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LOWER EXTREMITY REVIEW

October/November 23 / volume 15 / number 10

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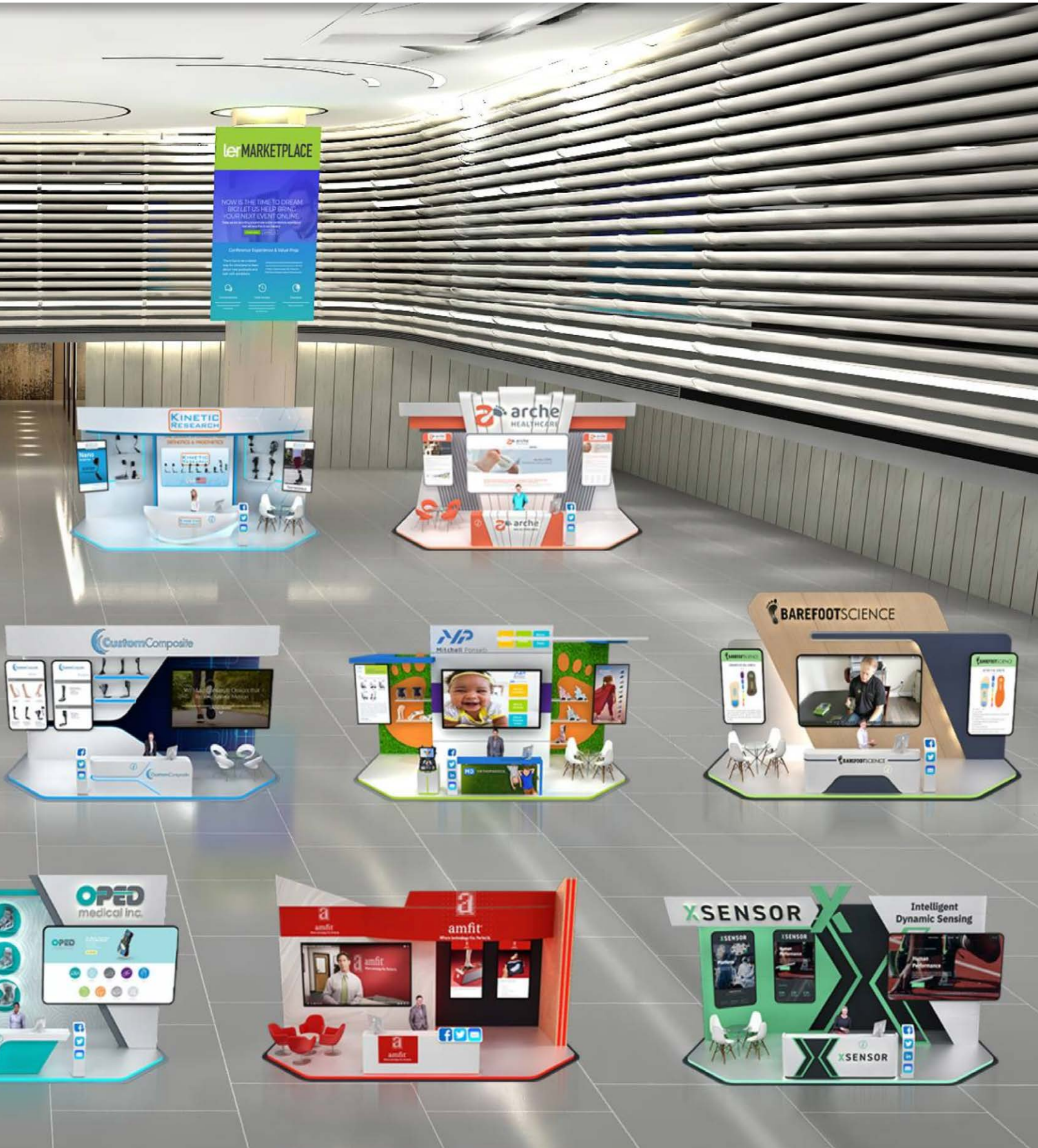

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Lower Extremity Review

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

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Lower Extremity Review Mission

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

EDITORIAL PILLARS

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

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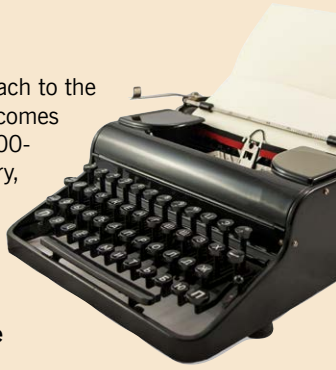
LER encourages a collaborative multidisciplinary clinical approach to the care of the lower extremity with an emphasis on functional outcomes using evidence-based medicine. We welcome manuscripts (1000-2000 words) that cross the clinical spectrum, including podiatry, orthopedics and sports medicine,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



