understand how a device works, but they associate it with quality. This leads to the perception of a higher level of care.

In practice, this effect is easy to observe. Patients frequently comment on new equipment, often with statements such as, "This looks advanced," or "You must be very up to date." These remarks are not simply casual observations or kind words, they reflect a shift in confidence. That confidence can influence how patients engage the rest of the visit.

## Influence on Patient Behavior

The halo effect extends beyond perception into behavior. If technology shapes how patients perceive care, it also shapes how they behave in response to that care. Patients who view a practice as modern and capable are more likely to trust diagnoses, and in the end, adhere to treatment plans. This has direct implications for conditions that rely heavily on patient participation.

As an example, consider a patient presenting with plantar heel pain. From a clinical standpoint, the diagnosis can often be established through history and physical examination. However, when diagnostic imaging such as ultrasound is incorporated, the interaction changes. The condition becomes visual and concrete rather than abstract. Patients can see the area of inflammation or tissue change.  This serves to reinforce the explanation and treatment plan provided by the clinician.

This visualization often improves understanding, but something else is happening. While no one is paying attention, it secretly strengthens commitment. A patient who sees evidence of pathology is more likely to follow through with stretching protocols, orthotic use, activity modification, and even attend follow-up appointments. In this way, the technology indirectly supports better outcomes by improving adherence.

A similar dynamic is present in diabetic foot care and wound management. Patients facing the possibility of infection, hospitalization, or amputation often experience significant anxiety. The presence of advanced diagnostic tools (such as vascular assessment devices, digital imaging, or specialized wound therapies) can provide immediate reassurance. Without requiring detailed explanation, the environment communicates capability.

That reassurance has practical value. It allows patients to focus on the treatment plan rather than the potential for catastrophic events. It also fosters a sense of partnership. This is critical in managing complex, confusing, or longitudinal conditions.

## Impact on Referral Patterns

The halo effect is not limited to patient perception. Referring providers are influenced by many of the same signals (although often in a more indirect way). Primary care physicians, endocrinologists, and other specialists develop impressions based on communication, outcomes, and reputation within the medical community. It has its own "halo effect"

Technology contributes to that reputation by creating a distinct identity. A practice that invests in advanced tools or complex protocols becomes known for those specific capabilities. Over time, this association acts as a cognitive shortcut. When a referring provider encounters a challenging case, such as a patent with a condition involving limb preservation or advanced wound care, they are more likely to recall the practice perceived as having the necessary resources.

This pattern is supported by referral behavior research. This suggests that physicians often rely on familiarity and perceived expertise when directing patients. Technology, when integrated into a broader pattern of consistent outcomes and communication, reinforces both.

## Internal Effects on Team Culture

Within the practice, the presence of modern technology can influence team dynamics and morale. Staff members are highly attuned to whether a practice is investing in growth and improvement. The introduction of new tools often generates a sense of momentum and pride.

This internal response can also lead to operational benefits. Staff who feel they are part of a forward-moving organization tend to be more engaged in their roles. Their communication with patients becomes more positive, they adapt more readily to workflow changes, and they contribute to a more cohesive patient experience. In many cases, they also become informal ambassadors for the practice, sharing their experiences within their personal and professional networks

Because patients often see the medical assistant first, staff confidence in the available technology can provide early reassurance that the practice has the tools to help them. A visible commitment to advancement can reinforce a culture of continuous improvement–but only if implementation is thoughtful. Technology introduced without adequate training or integration is far more likely to create frustration instead of enthusiasm.

## Risks of Misalignment

The halo effect can be beneficial, but it is not inherently positive. Its impact depends on alignment between perception and reality. When technology is underutilized, poorly integrated, or inconsistently applied, it can undermine trust rather than build it–especially in practices with multiple providers where patients may see different clinicians over time.

Patients also notice when equipment appears unused or when its role in their care is unclear. An expensive device that sits idle in the exam room may be interpreted as unnecessary or wasteful. In some cases, it can raise questions about decision-making within the practice.

All of this highlights the importance of intentional adoption. Technology should be selected for its clinical value and integrated into workflows in a consistent and visible way. Every team member should understand not only how to use a device, but also how to explain its purpose in straightforward terms.

## Communication as a Multiplier

The effectiveness of technology is closely tied to communication. Most patients do not need detailed technical explanations, but they do need clarity. A simple statement from the provider explaining how a tool improves diagnosis, reduces uncertainty, or enhances treatment, will significantly increase its perceived value.

For instance, showing a patient an ultrasound image while explaining the source of their pain transforms the interaction. It shifts the conversation from abstract description to shared understanding. Multiple studies have shown that problems are easier to understand when visualized. This not only improves comprehension but also reinforces trust.

At the same time, it is important to maintain balance. Technology should support, not replace, the clinician-patient relationship. Patients seek expertise and reassurance from a person, not a device. The most effective practices use technology to enhance human interaction, not overshadow it.

## Relevance in Lower Extremity Care

In lower extremity medicine, the interplay between perception, technology, and outcomes is particularly pronounced. Many conditions we treat directly affect a patient's mobility. Patients are acutely aware of how their condition limits walking, working, and independence. While

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discussing these functional limitations is crucial, overemphasizing what the patient already knows can backfire. If the encounter feels like confirmation of the obvious, patients may conclude that the interaction offered little value.

This creates a setting in which both technical capability and patient confidence are essential. Advanced tools reinforce the seriousness with which conditions are evaluated and treated. Clear communication provides direction and reassurance. Together, they create a more structured and supportive care experience.

In high-risk populations, such as patients with diabetes or peripheral vascular disease, this combination becomes even more critical. It is well known that intervention, adherence to treatment, and timely follow-up can significantly influence outcomes. This is where the halo effect of technology, when aligned with strong clinical practice, can support each of these factors.

