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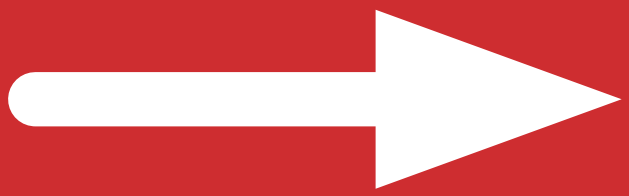

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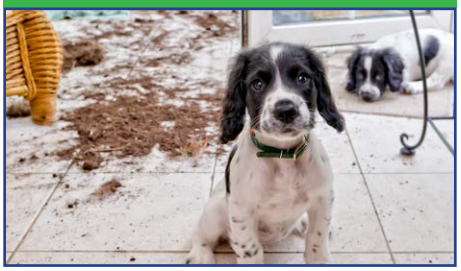

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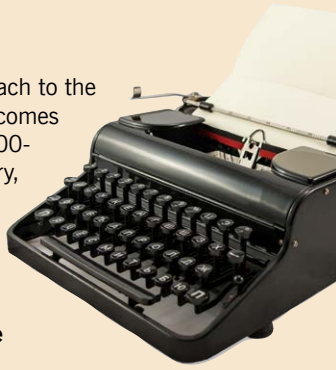

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Relasting as an Alternative to Custom Shoes

By Erick J. Janisse, CO, CPed

Much has been written about the problem of less-than-ideal patient adherence to use of therapeutic and custom footwear for management and prevention of diabetic foot complications. Over the last few decades, there have been numerous research projects, surveys, and studies designed to parse out the exact reasons for low adherence and to create real world, implementable solutions.

Some researchers conclude that the lack of perceived value or benefit of specialized footwear from the patient's perspective is to blame.[1,2] This is most certainly true, and a real challenge for not only pedorthists, orthotists, and shoe fitters, but for physicians, as well. Other studies, though, point to the culpability of the shoes' poor aesthetics.[3,4] And some suggest that if the patient had a wider and/or more consistent selection of footwear, adherence would likely improve.[3,5]

There's more to this, however. A 2018 article by Nicholls et al in *Journal of Foot and Ankle Research* hit the nail on the head.[6] The goal of their narrative review was to explore the sociology of footwear and discover ways to apply previous sociological findings about people and their shoes to improve patient adherence to therapeutic footwear – and not solely in patients with diabetes. The authors pointed out that shoes are not merely "neutral" objects, but rather, in many cases, shoes are the most expensive part of a person's outfit. They refer to previous sociological research that demonstrates just how important the role of footwear is presentation and management of oneself, body, and identity. One study referred to in the article is a 2018 study by Williams et al published in *BMC Musculoskeletal Disorders* and examined the therapeutic footwear experiences of patients with rheumatoid arthritis.[7] One of their conclusions was that, "[u]nlike any other intervention specialist therapeutic footwear replaces something that is normally worn and is part of an individual's body image. It has much more of a negative impact on the female patients' emotions and activities than previously acknowledged and this influences their behaviour with it." They also pointed out that, "[f]or several participants, orthopaedic or specialist footwear also compounded an existing negative self-image and could be linked with feelings of shame, anger, and humiliation. Those who did wear their prescribed footwear frequently suggested that it could limit their engagement with social activities." These are very real considerations that are frequently overlooked, undervalued, or misunderstood by referring physicians and orthotics, prosthetics, and pedorthic (OP&P) providers.

Even though there are many fine, reputable, and talented custom shoemakers and respected custom shoe companies in existence today, many within our profession and related professions would not consider most therapeutic custom footwear to be "normal looking". Herein lies the problem. In a therapeutic context, the only instances where a pedorthist resorts to provision of custom shoes are when the patients' deformities are so severe in nature that they simply cannot be accommodated by any so-called off-the-shelf shoes. Despite the custom shoemaker's best attempts, the shoes inevitably look quite a bit like the patient's deformed feet. There is no escaping the self-consciousness brought on by–and the stigma attached to–having to wear such shoes.

Midfoot relast for Charcot foot deformity, shown with foot cast and custom foot orthosis.

Admittedly, there are, and always will be, situations where custom shoes truly are the only practical option for a given patient. In many cases, though, there are alternatives. Many therapeutic or orthopedic footwear manufacturers offer in-depth shoes, double-depth shoes, and the availability of mismating sizes and widths left-to-right in order to accommodate unusually shaped feet as best as possible. There are even triple-depth shoes available in extreme sizes and widths from companies like Apis that can accommodate a great many of the feet with which this article is concerned.

There is one last, more aesthetically pleasing, alternative to custom shoes. Relasting. That is, using a relatively normal looking shoe – sometimes even a shoe that the patient already had in their closet – and customizing it by widening the sole to accommodate their foot deformities or painful prominences. Relasting frees up the patient and pedorthist to select from a wider variety of socially acceptable and cosmetically satisfactory footwear. When the patient looks down at their shoes, they

Medial midfoot relast for Charcot midfoot collapse

Left: Finished forefoot relast for severe hallux and bunionette deformities. **Middle:** Forefoot relast, in-process. **Right:** Forefoot deformity requiring relast.

see normal shoes that won't garner unwanted attention…and they themselves, in turn, feel more normal (and more likely to wear the shoes as prescribed).

Relasts can be applied to great effect for patients with Charcot arthropathy, prominent bases of fifth metatarsals, severe bunion or bunionette deformities, wide transmetatarsal amputations and a host of other conditions and deformities.

For a relast to be a long-lasting and successful solution, there are some important factors to consider. The shoe must be appropriate to start with – for both the foot and the modification. That is, it must be as close to properly fitting before modification and the sole construct must have enough structural integrity to undergo the modification. Another important consideration is that, regardless of what is done to the sole, the upper will always only have the same fixed amount of material. This means that by widening the shoe, the depth is necessarily decreased, and, in the case of an extreme widening, the length of the shoe may be shortened slightly.

The modification, while requiring the necessary time and skill set to perform, is straightforward and simple. The outsole is carefully cut off the shoe. The shoe is cut longitudinally with a jigsaw (if the shoe is board-lasted or has a midsole; if it is slip-lasted, it can be cut with a sharp knife) and the cut is wedged open to fit a pattern created from a weight-bearing tracing of the patient's foot. Blocks of firm crepe or neoprene are placed into the cut to hold it open, and a cardboard dam is glued to the topside of the insole inside the shoe. The gaps are filled with a very firm viscoelastic polymer like PQ® Gel by Riecken's or a rigid expanding foam. Once the filler is set, the surface is sanded smooth and level, and a new outsole is applied. The relasted shoe will need to be used in conjunction with a custom foot orthosis made to fit the shape of the modified shoe.

Relasts can be done in any part of the shoe. For obvious reasons, the midfoot is the easiest. The forefoot and hindfoot are more involved and challenging but can certainly be done. Relasts in the hindfoot may also necessitate modification of the counter itself.

Keep in mind, however, that the relasted shoe is a customized shoe and not a custom shoe. Therefore, it may not be billed as a custom shoe. The code L3254 may be used to bill for a relast if the modified shoe is an integral component of a lower extremity bracing system attached to the shoe. Outside of that, however, it will most likely be an out-of-pocket expense for the patient. Even so, once the patient tries the new shoe, be prepared for a happy patient and many more requests for additional shoes to be relasted.

Erick J. Janisse, CO, CPed, a certified orthotist and pedorthist, is Sales Training Manager at Enovis (formerly DJO) and Program Director for Midwest School of Modern Pedorthics in Mequon, Wisconsin.

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OPERATIVE VS NONOPERATIVE MANAGEMENT OF ACHILLES TENDON RUPTURES

Orthopedic researchers from the University of Michigan and the Toledo (Ohio) College of Medicine and Life Sciences recently reported that young adults with Achilles tendon ruptures (ATR) may be considered for either operative or nonoperative management.

In this single institution retrospective cohort study of young adults (18-30 years at time of injury), 28 operative and 14 nonoperative patients participated. Data collected from their medical records included demographics, smoking status, body mass index (BMI), Charlson Comorbidity Index (CCI), rate of deep venous thrombosis (DVT) after treatment, and rate of rerupture. Patients then completed Patient-Reported Outcomes Measurement Information System (PROMIS) physical function (PF) and pain interference (PI) questionnaires. Mann-Whitney nonparametric testing was used to evaluate for any statistical differences in PROMIS scores.

All patients had a CCI of 0. One patient in the operative cohort and 2 in the nonoperative reported active smoking. In the operative and nonoperative cohorts, respectively:

- average age was 24.4 and 27.8 years
- average BMI 26.5 (SD = 4.8) and 27.3 (SD = 4.3, $P = .52$)
- DVT rates 4 (6.1%) and 2 (5.4%)
- rerupture rates 2 (3.0%) and 1 (2.7%).

PROMIS scores did not differ in the operative and nonoperative groups: PROMIS PF mean of 60.4 (SD = 9.8) and 62.9 (SD = 9.1), respectively ($P = .33$); as well as PROMIS PI mean of 44.6 (SD = 5.9) and 43.9 (SD = 6.5), respectively ($P = .59$). ler

Source: *Ge L, Saunders N, Betts D, Holmes JR, Walton DM, Talusan PG. Midterm outcomes of operatively and nonoperatively managed Achilles tendon ruptures in young adults. Foot Ankle Orthop. 2023;8(3). doi:10.1177/24730114231198849*

COLLABORATIVE CARE BUILDS BETTER OUTCOMES

CARE FRAGMENTATION IMPACTS LE AMPUTATION OUTCOMES

Care fragmentation (CF) is a known risk factor for unplanned readmission, morbidity, and mortality after surgery. The goal of this study was to evaluate the impact of CF on outcomes of major lower extremity amputation for peripheral vascular disease.

Health-care Cost and Utilization Project Database for NY (2016) and MD/FL (2016-2017) were queried using International Classification of Diseases 10th edition to identify patients who underwent above the knee-, through the knee-, and below the knee-amputation for peripheral vascular disease. Patients with CF were identified as those with admissions to ≥2 hospitals during the study period. The authors compared the postamputation outcomes of mortality, readmission rate, length of stay (LOS) and hospital charges.

The authors identified a total of 13,749 encounters of 2,742 patients who underwent major lower extremity amputations. There were 1,624 (59.2%) patients with CF. Patients with CF were younger (68.4 years old vs 69.7 years old, $P = 0.005$), with higher Charlson Comorbidity Indices (4.4 vs. 4.1, $P < 0.001$), and required more hospital resources on index admission ($113,699 vs. $91,854, $P < 0.001$). These patients were prevalent for higher 30-, and 90-day readmission rates (34.7% vs. 24.5%, $P < 0.001$ and 54.7% vs. 42.0%, $P < 0.001$, respectively). On their first postamputation readmission, LOS (16.3 days vs. 14.7 days, $P = 0.004$) and hospital charge ($48,964 vs. $44,388, $P = 0.002$) were significantly higher. Multivariate regression analysis demonstrated that the CF was an independent predictor for 30-day (hazard ratio [HR] 1.65, 95% confidence interval (CI) 1.39-1.96, $P < 0.001$) and 90-day (HR 1.66, 95% CI 1.42-1.95, $P < 0.001$) readmission after the major lower extremity amputation, but not for mortality (HR 0.83, 95% CI 0.56-1.23, $P = 0.36$).

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Care fragmentation after major lower extremity amputation is associated with higher readmission rate, LOS, and hospital charge. Collaboration of care providers to maintain continuity of care for peripheral vascular disease patients may enhance quality of care and reduce health care cost.

Source: *Urie BR, Laskowski T, Richard M, Tihonov N, Katz D, d'Audiffret A, Lim S. Impact of Care Fragmentation after Major Lower Extremity Amputation. Ann Vasc Surg. 2024;100:47-52. doi: 10.1016/j.avsg.2023.10.020. Reprinted with permission from Elsevier. ©2023. All rights reserved.*

RE THE GUT-BRAIN AXIS

GENETIC LINK BETWEEN PARKINSON'S DISEASE AND INFLAMMATORY BOWEL DISEASE FOUND

Researchers at the Icahn School of Medicine at Mount Sinai have identified genetic connections between inflammatory bowel disease (IBD) and Parkinson's disease (PD). The 2 chronic disorders have been suggested to share risk factors and underlying pathophysiology consistent with the "gut-brain axis" hypothesis. Previous studies, including a meta-analysis with 12 million patients, indicate that both Crohn's Disease and Ulcerative Colitis (which make up IBD) are associated with an increased risk of PD diagnosis.