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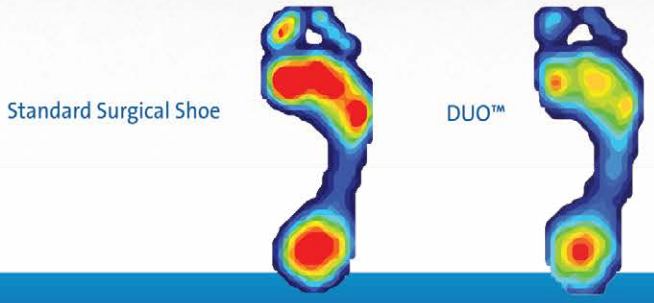

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NIH Grants $1.3M to Diversify Bioengineering

KENNESAW STATE O&P PROFESSOR WINS PRESTIGIOUS NIH GRANT

Kennesaw State University has begun a program to recruit and educate members of a diverse new generation of innovators in the field of bioengineering, backed by a $1.3 million grant from the National Institutes of Health (NIH).

The new program was developed by associate professor of prosthetics and orthotics Géza Kogler, PhD, CO, who helped establish the Master of Science in Prosthetics and Orthotics program in the Wellstar College of Health and Human Services at Kennesaw State. Kogler, who serves on the LER Editorial Advisory Board, credited associate professor of mechanical engineering technology Turaj Ashuri and professor emeritus of electrical engineering Bill Diong for connecting the grant to the Southern Polytechnic College of Engineering and Engineering Technology.

Participants will be immersed in the clinical realm of orthotics, prosthetics, and rehabilitation. Students will work in clinical settings, receive faculty mentoring, complete a capstone project, and work on an interdisciplinary research team, as well as interact with people who use assistive technology.

According to Kogler, the program will recruit underrepresented minorities, persons with disabilities, women, and economically- and socially-disadvantaged students, and expose them to spheres of engineering and clinical discovery over 4 years. Eight students will be recruited for each of the 4 years of the grant, starting in the fall of 2023.

The Kennesaw State program connects with the NIH's ESTEEMED (Enhancing Science, Technology, Engineering and Math Educational Diversity) program, which seeks to "support educational activities that enhance the diversity of the biomedical research workforce through early preparation for undergraduate students in STEM fields," specifically bioengineering. Kogler has named the program the BRITE project (Bioengineering Research and Interdisciplinary Training—ESTEEMED).

Students involved in BRITE will have their tuition paid for their first two years, then will enter the KSU Journey Honors College for their final two years, where they will have access to other sources of funding. They'll also receive stipends for summer work through the program.

The program addresses points of emphasis at Kennesaw State, most prominently interdisciplinary studies and pathways to graduate degree programs.

"Especially with bioengineering, you're looking at a very interdisciplinary field that takes in math, physics, biology and engineering," Kogler said. "A student might develop expertise in a certain aspect of engineering or science and they're applying those skills in a space that could be clinically valuable, or it could be on the research side to solve a problem."

"Normally a grant has a massive impact for a lab, but this one will affect the entire university on both campuses," he said. "So the tentacles of this grant have an extended reach, and it's not very often you get an opportunity to connect students and faculty in such a transformative way." ler

DIVERSIFYING O&P WILL ONLY IMPROVE HEALTHCARE

By Robert Lin, CPO

Over the past several decades, technology has effectively changed how global communities interface with one another. Travel is more affordable and efficient, and immigration has made cultural diversity a constant in all aspects of life. The internet literally transformed how we acquire information across the entire spectrum of human experiences. Now, the impact of artificial intelligence is considered by many to be the next challenge that will profoundly impact societies across the world. Businesses have had to adapt and healthcare and educational delivery models have had to fundamentally change how

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knowledge and skills are disseminated to the student population. Online learning, virtual consultations and the new pedagogy of clinical training must reflect the world as it stands today. More specifically, the profession of orthotics and prosthetics (O&P) must adapt to not only how future clinicians are educated, but equally important is to whom this training is provided. Diversity is a key component of success in any industry. Having cultural, religious and ethnic representation not only helps us serve the O&P patient population better, it helps us unite medical specialties and solidify communities.