## Technology as Opportunity and Responsibility

The integration of new technology into podiatric practice offers clear advantages. It can enhance diagnostic accuracy, expand treatment options, improve patient engagement, improve treatment efficiency, and strengthen referral relationships. At the same time, it can become a situation of be careful what you wish for, and this might introduce higher (or even unrealistic) expectations.

Patients who perceive a practice as advanced expect a corresponding level of care. Referring providers expect consistent outcomes. Staff expect systems that support efficiency and growth. Meeting these expectations requires more than acquiring equipment. It requires thoughtful implementation, ongoing training, and a commitment to communication.

When evaluating new technology, it is useful to consider both its functional and symbolic roles. Functionally, the question is whether it improves diagnosis, treatment, or workflow. Symbolically, the question is what it communicates about the practice. The most effective investments address both.

## Cost and Financial Considerations

Sales representatives present a steady stream of "next greatest" solutions, from equipment and supplies to medications. In an environment of declining reimbursement, products that add revenue can be attractive. Some equipment directly generates revenue, while other tools primarily support diagnosis or treatment without adding to the top line.

While cost sensitivity is essential, return on investment should include more than direct reimbursement. The halo effect of technology can influence new patient volume, referral patterns, and practice differentiation. When calculating ROI, it is worth asking: Will this equipment be a differentiator? Can it help increase new patient numbers? Does it improve efficiency so the practice can provide additional services? The value of these answers should factor into the calculus.

## Does Podiatry Really Change Based on the Halo Effect?

The halo effect of technology is a real and influential component of modern podiatric practice. It shapes how patients perceive care, how they engage with treatment, and how practices are viewed within the broader medical community. When aligned with strong clinical judgment and clear communication, it can enhance both experience and outcomes. For podiatrists, the practical question is not, "Should I buy more technology?" but, "Which technology will meaningfully improve care and how will we visibly integrate it into every visit?"

However, the effect is not automatic. It depends on thoughtful selection, consistent use, and integration into a patient-centered approach. Technology alone does not define quality, but it can reinforce it when used well.

In the end, the value of any tool lies in how it supports better care. The goal is not simply to appear advanced, but to deliver care that justifies that perception. The result must be consistent, clear, and effective. When that alignment is achieved, the halo effect becomes more than an impression. It becomes part of a practice's identity. ler

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*Dr. Daniels earned his Doctor of Podiatric Medicine from Temple University and an MBA in Healthcare Administration, combining clinical expertise with business strategy to deliver efficient, patient-centered care. His work focuses on complex reconstructive procedures, diabetic limb salvage, sports injuries, and minimally invasive techniques designed to accelerate recovery.*

*A Fellow of the American College of Foot and Ankle Surgeons and the American Professional Wound Care Association, Dr. Daniels also consults for biomedical technology firms and serves as a principal investigator in clinical research. His insights have appeared in Forbes, Parade Magazine, and CNN, and through his writing and mentorship, he continues to advance innovation*

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"A Foot Forward for Optimum Health" is a column designed to enlighten the old guard in a new way about lower extremity impairment as it pertains to foot drop. The intent is to challenge evidence-based research and practice so that it addresses real world issues shaped by social determinants of health. For every common issue is an uncommon response that will provide insight to improve health outcomes by putting one foot forward at a time–efficiently and effectively.

# Questions, Answers & Commentaries About AFOs

By Dr. Jennifaye V. Brown

This month, the column is reserved to answer questions and respond to commentaries that correspond to the articles written. The following 3 articles were written in the first quarter:

1. Is Neutral Enough for Ankle Dorsiflexion?
2. Sensory Input is Needed for Motor Output–The Foot of the Matter
3. Sensory Input is Needed for Motor Output: The Type of Self-Work for the Best Foot Work Matters

I will address the following comment:

> *I am so happy that we have such a knowledgeable physical therapist clinician who really considers the individuals functional context in addition to their pathophysiology. It is not often that clinicians consider social determinants of health and the ICF model so fluidly in practice when designing AFOs.*

I would like to thank the reader for acknowledging my expertise. I want to reiterate that the literature supports functional context as a focus of rehabilitation as opposed to just impairment-based interventions.[1] We must treat the person as a whole entity (person: mental, emotional, physical, spiritual, intellectual) of who they are in their lived spaces (environment) and what they do in that space (tasks).[2-9]

I focus on developing a relationship with the patient/client and their caregiver which begins with an introduction and flows into the subjective history by asking open-ended questions that gives me a picture of who that person was, is, and has the potential to be. The subjective portion of the examination sets the agenda for how I will conduct the objective portion of the examination and furthermore, sets the agenda for shared decision-making for the plan of care and goal setting.[10-11] I have built trust in the relationship and the patient/client and caregiver will trust the process by adhering to a plan that is reflective of their lifestyle.[12-14] For example, if the patient/client does not have a bed and sleeps on the floor, movement analysis begins with moving from the chair to the floor and doing the range of motion, manual muscle and or sensory test starting in the chair and finishing on the floor as warranted. Then, I can assess fall recovery from floor to stand using the chair. This exemplifies the task-oriented approach and sets the agenda for the plan of care.[15-16] The demonstrated movement requires variability in range of motion and strength/force generation: isometric, eccentric and concentric. I can develop exercises/activities as appropriate at the body-structure function level (hip abduction in supine) and at the activity level (side stepping with knee straight targeting stance phase stability in the frontal plane) and last, the participation level (side stepping in a modified squat position to take a seat in the pew at church).