Using advanced genomic analysis techniques to investigate the genetic overlap between IBD and PD, their findings point to mutations in the *LRRK2* gene as a common element linking both conditions and identify novel genes that are likely to be affected in people experiencing both IBD and PD.

"We've found that IBD and PD are caused by certain shared genetic factors, including variants in *LRRK2* and other genes previously unknown for this combined condition. This could dramatically change our approach to these diseases, allowing for therapies that target both conditions simultaneously," lead author Meltem Ece Kars, MD, PhD, said in a related press release.

The study analyzed data from the Mount Sinai BioMe BioBank, the UK Biobank, and a cohort of 67 patients diagnosed with both IBD and PD from the Danish National Biobank. This combined dataset enabled the researchers to explore high-impact rare genetic variants and identify new genes and biological pathways that contribute to the IBD-PD comorbidity.

"Our research not only links these two diseases genetically but also sets the stage for new forms of treatment, and potentially prevention strategies, that could lessen the burden of these diseases on patients," Kars said.

The researchers used a variety of computational methods to uncover significant associations between the *LRRK2* gene variants and the co-occurrence of IBD and PD, including the network-based heterogeneity clustering approach, which they have demonstrated to be highly effective for gene discoveries in small cohorts that cannot be analyzed by traditional gene association methods. Their analysis also revealed several pathways related to immunity, inflammation, and autophagy, the body's cellular recycling system, that are involved in both conditions.

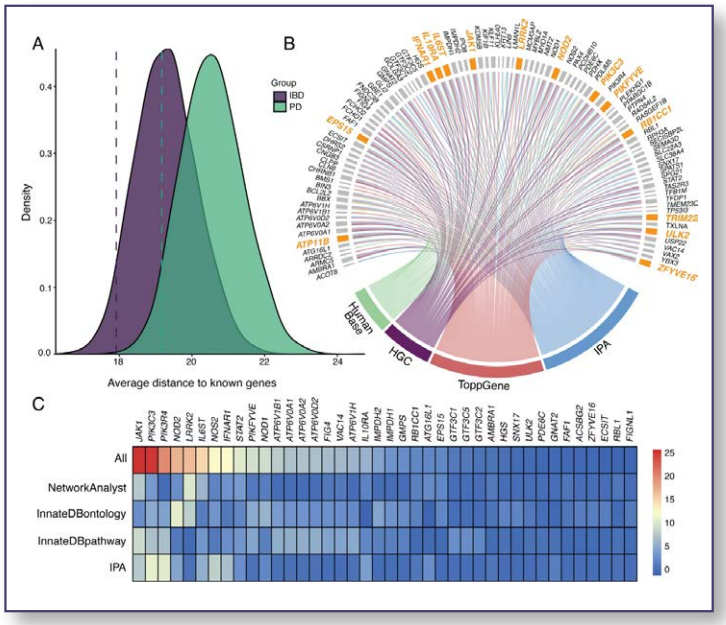

Figure. Candidate gene prioritization and validation using a phenotype-wide association study (PheWAS). A Density plots displaying the distribution of the average distances of 120 random genes (Drandom) to known inflammatory bowel disease (IBD, in purple) and known Parkinson's disease (PD, in green) genes obtained from 10,000 resampling iterations. Dashed lines represent the average distance of the candidate gene set (Dcandidate, n = 120) to known IBD and PD genes. B Circos plot showing the candidate genes identified by four complementary pathway and biological relatedness approaches. Final candidate genes that were identified by all four methods are highlighted in orange. C Heatmap of the combined biological importance scores of the IBD-PD candidate genes. A higher score indicates a higher number of shared pathways, ontologies, or modules with known IBD and PD genes. The colors represent the magnitude of the scaled scores calculated by each method. The highest-scaled scores are depicted in red, whereas the lowest scores are shown in blue. The top 40 genes are shown in the plot.

These insights have potential implications across multiple areas of medicine, suggesting that understanding genetic factors could lead to better-targeted therapies. The study underscores the importance of genetic research in developing personalized medicine approaches that could improve treatment for patients with both IBD and PD.

The promise of these findings extends beyond current treatment paradigms: "By pinpointing the genetic underpinnings common to both IBD and PD, we pave the way for innovative treatments, whether through the development of novel drug targets or the repurposing of existing drugs, that could potentially tackle the root causes of these conditions," Kars said.

The results of this study could also influence future research directions, encouraging a more integrated approach to studying diseases that may appear unrelated but share common genetic pathways.

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Source: *Kars ME, Wu Y, Stenson PD, et al. The landscape of rare genetic variation associated with inflammatory bowel disease and Parkinson's disease comorbidity. Genome Med. 2024 May 14;16(1):66. doi: 10.1186/s13073-024-01335-2.*

INITIATING BP MEDS INCREASES FALL RISK IN NURSING HOME RESIDENTS

Initiating a new prescription for blood pressure medications may serve to more than double the risk of life-threatening bone fractures, according to a recent study of more than 30,000 nursing home residents.

The study, which was published in *JAMA Internal Medicine*, asked whether the initiation of antihypertensive medications is associated with increased fracture risk among long-term Veterans Health Administration (VA) nursing home residents.

The retrospective cohort study used data derived from 29,648 older VA nursing home residents from 2006-2019.Average age was 78.0 and the group was 97.7% male. The control arm included 64,710 residents, average age 77.9 years. When looking fractures to the hip, pelvis, humerus, radius, or ulna, the researchers found the incidence rate of fractures per 100 person-years was 5.4 in the group initiating antihypertensives compared with 2.2 in the control group. These medications were also linked to higher risk of severe falls requiring hospitalizations or emergency department visits. Fracture risk affected subgroups differently, with dementia, systolic BP of ≥140mgHg, and diastolic BP of ≥80mmHg facing at least triple the fracture risk of the control group.

The findings, the authors concluded, indicated that initiation of blood pressure medications may be associated with elevated risks of both fractures and falls. They advise additional monitoring of such patients when initiating these drugs. ler

Source: *Dave CV, Li Y, Steinman MA, et al. Antihypertensive Medication and Fracture Risk in Older Veterans Health Administration Nursing Home Residents. JAMA Intern Med. 2024;184(6):661–669. doi:10.1001/jamainternmed.2024.0507*

NANO DRUG ACCELERATES DIABETIC WOUND HEALING IN MICE

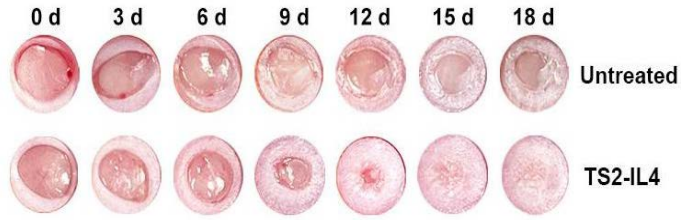

Figure: Mice treated with trisulfide-derived lipid nanoparticle mRNA therapy showed accelerated wound healing compared to untreated mice. Image credit: Lab of Yizhou Dong, PhD, at Icahn Mount Sinai.

Researchers at the Icahn School of Medicine at Mount Sinai in New York City have designed a regenerative medicine therapy to speed up diabetic wound repair. Using tiny fat particles loaded with genetic instructions to calm down inflammation, the treatment was shown to target problem-causing cells and reduce swelling and harmful molecules in mouse models of damaged skin. Details on their findings were published in the *Proceedings of the National Academy of Sciences (PNAS)*.

Diabetic wounds, often resistant to conventional treatments, pose serious health risks to millions of people worldwide. Immune cells known as macrophages, which are supposed to help, end up causing inflammation instead. This inflammation harms other cells and makes it harder for the wound to heal properly and quickly.

Using lipid nanoparticles (LNPs) loaded with RNA encoding IL-4, a cytokine, the therapy targeted dysfunctional macrophages while simultaneously reducing inflammation and "reactive oxygen species" (ROS) in diabetic wounds.

ROS molecules are produced naturally in the body during various metabolic processes and play roles in cell signaling and immune responses. However, excessive ROS production can lead to oxidative stress, causing damage to cells, proteins, and DNA. This stress is associated with various diseases and conditions, including inflammation and aging.

"In preclinical models, we basically showed the therapy's ability to reprogram pro-inflammatory macrophages into reparative ones, leading to improved wound healing outcomes," says Yizhou Dong, PhD, corresponding author of the study, Professor of Immunology and Immunotherapy, and a member of the Icahn Genomics Institute and the Marc and Jennifer Lipschultz Precision Immunology Institute at Icahn Mount Sinai. "Dysfunctional macrophages drive diabetic non-healing wounds, but we can reprogram them to stop the damage and instead help the healing process. We aim to promote faster and more effective wound closure by reprogramming these cells and modulating the inflammatory environment."

Earlier this year, in a related study, Dong and colleagues reported on lipid nanoparticles that enhanced the tissue engineering and regeneration

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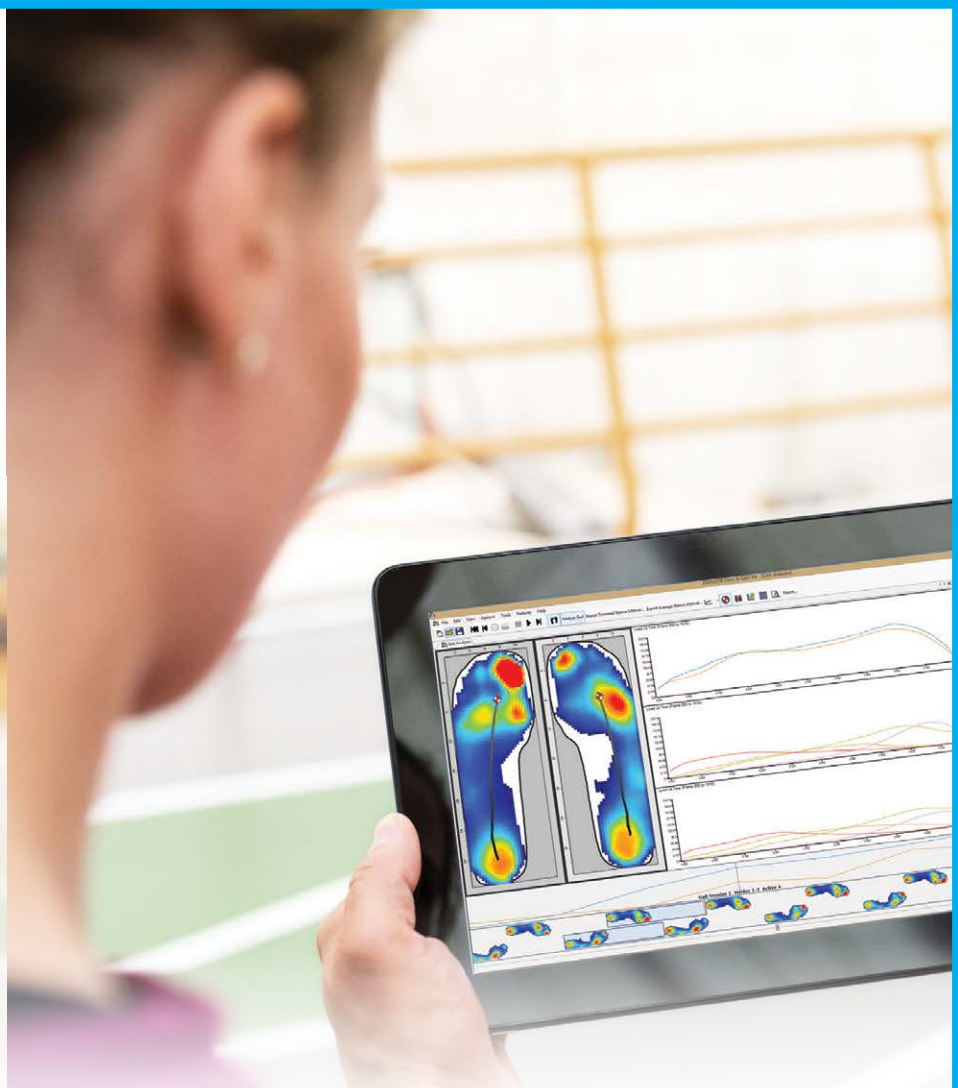

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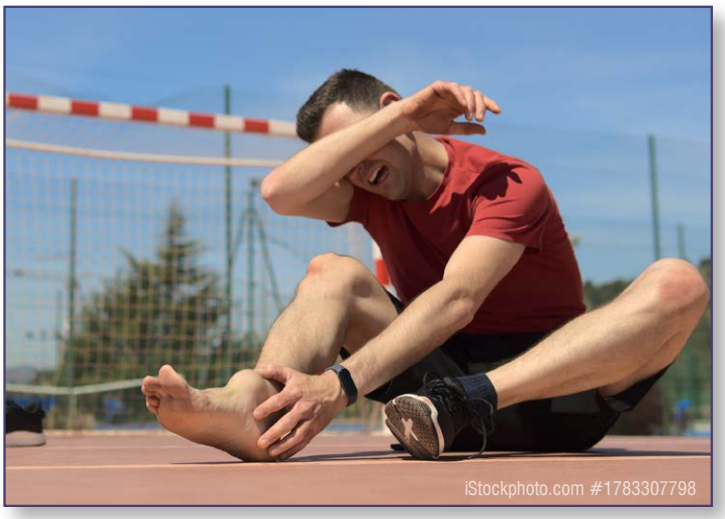
activity of adipose stem cells for treating diabetic wounds.