As a practicing orthotist/prosthetist for the past 4 decades, I have personally witnessed the ABC-certified practitioner base evolve from a predominantly male, Caucasian craftsman whose introduction to the field was from a personal or familial connection to today's art and science of O&P. Today, in large part due to the Academy of Orthotics and Prosthetics's overt effort to reach a broader audience of young aspiring healthcare professionals, the field is enriched with much more diversity than ever before. According to a recent article in our own professional publication, the *Almanac*, women now constitute nearly 50 % of the matriculating class in any given year. Minorities and those from underserved/underprivileged communities are beginning to enhance their representation as well, but we have just scratched the surface. This NIH grant that Dr. Kogler has just received is monumental in that it will give O&P education/training much greater reach and ultimately broaden the clinical resources of more communities that are in such dire need. Disease and poor health know no socioeconomic boundaries and it is well documented that many epidemic-level conditions like Type 2 Diabetes affect the adult populations of racial and ethnic minorities with great disproportionality. Research shows that healthcare professionals who identify with or emerge from these environments are more likely to return to them to serve their communities. It is obvious to this writer that this grant initiative by Dr. Kogler will serve to further the mission of today's O&P leadership by not only increasing the breadth and scope of contemporary practice, but by changing the face of those who deliver the care.

Robert Lin, CPO, is managing partner at Biometrics INC., in Hartford, Connecticut. He also serves on the Lower Extremity Review Editorial Advisory Board.

CALL FOR MANUSCRIPTS

The Editors of *Lower Extremity Review* want to highlight the work of thoughtful, innovative practitioners who have solved their patients' vexing problems. We are seeking reports of your most intriguing cases in the following areas:

- Biomechanics
- Falls and other injury prevention
- Benefit of movement
- Prevention of diabetic foot ulcers
- Collaborative care

Before you begin to write, query the Editors about your proposed topic (email is fine). Doing so ensures that your manuscript will conform to the mission of the publication and that the topic does not duplicate an article already accepted for publication. Furthermore, a query often allows the Editors and the publication's advisors to make recommendations for improving the utility of the manuscript for readers.

Case reports should be no more than 1500 words (not including references, legends, and author biographies). Photos (≤4) are encouraged. Case reports can include a literature review as is appropriate for the topic. (Please note that for HIPPA compliance, photos should be de-identified before sending.)

Manuscripts must be original and not under consideration for publication elsewhere. Any prior publication of material must be explained in a cover letter.

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HINDFOOT NAILS AND GERIATRIC ANKLE FRACTURES

Ankle fractures can potentially limit an individual's mobility, autonomy, and quality of life, making them devastating injuries for geriatric patients. Researchers from the Donald and Barbara Zucker School of Medicine at Hofstra/Northwell, in Hempstead, NY, wanted to better understand the functional outcomes and complications related to hindfoot nails (HFN) – a common treatment for this condition – in geriatric patients who have suffered an ankle malleolar or distal tibia fracture.

Using a case series format, data was collected from a single surgeon for patients who underwent HFN for acute fixation or delayed reconstruction after an ankle or distal tibia fracture for demographics, comorbidities, baseline functional status, AO/OTA classification, surgical indications, need for external fixation, total operative time, length of stay (LOS), ambulation at discharge, and discharge disposition. The study's primary outcomes included 30-day complications, ambulation at follow-up, and time to fracture union and fusion.

There were 22 patients (average age 80.8 years). Mean LOS was 7.0 days, and 68.2% were discharged to subacute rehabilitation. Within 30 days, 1 patient developed a deep vein thrombosis and bilateral pulmonary emboli, and 2 experienced wound dehiscence requiring antibiotics. At 6 weeks, 1 patient sustained a fall with periprosthetic fracture requiring HFN revision, and another developed cellulitis necessitating hardware removal. Fracture healing was seen in 72.7% at 19.4 weeks, while radiographic fusion occurred in 18.2% at 43.0 weeks. 72.7% were ambulating with an assistive device at discharge, and 100.0% at 12-weeks post-operatively or last follow-up. All patients were ambulating without pain, upon final examination.

As a reliable alternative to traditional open reduction internal fixation, HFNs have the ability to improve quality of life for geriatric patients through a faster return to weight bearing. Additionally, radiographic fusion rates show that patients have favorable functional outcomes even without formal arthrodesis.

The authors concluded that HFN is beneficial for elderly patients with low functional demand and complex medical comorbidities, as it allows for early mobility after sustaining an ankle or distal tibia fracture.