This scenario aligns with the framework established by the World Health Organization known as the International Classification of Functioning, Disability and Health (ICF).[17] Atkinson & Nixon-Cave illustrate the use of this framework as a tool for patient management. Through its use, the practitioner is guided to address the health disease status by identifying impairments associated with body structures and functions, activities, and participation in societal roles. The patient/client is integrated in the framework under the context of environment described by internal identifiers such as behaviors, roles and habits but who is also impacted by external factors identified as for example, family and insurance.[18] The environment portion of this framework aligns with the social determinants of health which should be uncovered during the chart review and subjective portion of the examination.[19-20] Acknowledging and appropriately integrating those social determinants will refine and focus the plan of care into achievable goals. The American Board of Physical Therapy Specialties of the American Physical Therapy Association uses the content of the Atkinson & Nixon-Cave article as a template to demonstrate clinical reasoning, critical thinking and clinical decision-making for those applying for board recertification. This tool for patient management serves as a foundation to a systematic approach I take when examining clients/patients and thereafter, evaluating the data to create and address goals established through shared decision-making which leads to excellence in practice as the normative model in all that I strive to do.[11,21-24] I continue to consider patient/client values and the evidence (practice- and research -based) to assure person-centered care and always keeping the focus on function. ler

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# Dirty Truth #9: Fashion and Idiocy–Feet Need to Find Their Footing

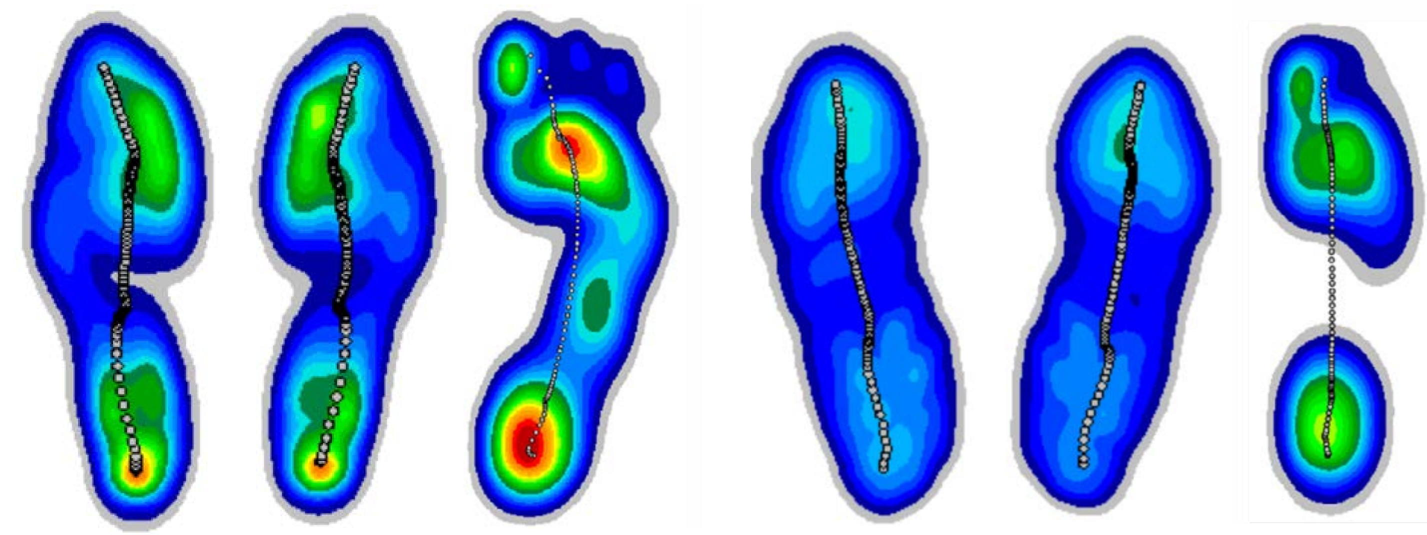

**Figure 1.** An iron grip is uncomfortable, like the CAGA hot spots on the examples of left heels and forefoot, and the polar opposite feels disconnected, laissez-faire, even aloof, like the CAGA straight-lasted minimized shock-absorbing characteristics on the right. Use visuals like this to connect what patients feel (comfort) to what's happening mechanically (loading, stability, and gait-line patterns) so "fashion" decisions don't override "function."

By Jay Segel, DPM; Sally Crawford, MS

If you have been following our articles, you may have noticed a trend in how computer-aided gait analysis (CAGA) data can help characterize unavoidable and avoidable truths about your 2 feet and the long-term consequences. When it comes to footwear, even research supports the fact that improper footwear and "wear and tear" over time will have negative impacts on foot health[1]. In this article, we highlight one of the sadder dirty truths and the one most directly under our own control; "looks good" does not mean "is good," also known as fashion doesn't equal function.

Consumer comfort through retail therapy often reverses the priorities of making healthy choices first, followed by taste and style. This dirty truth comes in number 1 for absurdity, when understanding that there are patients requesting that their doctor remove a lesser toe so they can fit into a particular shoe of their fancy. They often additionally remark, but they make me look so good. At that point, we change the focus to the clinical consequences of footwear-driven deformity.

Let's identify and address perhaps the core of this dirty truth: mental fit versus physical fit, and the need for foot splay–the natural widening and lengthening of the foot under loads. Take the example of shaking hands, a solid, firm but not "too firm" grasp is very satisfying. Our handshake preferences often carry over to the way we judge footwear fit.

During intake with a patient, even before CAGA testing, often the first sign of footwear misjudgment includes comments about–pressure, rubbing, "my toes feel crowded"–and that's the moment to intervene. The next question is usually "How long have you had this problem?" And, frequently, patients will respond that they have had the issue for a while.