While the results of the current study are encouraging, the researchers emphasize the need for a rigorous randomized controlled clinical trial to confirm safety and efficacy in humans. "Our ultimate goal is to translate these findings into tangible benefits for patients with diabetes. With further research and validation, this RNA-LNP therapy could potentially revolutionize diabetic wound management with one easily scalable application of a comparatively inexpensive therapeutic agent," says Dong. "The study also suggests the potential for RNA-LNP therapeutics to be more generally designed to reprogram disease-causing macrophages in an organism, as pro-inflammatory macrophages are implicated in a wide range of diseases."

Source: *Wang S, Zhang Y, Zhong Y, et al. Accelerating diabetic wound healing by ROS-scavenging lipid nanoparticle-mRNA formulation. Proc Natl Acad Sci USA. 2024;121(22):e2322935121. doi: 10.1073/pnas.2322935121.*

ROM/DYNAMIC STABILITY AFTER ANKLE SPRAIN: DOMINANT VS NONDOMINANT LIMB



Ankle sprains are the most common lower-leg musculoskeletal injuries, frequently occurring among athletes and other physical activity individuals. This study sought to compare the ankle range of motion and dynamic stability of healthy and injured athletes for their dominant and nondominant legs.

A cross-sectional study design was selected to investigate this study with 32 male soccer players with average age: 22.6 ± 3.3 years, weight: 69.6 ± 5.7 kg, height: 176.8 ± 5.32 cm,with a history of a lateral ankle sprain on the dominant leg for the past 2 years. Ankle range of motion was determined using dorsiflexion and plantar flexion by a goniometer. The dynamic stability was determined using the SWAY medical system. An independent t-test was used to study the differences between healthy and injured groups and between dominant and nondominant legs for dynamic stability, dorsiflexion, and plantar flexion range.

The authors found there were higher significant differences for dynamic stability in healthy participants than in injured participants for their dominant (P = 0.001) and nondominant (P = 0.001) legs. There were significant differences in dynamic stability in the dominant and nondominant leg (healthy [P = 0.033] and injured [P = 0.000] participants). The dominant leg shows higher dynamic stability in the healthy group, whereas nondominant leg shows higher dynamic stability in the injured group.

In their conclusion, the authors state that the study found significant differences between the injured and sound legs. The injured dominant and nondominant leg revealed a striking disparity in the ankle range of motion. Therefore, the study demonstrated that ankle sprain causes stiffness and tightness of the ankle joint, which limits ankle movements. Based on the findings, this study could be used as a return-to-play criterion for athletes after ankle sprain injury to determine whether they are ready to return to play or need to continue a specific rehabilitation training program.

Source: *Alomar AI, Nuhmani S, Ahsan M, Muaidi QI. A comparison of the range of motion and dynamic stability of the ankle joint of athletes with an ankle sprain as compared to healthy controls: A cross-sectional study. Int J Crit Illness Injury Sci. 2023;13(3):p 138-144. DOI: 10.4103/ijciis.ijciis_2_23.*

NEW WOUND SURGICAL INTEGRATED TREATMENT USES ANTIBIOTIC-LOADED BONE CEMENT FOR NON-WEIGHT BEARING DFUS

Diabetic foot ulcers (DFUs) present significant challenges due to associated amputation rates, mortality, treatment complexity and excessive costs. Earlier work by these authors introduced a wound surgical integrated treatment (WSIT) for DFUs, yielding promising outcomes. This study focuses on a specific WSIT protocol employing antibiotic-loaded bone cement (ALBC) in the first Stage, and free vastus lateralis muscle-sparing (VLMS) flaps and split-thickness skin grafts (STSGs) in the second stage to repair non-weight-bearing DFUs.

From July 2021 to July 2023, seven DFU patients (aged 47–71 years) underwent this treatment. Demographic data, hospital stay, and repair surgery times were collected. Histological and immunohistochemical analyses assessed angiogenesis, collagen deposition and inflammation. SF-36 questionnaire measured pre- and postoperative quality of life. Preoperative ultrasound Doppler showed that the peak blood flow velocity of the recipient area artery was significantly >30 cm/s (38.6 ± 6.8 cm/s) in all patients. Muscle flap sizes varied from 8 × 3.5 × 1 to 18 × 6 × 2 cm. The operation time of the repair surgery was 156.9 ± 15.08 minutes, and the hospital stay was 18.9 ± 3.3 days.

Histological analysis proved that covering DFUs with ALBC induced

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Case Study: A 54-year-old male had diabetes and dorsum DFU on the left foot. (A) After stage I debridement, the wound was covered with bone cement. (B) During stage II, after ALBC's removal and tendon exposure, the formation of an 'induction membrane' could be seen. (C) A free VLMS flap was used to cover the wound. (D) The thigh STSG was used to cover the muscle. (E) At the 12-month postoperative follow-up, the flap showed a full and soft appearance. (F) The donor site scar was minor and easily concealed.

membrane formation and increased collagen deposition (CVF: preoperatively: 20.41 ± 5.78%; postoperatively: 41.10 ± 5.20%, $P < 0.0001$), neovascularization (CD31 blood vessels: preoperatively: 6.57 ± 2.44/HPF, postoperatively: 9.71 ± 2.56/HPF, $P < 0.05$), and M2 macrophages fraction (CD206+ cells: preoperatively: 9.43 ± 3.51/HPF, postoperatively:182.14 ± 44.54/HPF, $P < 0.0001$) while reducing M1 macrophages (iNOS+ cells: preoperatively: 24.29 ± 1.89/HPF, postoperatively: 7.14 ± 1.95/HPF, $P < 0.0001$). All grafts survived without amputation during a 7- to 24-month follow-up, during which SF-36 scores significantly improved.

The authors concluded that a combination of ALBC with free VLMS flaps and STSGs proved to be safe and effective for reconstructing non-weight-bearing DFUs. The protocol rapidly controlled infection, enhanced life quality and foot function, and reduced hospitalization time. They advocate integrating this strategy into DFU treatment plans. (ler)

Source: *Chang S, Jian Y, Liu C, et al. Combining antibiotic-loaded bone cement-based free vastus lateralis muscle-sparing flap with split-thickness skin grafts: A reliable strategy for reconstructing diabetic foot ulcers at non-weight-bearing areas. Int Wound J. 2024;21(5):e14900. doi: 10.1111/iwj.14900.*

OBESITY & ARCH DEVELOPMENT IN CHILDREN

In a unique longitudinal study out of China, researchers looked at the development of the arch structure in children in 3 scans (Footscan® plantar pressure system) over 2 years. They looked at gait data from 33 normal weight children and 26 children with persistent obesity.

Children with persistent obesity

- did not exhibit a significant decrease in the arch index during this important period of development

- had significantly higher plantar pressure values than the normal weight children in the third check
- showed increased load accumulation in the lateral rearfoot, first metatarsophalangeal joints, and the great toe regions
- had significantly greater medial-lateral displacements in the initial contact phase and forefoot contact phase than normal children in the first check, these differences diminished between the second and third checks.

The authors concluded that:

- Development of gait stability could not be constrained by persistent obesity.
- Persistent obesity during arch-important development causes abnormal foot arch.
- Persistent obesity causes the gait pattern with heel inverted and forefoot everted.
- Poor gait induced by high loads cannot improve naturally for at least two years. (ler)

Source: *Yang L, Liu X, Liu Y, Zheng W, Wang W, Yan S. Altered gait patterns during arch important development period in children with persistent obesity: An experimental longitudinal study. Gait Posture. 2024;111:143-149. DOI:10.1016/j.gaitpost.2024.04.026*

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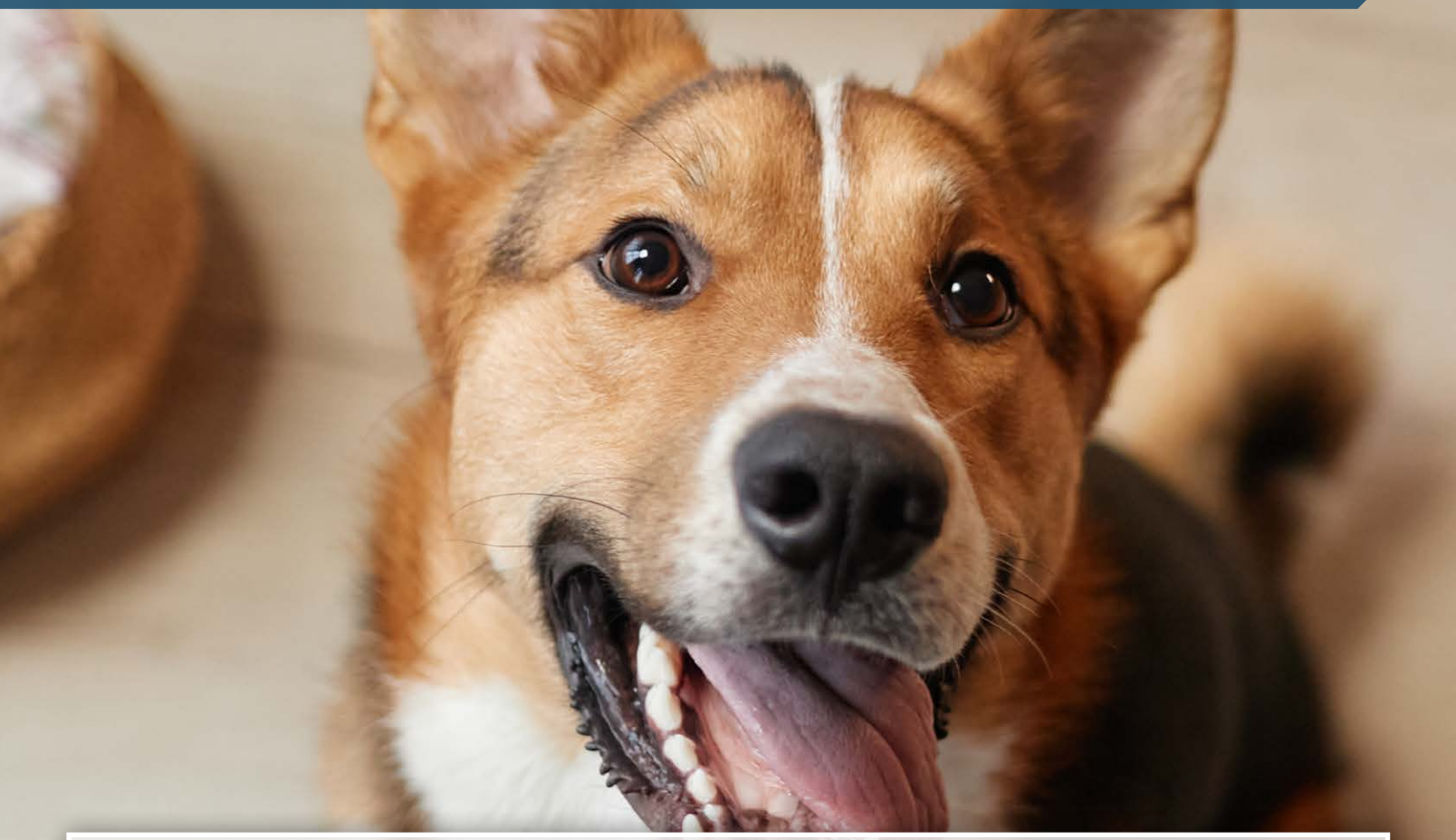
Dog-Related Falls Affecting the Lower Extremity Treated at United States Hospital Emergency Departments

By Mathias B. Forrester, BS



Background: Falls are a leading cause of non-fatal injuries in the United States (US). There are a variety of fall risk factors, among which are pets. Tens of thousands of fall injuries associated with dogs are treated at US hospital emergency departments (EDs) each year. The objective of this study is to describe dog-related falls affecting the lower extremity treated at US hospital EDs.

Methods: Dog-related falls affecting the lower extremity during 2000-2023 were identified using the National Electronic Injury Surveillance System (NEISS), a database of consumer product-related injuries treated at a representative sample of US hospital EDs. Cases reported to the NEISS can be used to calculate national injury estimates. The distribution of dog-related falls affecting the lower extremity was determined for patient demographics, injury circumstances, and management.

Results: Of an estimated 1,381,305 total dog-related falls treated at US hospital EDs during 2000-2023, 283,468 (20.5%) affected the lower extremity. The circumstances of the injuries were 50.5% tripped by or tangled with the dog; 13.8% pulled by the dog; 6.0% knocked down by, pushed by, or collided with the dog; and 29.7% other or unknown circumstances. The patients were 73.6% female, and 24.4% were aged 60 years or older. Strain or sprain was reported in 33.1% of the estimated falls, followed by fracture (28.8%), contusion or abrasion (19.1%), and laceration (5.5%). The patient was treated or evaluated and released in 89.5% of the estimated injuries.

Conclusion: Approximately half of dog-related falls affecting the lower extremity were due to being tripped by or tangled with the dogs. Almost three quarters of the patients were female, and almost one-quarter of patients were aged 60 years or older. The most frequently reported injuries were strain or sprain, fracture, and contusion or abrasion. Most patients were treated or evaluated at the ED and released. The information in this study may be useful for healthcare providers and others to identify those individuals most at risk for dog related falls affecting the lower extremity and creating plans to manage and prevent these injuries.

Table 1. Distribution of dog-related falls treated at United States emergency departments during 2000-2023 by circumstance of injury

Circumstance	Lower extremity injuries		All injuries		%LE/all*
	Estimate	%	Estimate	%	
Tripped by or tangled with the dog	143,157	50.5	660,874	47.8	21.7
Pulled by the dog	39,220	13.8	218,903	15.8	17.9
Knocked down by, pushed by, or collided with the dog	16,878	6.0	117,730	8.5	14.3
Other or unknown	84,212	29.7	383,797	27.8	21.9
Total	**283,468**		**1,381,305**		**20.5**

Estimate = Weighted estimate (sum of the Weight numeric field in the National Electronic Injury Surveillance System database). The numbers in the Weight field are not whole numbers but include decimals. As a result of rounding to whole numbers when performing analyses, the sum of the estimates for a given variable might not equal the total.

*Percent of all injuries that are comprised of lower extremity injuries.

According to the American Veterinary Medical Association (AVMA), by year-end 2016, there were 77 million pet dogs in the United States (US), and 38.4% of US households owned a dog.[1] The 2021-2022 National Pet Owners Survey reported that 69.0 million US households owned a dog.[2]

Falls are a leading cause of non-fatal injuries in the US. There are a variety of fall risk factors, among which are pets. Tens of thousands of fall injuries associated with dogs are treated at US emergency departments (EDs) each year. The most common circumstances for dog-related falls are tripped over, pushed by, or pulled by the dog. The most common injuries in dog-related falls are fractures, contusions or abrasions, strains or sprains, and lacerations. The injury involves the leg or foot in roughly one-quarter of dog-related falls.[3]

The objective of this study is to describe dog-related falls affecting the lower extremity treated at US hospital EDs.

Methods

This descriptive study used data from the National Electronic Injury Surveillance System (NEISS), which is available at https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx. The NEISS database has been described in detail in *Lower Extremity Review* previously.[4] In brief, the NEISS, operated by the US Consumer Product Safety Commission (CPSC), is a database of consumer product-related injuries collected from a representative sample of approximately 100 US hospital EDs. National estimates are calculated from database records according to the sample weight assigned to each case based on the inverse probability of the hospital being selected for the NEISS sample.[5,6] Data are publicly available and de-identified; thus, the study is exempt from institutional review board approval. The previous study that examined dog-related fall injuries used data from a related database (National Electronic Injury Surveillance System – All Injury Program or NEISS-AIP).[3] The NEISS-AIP has been described previously in *Lower Extremity Review*.[7]

Cases were dog-related falls affecting the lower extremity reported to the NEISS database during 2000-2023. The identification of cases was performed in stages. First, to identify as many dog-related injuries as possible, the NEISS database was searched for all records that included the following letter groups in the Narrative field (a text field that provides a brief summary of the circumstances and type of injury):

"dog," or "pup," or "airdale," or "Akita," or "Malamute," or "shep," or "hound," or "beagle," or "terrier," or "collie," or "doodle," or "poodle," or "boxer," or "spaniel," or "mastiff," or "Corso," or "chihuahua," or "corgi," or "dachshund," or "dalmation," or "dober," or "labrador," or "retriever," or "dane," or "Pyrenees," or "husky," or " setter," or "Maltese," or "schnauzer," or "dalmation," or "Pomeranian," or "pug," or "rottw," or "rotw," or "Bernard," or "shar p," or "sharpie," or "shih," or "tzu," or "weim," or "whippet," or "pitbull," or "pit bull"

These letter groups were used because the dog might have been identified solely as a puppy or by breed. The letter groups were

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Table 2. Distribution of dog-related falls affecting the lower extremity treated at United States emergency departments during 2000-2023 by time period and location

Variable	Total*		Tripped		Pulled		Knocked	
	Est.	%	Est.	%	Est.	%	Est.	%
6-year period								
2000-2005	37,216	13.1	20,823	14.5	3,607	9.2	3,388	20.1
2006-2011	58,735	20.7	34,341	24.0	7,268	18.5	3,066	18.2
2012-2017	85,062	30.0	43,880	30.7	11,034	28.1	4,725	28.0
2018-2023	102,455	36.1	44,113	30.8	17,311	44.1	5,699	33.8
3-month period								
January-March	62,730	22.1	31,291	21.9	9,128	23.3	3,547	21.0
April-June	76,033	26.8	40,263	28.1	10,644	27.1	4,724	28.0
July-September	81,794	28.9	40,216	28.1	11,196	28.5	5,055	30.0
October-December	62,911	22.2	31,386	21.9	8,252	21.0	3,552	21.0
Location of injury incident								
Home/mobile home	178,343	62.9	101,519	70.9	14,969	38.2	11,897	70.5
Other public property	17,190	6.1	6,224	4.3	5,291	13.5	598	3.5
Street or highway	14,114	5.0	4,033	2.8	3,750	9.6	848	5.0
Place of recreation or sports	4,723	1.7	1,227	0.9	1,045	2.7	449	2.7
School	204	0.1	67	0.0	64	0.2	0	0.0
Not recorded	68,894	24.3	30,089	21.0	14,101	36.0	3,087	18.3
Total	**283,468**		**143,157**		**39,220**		**16,878**	

*Includes other or unknown circumstance.

Tripped = tripped by or tangled with the dog. Pulled = pulled by the dog. Knocked = knocked down by, pushed by, or collided with the dog.

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

Table 3. Distribution of dog-related falls affecting the lower extremity treated at United States emergency departments during 2000-2023 by patient demographics

Variable	Total*		Tripped		Pulled		Knocked	
	Est.	%	Est.	%	Est.	%	Est.	%
Age (years)								
0-5	5,826	2.1	2,665	1.9	354	0.9	1,423	8.4
6-12	14,222	5.0	5,978	4.2	1,631	4.2	1,371	8.1
13-19	17,790	6.3	8,056	5.6	1,711	4.4	1,649	9.8
20-29	36,798	13.0	18,874	13.2	5,872	15.0	1,649	9.8
30-39	42,830	15.1	21,760	15.2	5,140	13.1	2,334	13.8
40-49	47,148	16.6	24,339	17.0	6,582	16.8	2,408	14.3
50-59	49,579	17.5	26,358	18.4	6,705	17.1	2,188	13.0
60+	69,275	24.4	35,126	24.5	11,226	28.6	3,857	22.9
Sex								
Male	74,710	26.4	33,126	23.1	9,264	23.6	5,796	34.3
Female	208,758	73.6	110,031	76.9	29,956	76.4	11,082	65.7
Total	**283,468**		**143,157**		**39,220**		**16,878**	

*Includes other or unknown mechanism. Please see full footnote on Table 2.

included in the names of some of the more common dog breeds and are not considered to be comprehensive.

Second, to identify as many falls as possible, this subset of records was searched for all records that included the following letter groups in the Narrative field:

"fall," or "fell," or "trip," or "slip," or "knoc," or "nock," or "down," or "push," or "pull," or "foos," or "T'D&F," or "TD&F," or "S'D&F," or "SD&F," or "bump," or "ran into," or "run into," or "stumb," or "jump," or "land," or "crash," or "collid," or "collis"

Third, the Narrative fields of the resulting second subset of records were individually reviewed to determine whether they appeared to represent dog-related falls. If so, the circumstance of the injury was assigned to one of the following categories:

1. Tripped by or tangled with the dog – includes if tripped or tangled by a leash, even if the leash was not attached to a dog
2. Pulled by the dog – includes if pulled by a leash, even if the leash was not attached to a dog
3. Knocked down by, pushed by, or collided with the dog – includes if the dog knocked into or pushed something the person was standing or sitting on or in (e.g., ladder, chair, stroller)
4. Other or unknown

Records were included if the Narrative indicated a trip or slip even if a fall was not explicitly stated. Records also were included if the person fell into or onto something other than the ground (e.g., wall, stairs, furniture). Records were excluded if, aside from a leash, the fall was due to a dog-related item (e.g., dog gate, dog cage, dog toy, dog urine).

Finally, those dog-related falls affecting the lower extremity were identified. The NEISS database contains two numeric fields for coding the affected body part (Body_Part and Body_Part_2) and two numeric fields for coding the type of injury or diagnosis (Diagnosis and Diagnosis_2). The Body_Part_2 and Diagnosis_2 fields were added in 2018, although they do not appear to have been used until 2019.[6] For consistency over the entire study period, the Body_Part and Diagnosis fields alone was examined for the analysis. Only those records where the Body_Part field contained codes for a lower extremity (upper leg, knee, lower leg, ankle, foot, toe) were included in the study.

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Table 4. Distribution of dog-related falls affecting the lower extremity treated at United States emergency departments during 2000-2023 by injury type and disposition

Variable	Total*		Tripped		Pulled		Knocked	
	Est.	%	Est.	%	Est.	%	Est.	%
Body part								
Knee	94,417	33.3	49,547	34.6	15,424	39.3	5,690	33.7
Ankle	83,128	29.3	38,795	27.1	12,237	31.2	3,507	20.8
Foot	36,909	13.0	20,477	14.3	4,157	10.6	1,660	9.8
Lower leg	36,762	13.0	16,644	11.6	4,277	10.9	3,453	20.5
Upper leg	17,443	6.2	8,047	5.6	2,591	6.6	1,785	10.6
Toe	14,810	5.2	9,647	6.7	535	1.4	783	4.6
Most common type of injury (diagnosis)								
Strain or sprain	93,699	33.1	47,691	33.3	12,761	32.5	4,966	29.4
Fracture	81,745	28.8	38,764	27.1	12,092	30.8	4,302	25.5
Contusion or abrasion	54,208	19.1	30,157	21.1	7,933	20.2	3,330	19.7
Laceration	15,589	5.5	7,344	5.1	1,717	4.4	1,188	7.0
Disposition								
Treated or examined and Released	25,3764	89.5	130,516	91.2	34,089	86.9	15,628	92.6
Treated and admitted for hospitalization	24,732	8.7	10,410	7.3	4,597	11.7	717	4.2
Treated and transferred to another hospital	2,444	0.9	946	0.7	250	0.6	444	2.6
Held or admitted for observation	982	0.3	495	0.3	16	0.0	89	0.5
Left without being seen/Left against medical advice	1,545	0.5	790	0.6	269	0.7	0	0.0
Total	**283,468**		**143,157**		**39,220**		**16,878**	

*Includes other or unknown mechanism. Please see full footnote on Table 2.