Upon further query, "Have you sought help for this before?" we often hear, "No, I thought it would get better, before it didn't look right, but now it's hideous and painful." This is a great moment for patient education, not just for them, but perhaps for their children, other family members, and/or circle of friends. If we can help people to seek our advice when first noticed, their issues would not likely progress to the presenting level of deformity or pain. Simply stated, one clear thing is that early intervention can slow, arrest, or reverse deformity and perhaps prevent pain. Henceforth, waiting is idiocy, not logic.

So, to end with a little CAGA logic: systematic reviews and critical/scoping reviews consistently point to the value of biomechanical assessment, individualized recommendations like personalized fitting, and preventive care for protecting long-term foot health and mobility[2,3,4]. The point is not that style and comfort are irrelevant–it's that, without quantifying function, "feels good" and "looks good" can still create small triggers that snowball into chronic and preventable issues, altered gait patterns, and even visible deformity.

What CAGA adds that subjective comfort can't is data–objective proof of function, so your footwear choices are based on biomechanics, not just look and feel.

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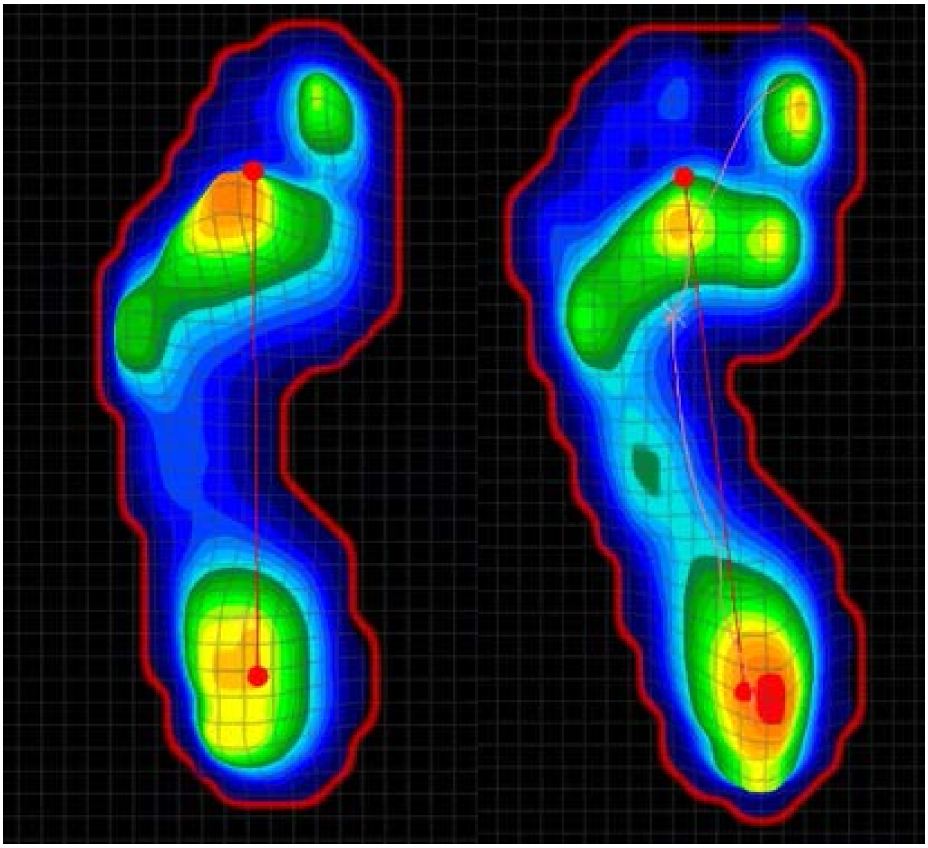
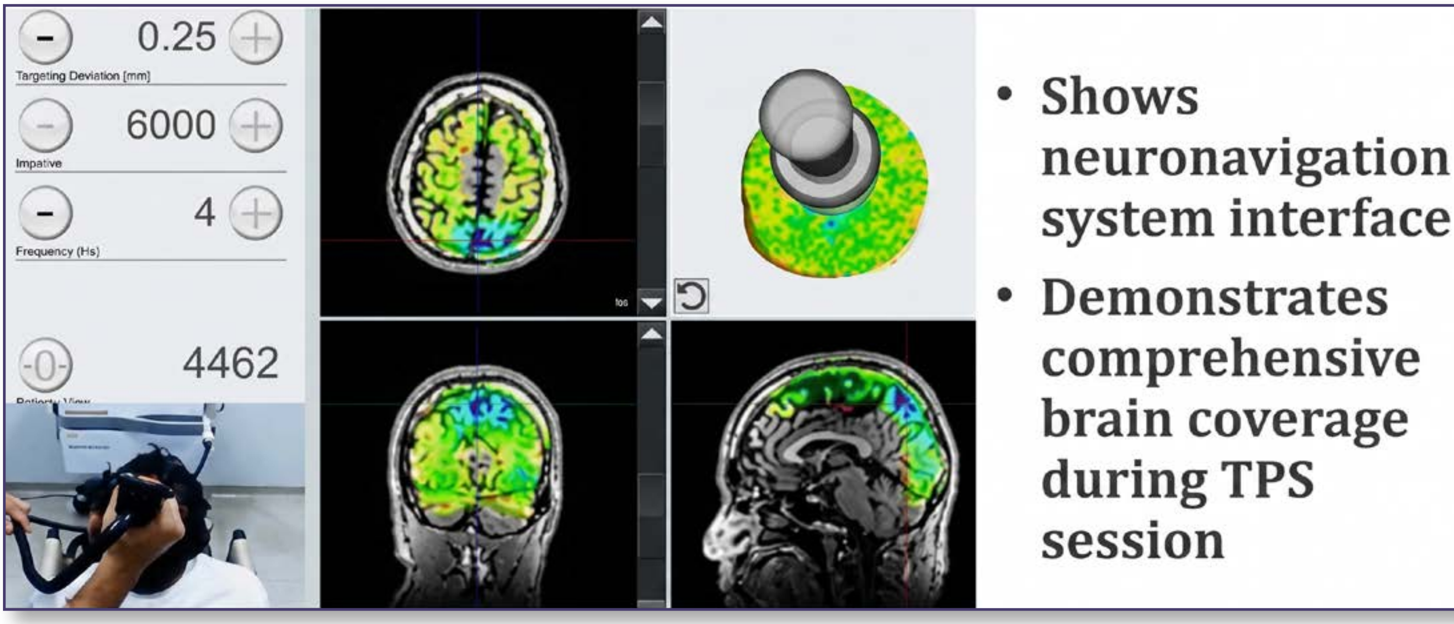


**Figure 2.** When our feet are not weight-bearing, like our hands, they occupy a smaller regional volume, but when our feet are loaded during weight-bearing, they splay, and we want this to happen to accommodate impact, ground reaction forces, directed motion, and balance. Simply put, our feet need to find their footing. When trying to satisfy the mental itch of that firm hold, we deny the feet the ability to meet the challenges of weight-bearing and locomotion. So, all this explanation to say, give your feet room in shoes to reach their ideal weight-bearing structure.

# Application Of Transcranial Pulse Stim in Rehab: Pain Management in Knee Osteoarthritis




Knee osteoarthritis (KOA) is the most prevalent form of arthritis among adults and a leading cause of disability worldwide. The condition affects hundreds of millions of individuals and represents a substantial burden on healthcare systems. Chronic knee pain is the primary symptom and frequently prompts individuals to seek medical care. However, the management of chronic osteoarthritis pain remains challenging. Conventional therapies, including pharmacologic management, rehabilitation, and lifestyle interventions, do not always provide sufficient relief. As a result, many patients experience persistent pain and functional limitations, which can ultimately lead to surgical interventions such as knee replacement. Consequently, there is increasing interest in novel therapeutic strategies aimed at improving pain management in patients with refractory KOA.

One emerging intervention is transcranial pulse stimulation (TPS), a non-invasive neuromodulation technique that uses focused ultrasound shockwave pulses to stimulate targeted regions of the brain. TPS has previously demonstrated therapeutic potential in neurological disorders, particularly Alzheimer's disease, where it has been associated with improvements in cognitive and neuropsychiatric symptoms. Researchers have hypothesized that similar neuromodulatory mechanisms may influence brain regions involved in pain perception and regulation, potentially providing relief for patients with chronic osteoarthritis pain.

To explore this possibility, researchers conducted a prospective case series involving 8 patients with primary knee osteoarthritis who experienced persistent pain despite conventional treatment. All participants were female and ranged in age from 63 to 77 years, with a mean age of approximately 69 years. Each participant met the clinical and radiographic diagnostic criteria for KOA and reported moderate to severe pain lasting at least 3 months. The study was conducted in a tertiary rehabilitation outpatient clinic at a university hospital.

Participants underwent 6 TPS treatment sessions. During each session, ultrasound gel was applied to the scalp, and a specialized device delivered focused shockwave pulses to specific cortical regions. Targeted brain areas included the precuneus and the primary motor cortex, which are associated with pain processing and modulation. Additional stimulation was applied across broader cortical regions, including the frontal, temporal, parietal, and occipital areas, with the aim of influencing interconnected neural networks involved in pain perception. Each treatment session lasted approximately 26 minutes and delivered around 6,000 pulses.

In total, 8 female patients were evaluated for the Visual Analogue Scale score (VAS), a widely used 10-point scale in which 0 represents no pain and 10 indicates the worst possible pain before and after therapy. The mean initial (before therapy) VAS score for the right knee was 6.4 (± 2.5) across the patients, and that score reduced to an average of 1.1 (± 1.6) by the end of the therapy. Similarly, the average for the left knee reduced from 7.2 (± 1.4) to 1.4 (± 1.8). Pain scores were recorded before the first treatment session and again after completion of the final session. This resulted in an average reduction in pain of 5.3 points for the right knee and of 5.8 points for the left knee. All patients improved their scores. Proper adherence and tolerance to the transcranial pulse stimulation protocol was observed, with no severe side effects. All participants experienced improvement in their pain scores, and statistical analysis confirmed that these reductions were significant.

Transcranial pulse stimulation was delivered in 6 sessions per participant, diagnosed with knee osteoarthritis using the American College of Rheumatology and the Kellgren-Lawrence radiographic grading criteria, with a nominal weekly interval but an adaptive schedule that accommodated individual and logistical constraints.

TPS was generally well tolerated by the participants. No serious adverse events were reported during the treatment course. One patient reported a mild, transient headache during a session, which resolved without intervention. Overall, the treatment demonstrated a favorable safety profile in this small cohort.

Several mechanisms may explain the potential analgesic effects of TPS. Mechanical stimulation produced by ultrasound shockwaves can trigger cellular responses through mechanotransduction, a process in which mechanical forces activate biochemical signaling pathways. These responses may promote the release of neurotrophic factors that support neuronal survival, growth, and synaptic plasticity. Additionally, TPS may influence inflammatory pathways and enhance communication between brain regions involved in pain modulation, potentially contributing to reduced pain perception.