Table 5. Distribution of dog-related falls affecting the lower extremity treated at United States emergency departments during 2000-2023 by injury type and patient age

Variable	0-5 years		6-19 years		20-59 years		60+ years	
	Est.	%	Est.	%	Est.	%	Est.	%
Most common injury (diagnosis)								
Strain or sprain	758	13.0	13,402	41.9	66,992	38.0	12,547	18.1
Fracture	2,594	44.5	4,002	12.5	45,829	26.0	29,321	42.3
Contusion or abrasion	806	13.8	7,483	23.4	31,114	17.6	14,806	21.4
Laceration	742	12.7	3,587	11.2	8,140	4.6	3,121	4.5
Total	5,826		32,012				69,275	
Body part affected by fracture								
Ankle	228	8.8	969	24.2	14,084	30.7	7,316	25.0
Lower leg	1,579	60.9	1,205	30.1	8,954	19.5	4,477	15.3
Foot	147	5.7	923	23.1	9,884	21.6	3,380	11.5
Upper leg	635	24.5	325	8.1	2,239	4.9	7,784	26.5
Knee	0	0.0	113	2.8	3,951	8.6	5,303	18.1
Toe	5	0.2	467	11.7	6,716	14.7	1,061	3.6
Total	**2,594**		**4,002**		**45,829**		**29,321**	

Please see full footnote on Table 2.

The variables examined were circumstances of the injury, treatment year and month, location where the incident occurred, patient age and sex, type of injury (diagnosis), affected body part, and disposition. Analyses were performed using Microsoft 365 Access and Excel (Microsoft Corporation, Redmond, Washington, US). National injury estimates were calculated by summing the values in the Weight numeric field in the publicly available NEISS database. The distribution of estimated injuries was calculated for each variable for all injuries and for all of the circumstance categories except for other or unknown because it was a heterogenous category. The CPSC considers an estimate unstable and potentially unreliable when the estimate is <1,200.[5]

Results

Of an estimated 1,381,305 total dog-related falls treated at US hospital EDs during 2000-2023, 283,468 (20.5%) affected the lower extremity. Table 1 shows the distribution of injuries by the circumstances of the injury. For both total injuries and lower extremity injuries, the most common circumstance was tripped by or tangled with the dog followed by pulled by the dog, and then knocked down by, pushed by, or collided with the dog. The proportion of total injuries comprised of lower extremity injuries was highest for being tripped by or tangled with the dog and lowest for being knocked down by, pushed by, or collided with the dog.

Table 2 provides the distribution of dog-related falls affecting the lower extremity by time period and location. The estimated number of injuries increased over the 4 6-year periods of the study for total injuries and injuries due to being pulled by the dog. The estimated number of injuries due to being tripped by or tangled with the dog increased during the first 3 6-year periods then remained relatively flat during the fourth 6-year period. The estimated number of injuries due to being knocked down by, pushed by, or collided with the dog declined from the

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first 6-year period to the second 6-year period then increased over the next 2 6-year periods. The estimated number of injuries was highest in April-September and lowest in October-March. For those injuries where the location of the injury incident was recorded, the highest estimated number of injuries occurred at home (or mobile home). This was true for all 3 major circumstances of the injury, although the proportion was lower for injuries due to being pulled by the dog. The proportion of injuries that occurred at other public property or street or highway was higher for injuries due to being pulled by the dog than for injuries due to being tripped by or tangled with the dog or being knocked down by, pushed by, or collided with the dog.

Table 3 presents the distribution of dog-related falls affecting the lower extremity by patient demographics. The estimated number of injuries increased with increasing age, with approximately one-quarter occurring in patients aged 60 years or older. The majority of patients were female. This pattern was observed for total lower extremity injuries and for the 3 major circumstances of the injury.

Table 4 shows the distribution of dog-related falls affecting the lower extremity by injury type and disposition. The highest estimated number of total lower extremity injuries involved the knee followed by the ankle, foot, lower leg, upper leg, and toe. This pattern was also generally found in injuries due to being tripped by or tangled with the dog and being pulled by the dog. However, for those lower extremity injuries due to being knocked down by, pushed by, or collided with the dog, the third most affected body part was the lower leg. The most frequently reported type of injury or diagnosis was strain or sprain followed by fracture, contusion or abrasion, and laceration. This pattern was observed for all 3 major circumstances of the injury. Most patients were treated or evaluated in the ED and released.

When the distribution of dog-related falls affecting the lower extremity was examined by most common injury type and 4 patient age groups (Table 5), patients aged 0-5 years had the highest proportion of total estimated injuries that were fractures. Among the 3 older age groups, the proportion of strains and sprains decreased and the proportion of fractures increased with increasing patient age. When the distribution of fractures alone was examined by the 4 patient age groups (Table 5), aside from patients aged 0-5 years, the proportion of total estimated fractures involving the lower leg decreased, involving the foot decreased, and involving the knee increased with increasing the patient age. Patients aged 60 years or older had the highest proportion of total estimated fractures that involved the upper leg, followed by patients aged 0-5 years.

Discussion

This study found that roughly half of estimated dog-related falls affecting the lower extremity were due to being tripped by or tangled with the dog, with 14% due to being pulled by the dog and 6% being knocked down by, pushed by, or collided with the dog. This pattern is similar to a previous study of dog-related falls, which found that the most common circumstance of the injury was fell or tripped over the dog (31.3%) followed by pushed or pulled by dog (21.2%).[3]

The estimated number of dog-related falls affecting the lower extremity increased over the 24-year period of the study. Other studies have reported increases in dog leash-related injuries, including those affecting the lower extremity, leash-dependent dog walking-related injuries, and fractures in elderly adults while walking leashed dogs.[4,8-10] The increasing trend in these dog-related injuries may partly be due to an increase in the number of pet dogs in the US. According to the AVMA, the rate of households owning dogs in the US increased from 36.1% in 2001 to 38.4% in 2016, and the estimated number of pet dogs increased from 72.1 million in 2006 to 76.8 million in 2016.[1]

Dog-related falls affecting the lower extremity were seasonal. The highest estimated number of injuries was reported in July-September, and the lowest estimated number was reported in January-March. This is similar to a study of dog leash-related injuries that observed 27% of the injuries in June-August and 19% in December-February.[9] The similarity may be due to many dog-related falls resulting from tripping over or tangling with the dog leash or being pulled by a leashed dog. People might be more likely to walk dogs in warmer weather.

The majority of dog-related falls affecting the lower extremity occurred at the patient's home. Of particular note, the proportion of falls that occurred at home was lower and falls that occurred at other public property and street or highway was higher when being pulled by the dog than when being tripped by or tangled with the dog or knocked down by, pushed by, or collided with the dog. Falls due to being pulled by the dog may be more likely to occur when walking a leashed dog than falls due to the other 2 circumstances; injuries while walking a dog may be more likely to occur away from home.

Almost three-fourths of the patients involved in dog-related falls affecting the lower extremity were female. In addition, the estimated number of dog-related falls affecting the lower extremity increased with patient age, with almost one-fourth of patients aged 60 years or older. The prior study of dog- and cat-related falls reported 69% of the patients to be female and 24% aged 65 years or older,[3] and other studies of dog-leash related injuries likewise found most patients to be female and 15-32% aged 60 years or older.[4,8-10] Females and older adults may be at particular risk of dog-related falls. Healthcare providers and others may want to take this into consideration when trying to prevent dog-related falls.

The most common injury type (diagnosis) in dog-related falls affecting the lower extremity was strain or sprain followed by fracture, contusion or abrasion, and laceration. Most such injuries might not be expected to require extensive hospital intervention. This is consistent with the observation that almost 90% of the patients were treated or evaluated and released from the hospital ED.

The pattern of injuries (diagnoses) varied with the patient's age. Patients aged 0-5 years had the highest proportion of total estimated injuries that were fractures. Among older patients, the proportion of strains and sprains decreased and the proportion of fractures increased with increasing patient age. Moreover, the distribu-

tion of fractures by affected body part varied with the patient's age. For patients aged 6 years or older, the proportion of total estimated fractures involving the lower leg decreased, involving the foot decreased, and involving the knee increased with increasing the patient age. Patients aged 60 years or older had the highest proportion of total estimated fractures that involved the upper leg, followed by patients aged 0-5 years. Healthcare providers might want to consider age differences in the pattern of injuries when planning education and prevention strategies for specific age groups.

There are general strategies for preventing dog-related falls. Healthcare providers and other organizations can promote public awareness about the circumstances or situations that can lead to falls, such as walking and chasing dogs. In addition, the public can be informed about the AVMA recommendations for obedience training for dogs to minimize hazardous behaviors such as pulling and pushing.[3]

This study has limitations. The source of the data was NEISS. NEISS primarily collects data on consumer product-related injuries treated at US hospital EDs. Thus, only those dog-related falls affecting the lower extremity considered to be related to consumer products would be included in the study, a subset of all dog-related falls affecting the lower extremity. However, the NEISS data are publicly available and represent all hospitals and all regions of the US. Also, the NEISS database has been used for previous dog-related injury investigations.[4,9-12] Moreover, the general pattern of dog-related falls affecting the lower extremity observed in the present study was similar to the pattern of dog- and cat-related falls found in a study that used data from the NEISS-AIP database, which is not limited to consumer product-related injuries.[3]

As another limitation, dog-related falls involving injuries were identified first by searching the record Narrative field for specific letter groups. If the Narrative field for a record of a dog-related fall injury did not include these letter groups, it would not be included in the study. In addition, the further selection of records to be included in the study and the sorting of them into the various circumstances of injury was performed by a single person and was based on the Narrative field, which contains a limited amount of information that at times was difficult to read and interpret. Errors in the selection and classification of records may have resulted in records being included or excluded erroneously or misclassified. Finally, only those dog-related falls affecting the lower extremity treated at hospital EDs were included in the study. The number of such injuries not seen at EDs is unknown.

In conclusion, the estimated number of dog-related falls affecting the lower extremity and treated at US hospital EDs has increased over the last 24 years. Approximately half of these injuries were due to being tripped by or tangled with the dogs. Almost three quarters of the patients were female, and almost one-quarter of patients were aged 60 years or older. The most frequently reported injuries were strain or sprain, fracture, and contusion or abrasion. Most patients were treated or evaluated at the ED and released. The information in this study may be useful for healthcare providers and others to identify those individuals most at risk for such injuries and creating plans to manage and prevent these injuries. ler

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Bracing Posterior Tibial Tendon Dysfunction Long Term

By Roger Marzano, CPO, CPed

Posterior Tibial Tendon Dysfunction (PTTD) is a pervasive condition impacting the foot and ankle, representing a significant challenge in long-term management for both the patient and the healthcare team. This dysfunction occurs when the posterior tibial tendon, a vital structural support for the arch that enables efficient foot function, becomes injured or degraded, either through trauma, the wear-and-tear of aging, or misaligned biomechanics. Chronic PTTD manifests as a persistently recurring issue, leading to progressive flatfoot deformity.

Bracing has evolved significantly as a viable treatment option for managing PTTD, particularly in stages II and beyond, where conservative measures have failed. Initially perceived as a last resort before considering surgical intervention, the adoption and innovation in ankle-foot orthoses (AFOs) have propelled bracing to the forefront of non-operative management for PTTD. Historical perspectives show that early interventions were primarily focused on symptomatic relief, whereas now, the goal extends to correcting foot deformity, improving functionality, and averting progression. Advances in materials, design, and customization of AFOs have greatly enhanced bracing efficacy, making it a cornerstone in long-term PTTD management.