Despite these promising findings, several limitations should be acknowledged. The study involved a small sample size and lacked a control group, limiting the ability to draw definitive conclusions regarding treatment efficacy. Furthermore, long-term follow-up data were not available, making it difficult to determine the durability of the observed improvements. Future research should include larger randomized controlled trials and extended follow-up periods to better evaluate the long-term therapeutic potential of TPS for KOA.

In summary, this preliminary investigation suggests that transcranial pulse stimulation may represent a promising neuromodulation approach for patients with chronic knee osteoarthritis who do not respond adequately to conventional therapies. The significant reduction in pain observed after a relatively short treatment course highlights the potential of TPS as an adjunctive intervention within comprehensive rehabilitation strategies aimed at improving patient outcomes and quality of life.

***Source:*** *Imamura M, Shinzato GT, Yoshioka LH, et al. A novel application of transcranial pulse stimulation in rehabilitation: pain management in refractory knee osteoarthritisa case series. J Rehabil Med. 2025 Sep 23;57:jrm42403. doi: 10.2340/jrm.v57.42403.*

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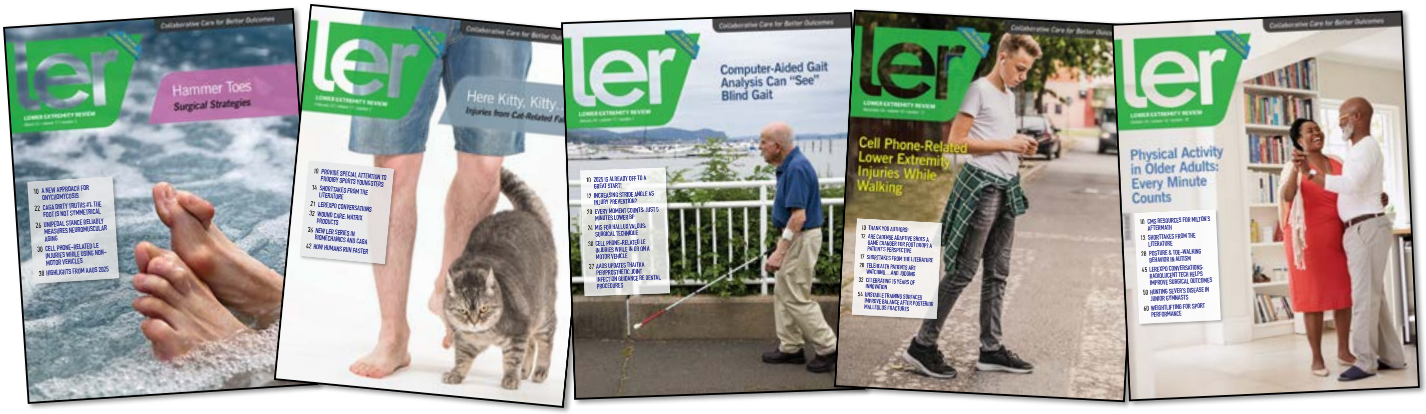




LOWER EXTREMITY REVIEW
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# New & Noteworthy

Noteworthy products, association news, and market updates

## PERFORMANCE SOCKS

Revitalign® Performance Socks are designed to meet the demands of a dynamic lifestyle. Recognizing that support shouldn't end with shoes, the company developed a sock that incorporates biomechanical technology to enhance foot wellness throughout the day. Each pair is crafted with a focus on technical innovation. Key features include a Y-shaped heel design to prevent rubbing and a seamless toe to eliminate irritation. For impact absorption, the socks have a 360-degree cushioned heel zone and additional forefoot padding. The signature PWR-BRIDGE compression band delivers targeted support to the medial and lateral arches, while a wide toe box allows toes to splay naturally for better balance and comfort. The breathable cotton/spandex blend fabric also ensures feet stay cool and dry for all-day wearability. The collection is available in a size range covering women's 5–14.5 and men's 6–15.5, and in 3 colors: heathered black, heathered gray, and white.

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## IMPLANTABLE NEUROTECHNOLOGY COULD HELP PROSTHETIC LEGS WORK MORE LIKE INTACT LIMBS

A research team led by researchers at Chalmers University of Technology in Sweden has successfully decoded leg movements directly from the remaining nerves in people with transfemoral amputations. Using novel implantable neurotechnology and an artificial intelligence (AI) method based on the nervous system's own "language," the researchers could interpret detailed movements—even the will to wiggle toes. This technology opens the way to future leg prostheses that feel and act more like a natural part of the body. The new study was published in *Nature Communications*.

Decoding motor intentions directly from within peripheral nerves may enable more natural and intuitive control of prosthetic limbs. In the study, researchers successfully interpreted signals from the sciatic nerve of above-knee amputees with high accuracy using AI-based spiking neural networks that mimic biological neural communication.

According to Giacomo Valle, assistant professor at Chalmers and one of the study's senior authors, the research group has succeeded in meeting this challenge with a new approach, focusing on individuals with lower-limb amputations, in which the key role is played by a neurotechnological implant, combined with a new, AI-based algorithm. The technique is based on so-called Spiking Neural Networks (SNNs), which processes time-based signals known as spikes. According to Elisa Donati, professor at the University of Zurich and ETH Zürich and the other senior author of the study, these signals mimic more closely how biological neurons communicate.

"With this approach, we were able to map specific nerve signals to specific movements and predict, with high accuracy, which movements the participants were attempting," said Valle. "The method provides the opportunity to interpret very specific leg movements for the knees, ankles, and toes–even those that were previously impossible to decode."

Another advantage is that the technology is bidirectional so it can be used for both motor control and restoring sensation, with a single implant. "So, for the first time, a single neurotechnology can provide both natural neural control and sensory feedback in the same implantable device," said Valle.