The journey to manage and alleviate symptoms of chronic PTTD is a complex one, especially as patients often see multiple providers who offer various orthotic prescriptions, not all of which are accurately prescribed or adhered to by patients. Long-term management strategies, such as bracing, play a pivotal role in offering relief and enhancing the quality of life for patients. PTTD is one part of the Progressive Collapsing Foot Deformity (PCFD), which also includes:

- Adult Acquired Flatfoot Deformity (AAFD)
- Adult Flexible Flatfoot Deformity (AFFD)
- Posterior Tibial Tendon Rupture (PTR)
- Peritalar Subluxation (PTS)
- Progressive Talipes Equinovalgus (PTEV)

PTTD is characterized by the degradation of the posterior tibial tendon, which plays a critical role in supporting the arch of the foot. As the condition progresses, it can lead to a persistently flatfoot posture, resulting in pain, discomfort, and diminished mobility. Generally managed conservatively in its early stages, PTTD often progresses beyond the efficacy of initial treatments such as physical therapy or off-the-shelf orthotics. The transition to considering bracing options is a critical juncture in the management of chronic PTTD, and typically occurs after 12-18 months of unresolved pain for the patient.

Is Bracing Successful in Managing Chronic PTTD

Bracing, specifically using custom AFOs, has emerged as a cornerstone in the long-term management of PTTD. Research on the efficacy of various AFO designs has shown promising results, with significant percentages of patients reporting relief and improved function across multiple studies with various devices.

That evidence includes:

- Alvarez et al[1] reported that 89% of patients responded well to the rehabilitation program which required the ability to perform 50 heel raises with minimal or no pain, and to toe walk 100 feet and conversion from an AFO to foot orthoses. 83% of the patients successfully reached these goals and another 6% reported being satisfied with their treatments and continued to wear their AFO's for pain control or personal choice even with minimal or no pain.
- In a retrospective cohort study that focused on nonoperative measures, including posterior shell bracing, physical therapy, and anti-inflammatory medications used to treat adult acquired flatfoot in 64 patients, Nielsen et al[2] found that 87.5% had successful nonsurgical treatment over the 27-month observation period.
- In a retrospective study by Lin et al[3] with 7-10 year follow-up, patients were first treated for 6 weeks in a walking cast, then transitioned to a double upright AFO with medial t-strap and rocker bottom shoes. The AFO was used until the patient's symptoms were resolved (average 14.9 months). At an average of 8.6 year follow-up, 69.7% of patients were orthosis free, had avoided surgery, and reported quality of life scores that were similar to national norms. An additional 15.2% of the patients had

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symptom improvement and avoided surgery but continued to wear the orthosis full or part-time.

- Augustin et al[4] looked at patients with PTTD (stages 1-111) who used an Arizona brace (AFO) and found 90% of patients had a statistically significant improvement in symptoms and quality of life after an average of 1 year follow up. A considerable percentage of patients (28.5%) had bilateral involvement and all of them saw improvement.
- In a study out of the United Kingdon, Jari et al[5] reviewed their institution's standard treatment using bracing and found that 82% were satisfied with nonsurgical results (average age 60 years, average follow up 2 years) and did not wish to consider surgery.

While many of these patients have significant co-morbidities which increase the risk of surgical management, this research shows that more than 60% of patients will avoid surgery with conservative therapy. Furthermore, there is no evidence that conservative treatment allows progression of their deformity. And rehabilitation—namely physical therapy—has been shown to improve outcomes in conservative management.

Clinical Insights into Bracing Solutions

Bracing for PTTD is nuanced. It's not merely about prescribing an AFO; it's about timing and customizing the bracing approach to address the specific mechanics and symptoms presented by each patient. Innovations such as medial forefoot posting within AFOs have been particularly effective in managing the biomechanical challenges posed by PTTD. Moreover, embracing a dynamic bracing strategy that evolves with the patient's symptoms and progress underscores the importance of personalized care in managing this condition over the long term.

Types of AFOs Used in PTTD

Ankle Foot Orthoses come in various designs, each tailored to address specific needs in PTTD management. Notable types include:

- Hinged AFOs: These allow controlled ankle movement enabling joint mobility while offering support. They are particularly useful in intermediate stages of PTTD where motion preservation is desirable.
- Solid AFOs: For advanced cases, solid AFOs restrict ankle movement, providing maximum support to stabilize the foot and reduce pain effectively.
- Gauntlet AFOs: These encase the foot and ankle, offering comprehensive support. They are adaptable to various stages of PTTD, focusing on alignment correction and pain alleviation.
- Custom-fitted AFOs: Tailored to the patient's foot, custom AFOs ensure better fit, comfort, and effectiveness, making them a preferred choice for long-term management.

Customizing Bracing for Individual Needs

The individualization of bracing solutions plays a pivotal role in managing PTTD effectively. Different types of AFOs (articulated, gauntlet-style, posterior shell brace) have been employed to match the unique needs of each case, with significant emphasis on adjusting for comorbidities and proximal joint issues. For example, adjusting or completely locking the ankle joint in cases where lateral pain due to dorsiflexion moment has already manifested. Another adaptation involves using medial forefoot posting on AFOs and foot orthotics to address forefoot to hindfoot misalignment, illustrating how specific adjustments can enhance the effectiveness of the bracing solution.

Early Intervention and Proper Device Selection

The success of bracing in managing PTTD underscores the importance of early intervention and the selection of the correct bracing device. Implementing bracing as a treatment option during the earlier stages of PTTD, even when symptoms might still respond to less aggressive treatments, can prevent the progression of the condition. Proper device selection, customized to the individual's specific condition and lifestyle needs, significantly contributes to achieving positive outcomes, demonstrating the necessity of a tailored approach to treatment.

***To learn more** about how to customize your approach to PTTD management with bracing and hear 3 case studies, see Roger Marzano's full lecture, "Bracing PTTD Long Term, Have We Been Successful?," from the 38th Annual No-Nonsense Seminar, available at https://nononsense2024.lerexpo.com/.*

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Benefits of Buerger-Allen Exercises for People with Diabetes: A Mini-Review

By Ahmad Mahdi Ahmad, Akram Abdel-Aziz, Walaa Anwar Mohamed Khalifa, and Alaa Abulfotouh Mohammed

People with diabetes suffer from serious micro and macrovascular complications of the disease with negative effects on blood flow and lower extremity sensation. Drug therapy alone might be insufficient to prevent or treat these health problems, and patients may need complementary therapy. Exercise therapy is an essential part of the treatment plan for diabetes mellitus and can complement drug treatment. Buerger-Allen exercises have recently become an evidence-based form of exercise to improve peripheral blood flow in people with diabetes. This short report briefly reports the clinical benefits of Buerger-Allen exercises.

Patients with diabetes mellitus, particularly those with poor glycemic control, often have impaired blood flow in the lower extremities and an increased risk of foot ulcers, gangrene, or amputations. Buerger-Allen exercises can improve peripheral blood flow in patients with diabetes mellitus.[1] The Buerger-Allen exercises was first described by Leo Buerger in 1926 and later modified by Arthur Allen in 1930.[2]

Buerger-Allen exercises are active postural exercises in which gravity alternately deflates and fills blood vessels to increase blood flow to the lower limbs.[3] The Buerger-Allen exercises includes several stages as follows: (a) The patient lies supine with the leg raised 45 degrees and 60 degrees using a pillow and performs ankle motion for 3 minutes or until the feet become pale; (b) Then, the patient sits on the edge of the bed with his/her feet dangling over and performs dorsiflexion and plantar flexion and moves legs in and out for 3 minutes; (c) Finally, the patient lies supine, covered with a blanket, for 3 minutes.[4] The entire cycle can be repeated 3 to 6 times per session and each session can be repeated 3 times per day.[4] Impaired blood flow in the lower extremities can be identified by measuring the ankle-brachial index (ABI), a standard non-invasive method of assessing blood flow to the lower extremities, which is the ratio of the higher of the two systolic blood pressures of either dorsalis pedis artery or posterior tibial artery, and the higher of the two systolic blood pressure values of the upper extremities.[5] A circulatory disorder can be identified with an ABI value below 0.90 and a severe circulatory disorder can be identified with an ABI value below 0.4.[5] However, in patients with diabetes and those on dialysis, the ABI may be an invalid method due to the presence of arterial calcification, and in such case, the toe-arm index should be used instead.

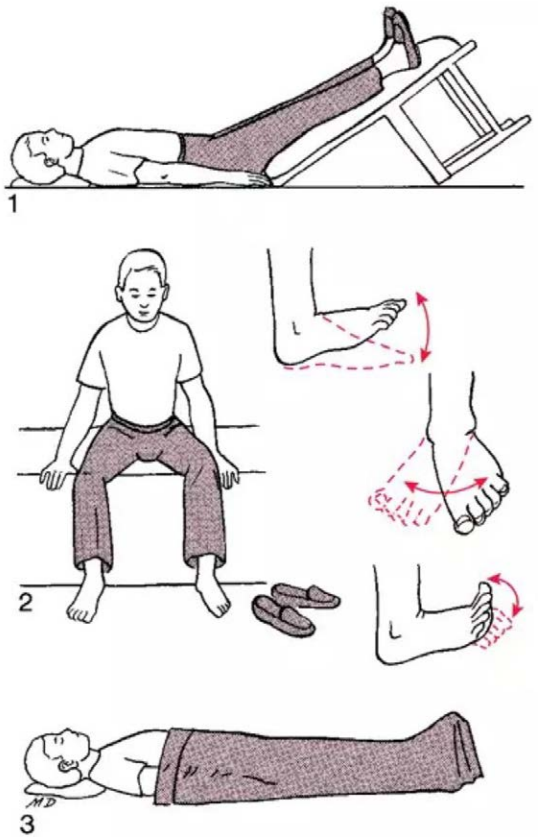

Image from Black and Matassarin-Jacobs, 1997.

Buerger-Allen Exercises

1. In the first step, the lower extremities were elevated to a 45-90 degree angle and supported in the same position for 5 minutes until the skin became pale.

2. In the second step, the patients were made to sit in a relaxed position with their feet and legs rested below the level of the remaining parts of their body and performed individual foot flexion/extension and then pronation/supination for 5 minutes until redness appeared.

3. The third step was horizontal positioning, and the patient was asked to lie down quietly for 5 minutes with both their legs rested on the bed .

Discussion

The clinical benefits of Buerger-Allen exercises can be listed as follows:

(a) a reduction in the risk of neuropathy in people with diabetes;[6]

(b) a reduction in symptoms of peripheral neuropathy in patients with diabetes;[7]

(c) an increased ABI in people with diabetes;[8]

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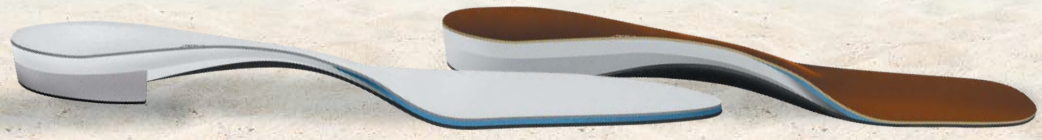

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(d) a reduction in capillary filling time in the lower extremities of people with diabetes;[9]

(e) improvements in peripheral pulse, temperature and skin color in patients with type 2 diabetes;[9]

(f) an increase in peripheral blood flow in patients with diabetic foot ulceration as evidenced by increased skin perfusion pressure;[10]

(g) an improvement in wound status in people with diabetic foot ulcers;[11] and

(h) elevated peripheral oxyhemoglobin, required for proper healing in patients with diabetic foot ulcers.[12]

The mechanism of Buerger-Allen exercises involves the use of gravity to alternately empty and fill the columns of blood through the blood vessels of the lower extremity.[2] Benefits of Buerger-Allen exercises can include ease of use and learnability, safety, no cost, suitability for home care programs, less physical stress, and time efficiency.

Conclusion

Buerger-Allen exercises have numerous advantages and benefits and may be of clinical importance for people with diabetes who have impaired blood flow to the lower extremities and/or peripheral neuropathy. Clinicians and other health care professionals who deal with people with diabetes may consider implementing Buerger-Allen exercises into the treatment plan for diabetes mellitus. ler

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Buerger-Allen exercises can improve peripheral blood flow in patients with diabetes mellitus.

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Assessment of Weight Bearing and Non-weight Bearing Dorsiflexion ROM in Foot, Ankle Injuries

By Yuta Koshino, Tomoya Takabayashi, Hiroshi Akuzawa, Takeshi Mizota, Shun Numasawa, Takumi Kobayashi, Shintarou Kudo, Yoshiki Hikita, Naoki Akiyoshi, and Mutsuaki Edama

It is necessary to identify measurement methods that can detect greater ankle dorsiflexion range of motion limitation in patients with foot and ankle injuries.

In clinical practice, ankle dorsiflexion range of motion (DROM) is commonly assessed in patients with foot and ankle injuries (eg, fractures, ligament, and tendon injuries). To date, DROM has been assessed using a variety of methods, including knee extension, knee flexion, weight bearing (WB), and non-weight bearing (NWB) positions. For example, DROM limitation during knee extension can be attributed primarily to the gastrocnemius muscle. If the limiting factor is something other than the gastrocnemius muscle, measurements in knee extended position may not adequately detect the limitation to DROM. In addition, DROM limitations may be more evident in the WB than in the NWB position, because DROM is significantly greater in the WB than in the NWB position. In the WB position compared to the NWB position, greater ankle moment and a greater contribution of foot motion are thought to lead to greater DROM. However, for patients with foot and ankle injuries, it remains unclear which assessment methods are more likely to detect dorsiflexion limitation. If DROM is not assessed with appropriate measurement methods, it could lead to underestimating or overlooking DROM limitations, which in turn will lead to inappropriate treatment programs.

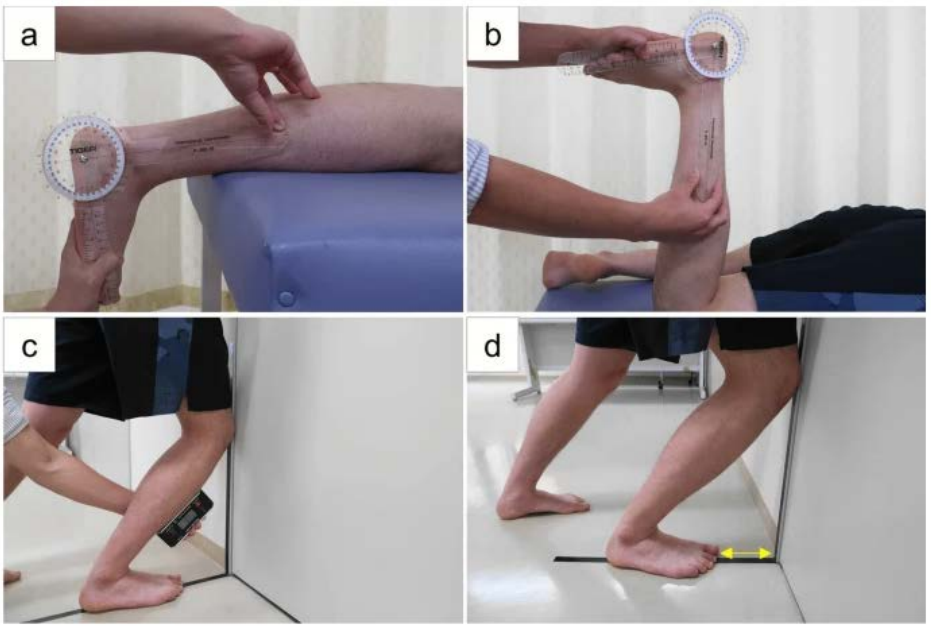

Figure 1: Four measurements of DROM. (A) NWB with knee extended; (B) NWB with knee flexed 90 degrees; (C) WB angle measurement; and (D) WB distance measurement.

Toward this end, this study aimed to: (1) identify assessment methods that can detect greater ankle DROM limitation in the injured limb; (2) determine whether differences in WB measurements exist even in the absence of DROM limitations in the injured limb according to NWB measurements; and (3) examine associations between DROM in the WB and NWB positions and compare those between a patient group with foot and ankle injuries and a healthy group.

Methods

Eighty-two patients with foot and ankle injuries (eg, fractures, ligament, and tendon injuries) and 49 healthy individuals participated in this study. Height, weight, and sex ratio did not differ significantly among the groups, while age was significantly higher patient group (mean, 45.5 years) than in the healthy group (mean, 26.3 years). NWB DROM was measured under 2 different conditions: prone with knee extended and prone with knee flexed 90 degrees. WB DROM was measured as the tibia inclination angle (weight bearing angle) and distance between the big toe and wall (WB distance) at maximum dorsiflexion—the lunge test. (Figure 1.) The effects of side (injured, uninjured) and

This article has been excerpted from "Differences and relationships between weightbearing and non-weightbearing dorsiflexion range of motion in foot and ankle injuries." J Orthop Surg Res 19, 115 (2024). https://doi.org/10.1186/s13018-024-04599-x. Editing has occurred, including the renumbering or removal of tables, and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

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DROM limitations due to foot and ankle injuries may be overlooked if measurements are only taken in the NWB position and should also be measured in the WB position. Furthermore, DROM measurements in NWB and WB positions may assess different characteristics, particularly in the patient group.

measurement method on DROM in the patient groups were assessed using 2-way repeated-measures ANOVA and t-tests. Pearson correlations between measurements were assessed. In addition, the study authors analyzed whether patients without NWB DROM limitation (≤3 degrees) showed limitations in WB DROM using t-tests with Bonferroni correction.

Results

For the patient group, significant main effects of measurement method ($P < 0.001$), side ($P < 0.001$), and interaction ($P < 0.001$) were found for dorsiflexion angle. For the between-side differences, post hoc analysis revealed that dorsiflexion angles differed significantly between injured and uninjured sides in NWB with knee extension, NWB with knee flexion, and WB angle ($P < 0.001$). For differences between measurement methods, dorsiflexion angles were significantly greater for NWB with knee extension, NWB with knee flexion, and WB angle, in ascending order ($P < 0.001$). For WB distance, distances between the injured and uninjured sides also differed significantly ($P < 0.001$). The effect size of differences in DROM measurements between injured and uninjured sides in each measurement method was largest for WB angle (d = 0.95).

In the patient group, 48 patients showed no DROM limitations in NWB with knee extension. These patients showed significant differences in DROM measurements between the injured and uninjured sides for all NWB with knee flexion, WB angle, and WB distance ($P < 0.001$). Effect sizes of the difference were large for WB angle and WB distance (d = 1.06 and 1.02). In NWB with knee flexion, 37 patients showed no dorsiflexion limitation. These patients showed significant differences in DROM measurements between injured and uninjured sides in WB angle and WB distance, and the effect sizes of these differences were large ($P < 0.001$, d = 0.98 and 0.97.)

In the patient group, NWB with knee extension showed no correlation with WB angle (R = 0.17, $P = 0.123$) and a significant but weak correlation with WB distance (R = 0.26). NWB with knee flexion correlated moderately with both WB angle and WB distance in the patient group (R = 0.45 and 0.49). The Healthy group showed moderate to strong correlations (R = 0.51–0.69). In the comparison of correlation coefficients, the correlation of dorsiflexion angles in NWB with knee extension and WB angle was significantly smaller in the patient group than in the healthy group ($P = 0.013$.)

Discussion

The main findings of this study were: (1) differences in DROM between injured and uninjured sides were significant for all measures, and the effect size was greater in the WB position in the patient group; (2) even in patients with no difference in DROM between injured and uninjured sides in the NWB position, the difference was significant and large in the WB position; and (3) correlations between measurements in the NWB and WB positions tended to be weak in the patient group compared to the healthy group.

The results of each measurement method suggest that a large difference in DROM between the legs can be detected in NWB with knee flexion, WB angle, and WB distance in the patient group. In the patient group, the difference between legs was increased by knee flexion in the NWB position, suggesting that factors other than the gastrocnemius muscle may be

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more involved in DROM limitations. In addition, in the WB position, greater torque is applied to the ankle, and the effects of other joint motions (eg, subtalar and midtarsal joints) and muscle activity due to loading may contribute to greater limitations on DROM. Measurement in the WB position would be recommended because DROM limitations may be overlooked when measurements are obtained only in the NWB position.

Even among patients with no DROM limitations in the NWB position, limitations were observed in the WB position. This finding suggests that assessing DROM only in the NWB position is inadequate and that assessment of DROM in the WB position is necessary. This finding also suggests that DROM limitations may have improved in the NWB position, but not yet in the WB position. Intervention programs following foot and ankle injuries would need to be designed while keeping in mind the possibility of residual DROM limitations in the WB position.

The correlation between measurements in the NWB and WB positions tended to be weak in the patient group, unlike in the healthy group. The correlation coefficient between NWB with knee extension and WB position was particularly weak, and that in the patient group was significantly smaller than that in the healthy group. Correlations for the healthy group were moderate to strong (R = 0.60–0.67), suggesting that DROM in the NWB and WB positions assesses different phenomena. The study authors' findings suggest that foot and ankle injuries further confound the association between DROM in the NWB and WB positions. This may be because injuries result in different factors limiting dorsiflexion than those seen in healthy individuals. The results suggest that DROM assessment differs between NWB and WB positions, particularly in those with foot and ankle injury.

Regarding clinical relevance, DROM should be measured in NWB and WB positions in patients with foot and ankle injuries, because these measurements do not correlate and may assess different DROM limiting factors. It should also be noted that measuring only at the NWB position is not sufficient. This is because even if the DROM is not restricted in the NWB position, it may be restricted in the WB position. In addition, clinicians may need to intervene to account for the possibility of more residual DROM limitations in the WB position in patients with foot and ankle injuries.

Conclusions

DROM limitations due to foot and ankle injuries may be overlooked if measurements are only taken in the NWB position and should also be measured in the WB position. Furthermore, DROM measurements in NWB and WB positions may assess different characteristics, particularly in the patient group. ler

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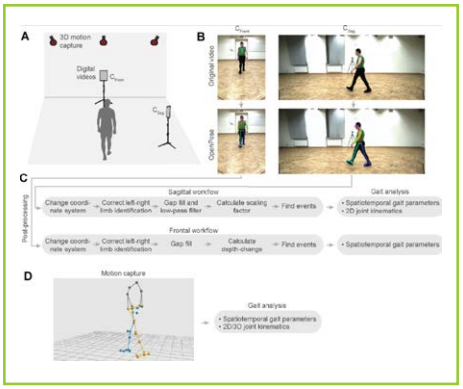
CELL PHONE VIDEO TECHNOLOGY UNVEILS NEW METHOD FOR GAIT, WALKING ANALYSIS



(A) 3D motion capture and digital videos of gait trials were performed by persons post-stroke and persons with PD. (B) Digital videos of the frontal (CFront) and sagittal (CSag) planes with OpenPose were analyzed to track anatomical key points. (C) Workflows were developed to perform a gait analysis, independently, for videos of the CFront and CSag planes. (D) Spatiotemporal gait parameters and joint kinematics from the workflows were compared to parameters obtained with 3D motion capture.

Researchers at Kennedy Krieger Institute and Johns Hopkins University (JHU) School of Medicine have developed a new, accessible approach to analyze a patient's walking ability and stances more effectively. Following numerous tests, they determined that a simple video recorded on a a smartphone or tablet can be used to measure gait at a clinical, high-quality level.

"Patients that have gait problems resulting from diverse conditions such as Parkinson's disease (PD), cerebral palsy, lower extremity injury or amputation, recovery from a stroke, and more, could benefit from this," said Ryan Roemmich, PhD, a research scientist at Kennedy Krieger and an assistant professor of physical medicine and rehabilitation at the JHU School of Medicine.

Clinicians use cutting-edge software in the assessment to record a cellphone video that captures the patient's walking pattern from any 1 of multiple perspectives. The videos could be recorded as the patient walks toward the camera, away from the camera, or from a profile angle depending on the condition being treated. The researchers use algorithms and their software to analyze the recorded data, marking the movement of patients' knees and ankles and step length. Their approach is also based on tracking the size of the person as they appear in the video image. Patients were observed walking on the ground and treadmill.