The study is a proof of concept, demonstrating that the technique is feasible. The next step is to test it on real prostheses.

## CLOG BUILT AROUND A CUSTOM ORTHOTIC

The Surefoot footwear collection was engineered entirely around a patient's custom orthotic. Powered by Amfit® full-contact foot-scanning technology, the collection represents a fundamental shift in how supportive footwear is designed, prescribed, and worn. The result is total alignment for comfort, built to preserve therapeutic intent without compromise. The collection includes a sneaker, classic clog, lined clog, and sandal. For clinics, the model is intentionally effortless. Clinicians simply scan the foot, transmit the data, and deliver a finished product built to integrate seamlessly with the prescribed orthotic. The Surefoot Classic Clog is available in black, khaki, and cream. It features waterproof premium suede for softness and breathability. A functional buckle allows micro-adjustments for a secure fit, while the orthotic supports stability and energy return throughout the day.

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## SENSORY INSOLE PROGRAM TO COMBAT DIABETES-RELATED COMPLICATIONS

Orpyx® Medical Technologies' next-generation sensory insole program is a proactive, scalable solution to prevent diabetes-related foot complications. This new platform combines durable wearable technology and behavioral support to enable healthcare providers to intervene early before complications escalate. The Orpyx® Sensory Insoles are embedded with proprietary sensors that continuously track plantar pressure, foot temperature, step count, and wear time—physiological indicators that signal early deterioration in foot health. Designed for effortless patient use, the insoles function for up to 6 months without charging and sync with an intuitive mobile app and home hub that uploads data directly and securely to the Orpyx cloud. Each program participant is paired with a dedicated Orpyx nurse who delivers personalized coaching, adherence support, and wellness checks, bridging the gap between medical appointments to help ensure continuity of care. The technology is clinically validated and economically proven in multiple peer-reviewed publications.

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## CMS ANNOUNCES 2 NEW L-CODES

The Centers for Medicare & Medicaid Services (CMS) recently released their final determinations from the Second Biannual 2025 Healthcare Common Procedure Coding System (HCPCS) code application meetings. Among the final determinations are 2 new L-codes pertaining to the lower limb, which are valid for claims with dates of service on or after April 1, 2026, as follows:

- L-2221: Addition to lower extremity orthosis, ankle system, microprocessor-controlled feature plantarflexion and/or dorsiflexion, includes power source
- L-5992: All lower extremity prosthesis, foot shell for modular foot/non-solid ankle cushion heel (sach) replacement only

## RESEARCHER DEVELOPING NEW DIABETIC NEUROPATHY TREATMENT

Laura De Castro, a biomedical sciences major, performs a western blot test in Dr. Jim Nichols' research lab. Photo by Eddy Duryea, courtesy of UCF.

A University of Central Florida (UCF) College of Medicine scientist is investigating a new approach to treat neuropathy without relying on pain pills and antidepressants. Assistant Professor Dr. Jim Nichols is focused on overlooked mechanisms in the body that may show how the inability to make insulin has "downstream" consequences in other areas, such as how the brain processes and registers sensation in the limbs. He theorizes that irregularities in the insulin signaling pathway of peripheral nerves may be the key contributor to diabetic neuropathy. Based on the potential of his early findings, the National Institute of Diabetes and Digestive and Kidney Diseases recently awarded UCF a $747,000 R00 grant to expand that research.

"We're diving into an area that's fresh," Nichols said. "The research aims we're going after are based on the insulin signaling pathway, and how the neuropathy evolves due to insulin dysregulation. Ultimately, we're looking at different ways to alter the insulin signaling pathway to prevent nerve degeneration."

During the next 3 years, Nichols and his team will document the behavior of neurons, their signaling systems, and surrounding cells to find ways to regulate them to alleviate symptoms of neuropathy. He hopes his investigational treatment can become a more viable alternative for patients with diabetes.

## TRIGGER OF TENDON DISEASE DISCOVERED

Throbbing pain behind the heel is a typical sign of Achilles tendon problems. Runners are often affected. Image: Oleg Breslavtev / Adobe Stock.

Overuse of our tendons can cause painful medical conditions, known as tendinopathy. Researchers have now deciphered an important molecular mechanism that triggers these problems. Their findings will facilitate the development of new treatments.

A team of researchers led by Jess Snedeker, a professor of orthopedic biomechanics at ETH Zurich and Balgrist University Hospital in Zurich, and Katrien De Bock, professor of exercise and health at ETH Zurich, has reached a new milestone. In the HIF1 protein—which is known to be presented at elevated levels in diseased tendons—they have identified a central molecular driver of tendon problems of this kind. A part of HIF1 acts as a transcription factor, which controls the activity of genes in cells.

In mouse experiments, the researchers observed tendon disease even without overloading in the mice with permanently activated HIF1. No tendon disease occurred in the mice if HIF1 was deactivated in tendons, even in the case of overloading. Both in the mice and in the experiments with human tendon cells, they were able to show that due to elevated HIF1 levels in the tissue, more crosslinks form within the collagen fibers that make up the basic structure of the tendons, making the tendons more brittle and impairs their mechanical function. However, in many organs of the body, HIF1 is responsible for detecting a lack of oxygen and activating a physiological adaptation. Thus, "switching HIF1 off throughout the body would likely lead to side effects," said DeBock.

It may be possible to look for methods that specifically deactivate HIF1 only in the tendon tissue. In DeBock's view, the more promising approach would be to explore the biochemical processes around HIF1 in the cells in greater detail. This could help to identify other molecules that are influenced or controlled by HIF1 and that could be more suitable targets for the treatment of tendinopathy.