With the ability to record these videos anywhere, they are not limited to testing in a physician's office. However, clinicians will first need to be trained in how to effectively use this technology to produce the best results. But eventually, the researchers want patients to be capable to shoot the videos at home themselves.

Code for the workflow can be accessed at https://github.com/janstenum/GaitAnalysis-PoseEstimation/tree/Multiple-Perspectives.

NORTHWEST PODIATRIC LABORATORY CELEBRATES 60TH ANNIVERSARY

Northwest Podiatric Laboratory (NWPL), Blaine, Washington, announced that it is celebrating 60 years of providing quality and

service to its valued healthcare providers, and helping patients by crafting custom and over-the-counter foot orthotics. From its humble beginnings operating out of a basement in Lynden, Washington, NWPL has grown to become a trusted name in the industry. Today, with over 45 employees using the latest innovation and technology, the company remains steadfast and continues to provide patients with the best possible products to help alleviate their pain.

The company also gave a shout out to its late founder Dennis Brown and former Vice President, Chris Smith, DPM, for their ingenuity and biomechanics excellence.

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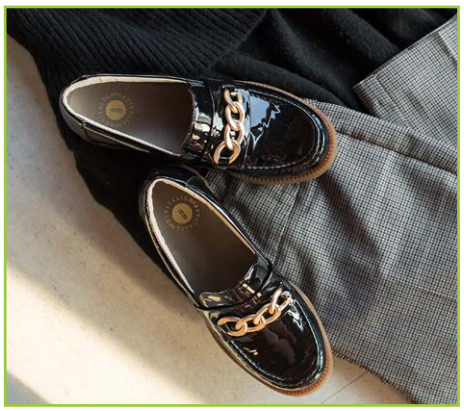

Waco Shoe Company has launched 2 new Revitalign® shoe designs: the Laurel Loafer and Carefree casual shoe. These additions meticulously blend cutting-edge orthotic support with the latest trends in fashion. Engineered for everyday wear without compromising on aesthetic appeal, both the Laurel Loafer and the Carefree casual shoe are fitted with the brand's proprietary Full Contact Comfort® insoles. The women's loafer pairs a bold gold chain accent and all-weather lugged outsole with colors in black patent, almond, and pink leather. The Carefree, which comes in both men's and women's sizes in multiple colors, features a slip-on style, high-textured textile canvas and a cork-covered memory foam footbed. Each product includes an innovative sole design with orthotic arch support and cushioned forefoot.

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HANGER INSTITUTE PUBLISHES 2023/24 ANNUAL REPORT

The Hanger Institute for Clinical Research and Education recently published its 2023/24 Annual Report. Focused on the Institute's mission of advancing clinical practice through leading-edge research in the orthotics and prosthetics (O&P) field, the report reflects the efforts made to improve clinical outcomes and provide evidence-based care. The report highlights a broad range of work, from analyses of real-world clinical outcomes data such as the Orthotic Research Initiative for Outcomes aNalysis (ORION) series that is aimed at advancing clinical practice and improving outcomes for patients seeking orthotic intervention and the Stability and Falls Evaluation after AMPutation (SAFE-AMP) series of studies that will examine the need for greater access to appropriate rehabilitation solutions for transtibial and transfemoral amputees in the diabetes community, to translating knowledge to the broader rehabilitation community.

To read the report, visit https://hanger-clinic.com/wp-content/uploads/2023-hanger-institute-annual-report.pdf.

INTERACTIVE THERAPY SOLUTION FOR OUTPATIENT CLINICS, HOME HEALTH

LudoFit PRO is an interactive therapy exercise solution designed for clinicians working with patients in clinic and home settings. It can be downloaded onto Windows computers, Mac

computers, or iPads, and no special equipment is needed. The app uses the device's web camera to capture the patient's movements and relay them to the avatar on the screen. For example, while the patient is doing squats and weight shifts, their character is skiing the Italian alps. The exercises are derived from evidence-based fall prevention protocols. The professional interface empowers clinicians to customize the program for each patient's needs. Patients can engage in the games during therapy sessions or on their own.

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SHOE TECHNOLOGY REDUCES RISK OF DFUS

UTARI's Veysel Erel, PhD, and Aida Nasirian show their diabetic shoe technology. Image courtesy of UT Arlington.

Researchers at the University of Texas at Arlington Research Institute (UTARI) have developed a new shoe insole technology that helps reduce the risk of diabetic foot ulcers (DFUs).

"The goal of this innovative insole technology is to mitigate the risk of diabetic foot ulcers by addressing one of their most significant causes: skin and soft tissue breakdown due to repetitive stress on the foot during walking," said Muthu B.J. Wijesundara, PhD, principal research scientist at UTARI.

"Although many shoe insoles have been created over the years to try to alleviate the problem of foot ulcers, studies have shown that their success in preventing them is marginal," he said. "We took the research a step further by creating a pressure-alternating shoe insole that works by cyclically relieving pressure from different areas of the foot, thereby providing periods of rest to the soft tissues and improving blood flow. This approach aims to maintain the health of the skin and tissues, thereby reducing the risk of diabetic foot ulcers."

With the pilot project having been successfully completed, the next step for the research team will be refining the technology to make it more accessible for users with varying weights and shoe sizes.

RED LIGHT THERAPY

Lumaflex Essential is a Class II US Food & Drug Administration–cleared red light therapy device designed for speedy 10-minute treatments. This portable, flexible device is not just for competitive athletes or fitness enthusiasts. Rather, it can help a wide range of people who are experiencing chronic pain or other conditions that could benefit from the healing powers of red and infrared light. Clinical studies have shown that red light therapy can be an effective treatment for numerous conditions, including inflammation, chronic pain, and muscle and joint pain. Key features include: targeted red-light wavelengths for maximum effect; non-invasive natural healing; and a lightweight yet durable design.

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SWISS PROSTHETIC LEG HELPS AMPUTEES TO FEEL THE FLOOR

Swiss researchers have developed a special prosthesis that enables amputees to feel the ground better when walking. This is thanks to a new method that allows sensors in the sole of the prosthesis to communicate more naturally with the brain. "The prosthesis feels more like a part of the body," Stanisa Raspopovic, PhD, from ETH Zurich told the Keystone-SDA news agency.

ETH researchers have developed a prosthetic leg that communicates with the brain via natural signals. Image courtesy of Keystone.

The 3 patients on whom the new signal transmission was tested were able to move faster and more safely. "Greater mobility is ultimately also good for health," said Raspopovic. According to the researcher, the test subjects were also able to concentrate on other things while walking. For example, they made fewer mistakes when trying to spell words backward while climbing stairs.

Prostheses that are connected to the nervous system have been around for several years. However, according to Raspopovic, these lead to unpleasant sensations in patients, such as an annoying tingling sensation on the skin due to the signals being transmitted via constant electrical pulsations. This is where Raspopovic's research team came in. The researchers relied on biomimetic stimulation—signals that were modelled on nature. "We have learnt the language of the nervous system, so to speak," explained Raspopovic.

To this end, PhD student Natalija Katic developed a computer model called FootSim, stated a ETH Zurich press release. It is based on data that records the activity of special sensory cells in the sole of the foot. The computer model shows exactly how the sensory cells in the soles of the feet behave during walking or running.

To test how well the model simulates the signals from the sole of the foot, the researchers first implanted electrodes in the leg nerve and spinal cord of cats. When they applied pressure to the cat's paw from below to generate the natural nerve activity during a cat's step, the activity patterns recorded in the spinal cord actually resembled the patterns that occurred in the spinal cord after the researchers had stimulated the nerve in the leg with biomimetic signals. In contrast, the conventional rigid stimulation produced a significantly different pattern in the spinal cord of the cats. According to Raspopovic, this shows that biomimetic stimulation is superior to conventional stimulation.

SURGICAL NAVIGATION SYSTEM FOR TAA

The ExactechGPS® Ankle is the world's first surgical navigation system for total ankle arthroplasty (TAA). GPS Ankle is a first-of-its-kind technology, which connects the preoperative plan with real-time intraoperative instrument guidance and confirms that resections meet the surgical plan. The system uses proprietary active tracker technology and a compact touchscreen tablet in the sterile field to provide surgeons with dynamic intraoperative feedback throughout their cases. GPS Ankle is compatible with Exactech's flagship Vantage® Total Ankle System. Pre-clinical studies, based on bench testing, reported an accuracy of 2mm and 2 degrees relative to the CT-based surgical plan. GPS Ankle is only available in the United State and will enter pilot launch with limited availability in 2024.

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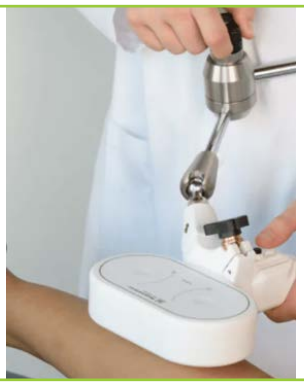
NONINVASIVE MAGNETIC PERIPHERAL NERVE STIMULATION FOR PDN



Neuralace Medical's Axon Therapy mPNS, for the treatment of chronic painful diabetic neuropathy (PDN), is the first US Food & Drug Administration–cleared non-invasive, magnetic peripheral nerve stimulation (mPNS) treatment for PDN. The device utilizes a pioneering approach of mPNS to deliver a quick, painless, and non-invasive treatment, while enhancing quality of life for patients. Each session, lasting just 13.5 minutes, harnesses the power of magnetic pulses to provide relief, representing a significant advancement in pain management. In a recent double-blind multi-center randomized controlled trial involving 71 patients, Axon Therapy demonstrated remarkable efficacy.

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WEARABLE BIOSENSOR MAY ENHANCE ATHLETIC PERFORMANCE, PREVENT INJURIES

Researchers at The University of Alabama in Huntsville (UAH) have designed a wearable biosensor that offers a new way to measure human muscle activation to potentially prevent injuries and enhance athletic performance. The breakthrough design is built around a new type of triboelectric nanogenerator (TENG), a device that converts mechanical or thermal energy into electricity for use in wearable electronics, that will cost less to manufacture than traditional nanotechnology. UAH's new sensor uses adhesive materials to harvest power by transferring an electric charge between 2 objects when they contact or slide against 1 another.

This biosensor design consists of Scotch tape and a metalized polyester sheet. "When it is pressed and released, we are able to detect human motions involving the elbow, knee, finger, eye, and jaw," said Gang Wang, PhD, an associate professor in the College of Engineering. "The design is an advance because it is self-powering, light weight, low cost, and disposable." Further, the UAH biosensor only involves commercial off-the-shelf materials and a simple fabrication scheme compared to those used in TENG-based sensors, and an external power source to function is not required.

Moonhyung Jang, PhD, left, operates TENG generator to light an LED display as Wang looks on in the Adaptive Structures Laboratory. Image courtesy of Michael Mercier with UAH.

The size of conventional devices also tends to be quite large when compared to the UAH device, and human skin must serve as another triboelectric layer, meaning the sensing performance could degrade with perspiration or other changes in skin condition. UAH's device using 'tacky' materials simplifies the design and provides a more comfortable user experience and can detect motion involving both gross and fine motor movements. Skin contraction and relaxation during body motion activate the contact and separation between the polypropylene and acrylic adhesive layers. Demonstrations have been conducted to detect various body motions, including elbow flexion, forearm protonation/supination, knee flexion/extension, and more.

The Key Role of Nutritional Elements on Sport Rehabilitation

Reference : Papadopoulou et al. Sports 2022

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- Increased muscle growth & strength after immobility & during rehab
- Protective effect on muscle oxidative damage

MINERALS

(Manganese, copper, zinc, iron, selenium)

- Antioxidant function
- Repair of oxidative damage

ANTI-INFLAMMATORY SUPPLEMENTS

Images provided by Presenter Media

- Anti-inflammatory and anti-oxidant functions regarding muscle damage and post-operative pain and fatigue
- Curcumin improves arthritis outcomes

Source: Papadopoulou SK, Mantzorou M, Kondyli-Sarika F, et al. The Key Role of Nutritional Elements on Sport Rehabilitation and the Effects of Nutrients Intake. Sports (Basel). 2022;10(6):84. doi: 10.3390/sports10060084.

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