## DYNAMIC AIR COMPRESSION DEVICE FOR HIPS, IT BANDS, LOWER BACK

The Normatec Elite Hips is a fully portable dynamic air compression device specifically engineered for the hips, iliotibial (IT) bands, and lower back. This standalone device represents a new era of targeted recovery, eliminating the need for separate control units and delivering clinical-grade compression therapy. With a sleek, cordless design, the device delivers clinical-grade compression therapy with up to 4 hours of battery life. Users can choose from seven intensities (40–110 mmHg) to match their specific needs. Two independent compression zones work together to provide seamless coverage across IT bands, thighs, hamstrings, hips, and lower back, ensuring no missed areas or uneven pressure distribution. Adjustable Velcro straps around the leg ensure a secure fit, delivering consistent pressure and optimal results every session. Bluetooth connectivity to the Hyperice app enables customized settings and personalized protocols.

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## GENERATIVE AI CAN HELP ATHLETES AVOID INJURIES

The model can create simulations with different levels of muscle activation. Image courtesy of UCSD.

Researchers at the University of California San Diego (UCSD) have created a model driven by generative artificial intelligence (AI) that will help prevent injuries in athletes and also aid in rehabilitation after an injury. The model could also help athletes train better.

The model, called BIGE (for Biomechanics-informed GenAI for Exercise Science), was trained with athlete movements together with information about the biomechanical constraints on the human body, such as how much force a muscle can develop. The model can generate videos of motions that athletes can mimic to avoid injury when they train and can generate motions that athletes can execute to keep exercising when they are injured. It can also be used to generate the best motions athletes can execute during exercise to avoid injury and improve performance, or the best motions for athletes that need rehabilitation after an injury.

To the best of the researchers' knowledge, BIGE is the only model that brings together generative AI and realistic biomechanics. Most generative AI models tasked with generating movements such as squats produce results that are not consistent with the anatomical and mechanical constraints that limit real human movements. Meanwhile, methods that do not rely on generative AI to generate these movements require a prohibitive amount of computation.

To train the model, researchers used data from motion-capture videos of people performing squats. They then translated the motions onto 3D skeletal models and used the computed forces to generate more physically realistic motions.

Next steps include using the model for movements beyond squats and personalizing the models for specific individuals. For example, the model could be used to determine fall risks in the elderly.

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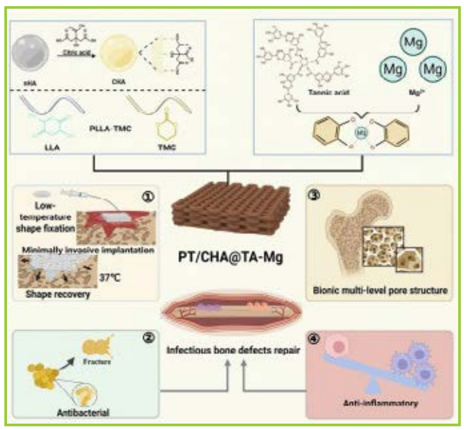
## SHAPE-SHIFTING SCAFFOLD FIGHTS INFECTION, REBUILDS BONE




Schematic illustration of the design and therapeutic mechanism of the PT/CHA@TA-Mg scaffold. Image courtesy of *Burns & Trauma*.

Researchers from Chongqing Medical University and Chengdu University in China have developed a body-temperature responsive, 3D-printed shape-memory scaffold coated with a metal polyphenol network to treat infectious bone defects. Using a combination of low-temperature 3D printing and surface biofunctionalization, the scaffold was designed to adapt to irregular bone defects while providing antibacterial activity, immune regulation, and osteogenic support. The study demonstrates both in vitro and in vivo efficacy in controlling infection and promoting bone regeneration.

The newly developed scaffold is composed of a biodegradable shape-memory polymer blended with citric acid–modified hydroxyapatite, producing a porous structure that closely mimics cancellous bone. At physiological temperature (37 degrees C), the scaffold rapidly recovers its original shape, allowing it to tightly fill irregular bone defects and improve mechanical integration after implantation. This adaptive behavior directly addresses the mismatch issues common in traditional rigid implants.

To combat infection, the scaffold surface is coated with a tannic acid–magnesium metal–polyphenol network. This coating exhibits strong antibacterial activity against common pathogens, including Staphylococcus aureus and Escherichia coli, while enabling pH-responsive release in acidic, infection-associated microenvironments. Beyond pathogen clearance, the coating also plays a crucial immunomodulatory role by shifting macrophage polarization away from a pro-inflammatory state and toward a regenerative phenotype.

Importantly, the scaffold supports robust osteogenic differentiation. Enhanced mineral deposition, elevated alkaline phosphatase activity, and increased calcium nodule formation were observed in stem cell cultures. In an infected rat bone defect model, the scaffold significantly reduced bacterial burden, suppressed inflammatory cytokines, and promoted new bone formation, as confirmed by micro-CT and histological analyses. Together, these results demonstrate a coordinated, multistage healing process driven by a single intelligent implant.

The shape-memory, bioactive scaffold offers broad potential for clinical translation in orthopedic trauma, chronic osteomyelitis, and revision surgeries following implant-related infections.

## How much training do you need to get 50-60% stronger?

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A massive seven-year study modeled data from 14,960 people (average age 48, SD 11) who completed a "minimal-dose" strength training program once per week for up to 352 weeks (~6.8 years).


**Source:** Steele J, Fisher JP, Giessing J, et al. Long-term time-course of strength adaptation to minimal dose resistance training through retrospective longitudinal growth modeling. Res Q Exerc Sport. 2023 Dec;94(4):913-930. doi: 10.1080/02701367.2022.2070592.


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