Source: *Duvvuri P, Trout SM, Bub CD, Goldman AT. Use of a Hindfoot Nail Without Separate Subtalar and Tibiotalar Joint Preparation to Treat Geriatric Ankle and Distal Tibia Fractures: A Case Series. Geriatr Orthop Surg Rehabil. 2023;14:21514593231195239. doi: 10.1177/21514593231195239.*

TRENDS IN WORLD-CLASS ENDURANCE TRAINING

In a recent invited commentary in the *International Journal of Sports Physiology and Performance,* a multidisciplinary expert panel of applied sport scientists identified recent trends in the evolving world of elite sport. Among the trends they identified:

- Over the past 10–15 years, key drivers included improved access to scientific knowledge for coaches and athletes alike, which lead to better integration of multidisciplinary perspectives throughout the sporting world and increasing use of advanced technology.

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- Categories of trends included: Better understanding of sport-specific demands; improved execution in competition; larger, more specific, and more precise training loads; improved training quality; and a more professional and healthier lifestyle.
- Key areas expected to drive future improvements included more extensive use of advanced technology for monitoring and prescribing training and recovery, more precise use of environmental and nutritional interventions, better understanding of athlete–equipment interactions, and greater emphasis on preventing injuries and illnesses. ler

Source: *Sandbakk Ø, Pyne DB, McGawley K, et al. The Evolution of World-Class Endurance Training: The Scientist's View on Current and Future Trends. Int J Sports Physiol Perform. 2023;18(8):885-889. doi: 10.1123/ijspp.2023-0131.*

KEY FACTORS FOR COMMUNITY PARTICIPATION AFTER AMPUTATION

Can we predict community participation after amputation? Researchers from the Delaware Limb Loss Studies, Department of Physical Therapy, at the University of Delaware in Newark, sought to answer that question using a secondary analysis of a cross-sectional data set to identify factors that may predict community participation among adults with lower limb amputation.

The study included 126 community-dwelling adults who were ≥1 yr after unilateral transfemoral- (n = 44; mean age = 59 ± 14 yrs) or transtibial-level amputation (n = 82; mean age = 59 ± 14 yrs) and were seen in an outpatient limb loss clinic. Participation was assessed with the Community Integration Questionnaire. Factors, that is, demographics,

comorbidities, prosthesis use per the Houghton Scale, Socket Comfort Score, assistive device use, falls history, and activity level per General Practice Physical Activity Questionnaire were evaluated. Moreover, balance confidence per the Activities-Specific Balance Confidence Scale, mobility per the Locomotor Capabilities Index, fast and self-selected gait speed per 10-meter walk tests, and functional mobility via Timed Up and Go were also included.

The team found that community participation was correlated with several factors ($P \leq 0.050$). Stepwise regression of correlated factors found absence of peripheral neuropathy and greater self-reported physical activity, balance confidence, and prosthesis use, as the strongest correlates, collectively explaining 50.1% of the variance in community participation post-lower limb amputation.

The authors concluded that their findings identify key modifiable factors for consideration in future prospective research seeking to enhance community reintegration and participation among adults living with a unilateral transfemoral- or transtibial-level amputation.

Source: *Sions JM, Seth M, Pohlig RT, Stauffer SJ, Horne JR, Sarlo FB. Key Modifiable Factors in Community Participation Among Adults With Lower Limb Amputation. Am J Phys Med Rehabil. 2023;102(9):803-809. doi: 10.1097/PHM.0000000000002209.*

DYSFUNCTIONAL EXOSOMES INVOLVED IN CHRONIC INFLAMMATION IN DIABETIC WOUNDS

- *Tiny signaling particles called exosomes isolated from the chronic wounds of people with diabetes were dysfunctional and promoted inflammation.*
- *Restoring functional exosomes may be a strategy to resolve chronic inflammation and help wounds in people with diabetes to heal.*

The processes that interfere with the normal healing process in people with diabetes remain incompletely understood. Recently, interest has grown in the role of exosomes in wound healing. Exosomes are nanosized, fluid-filled sacs released from cells that can carry cargo like proteins, peptides, and messenger RNA. They play an important role in communication between cells.

An NIH-funded research team led by Drs. Chandan Sen and Subhadip Ghatak from the University of Pittsburgh has been studying the role of exosomes in inflammation, which is a problem in chronic diabetic wounds. They have focused on the exosomes produced by keratinocytes, a common type of skin cell vital for wound healing and maintaining the barrier function of skin.

In their new study, they compared exosomes isolated from chronic wounds in 22 people with diabetes with those from wounds in 15 people without diabetes. The results were published recently in *Nano Today*.

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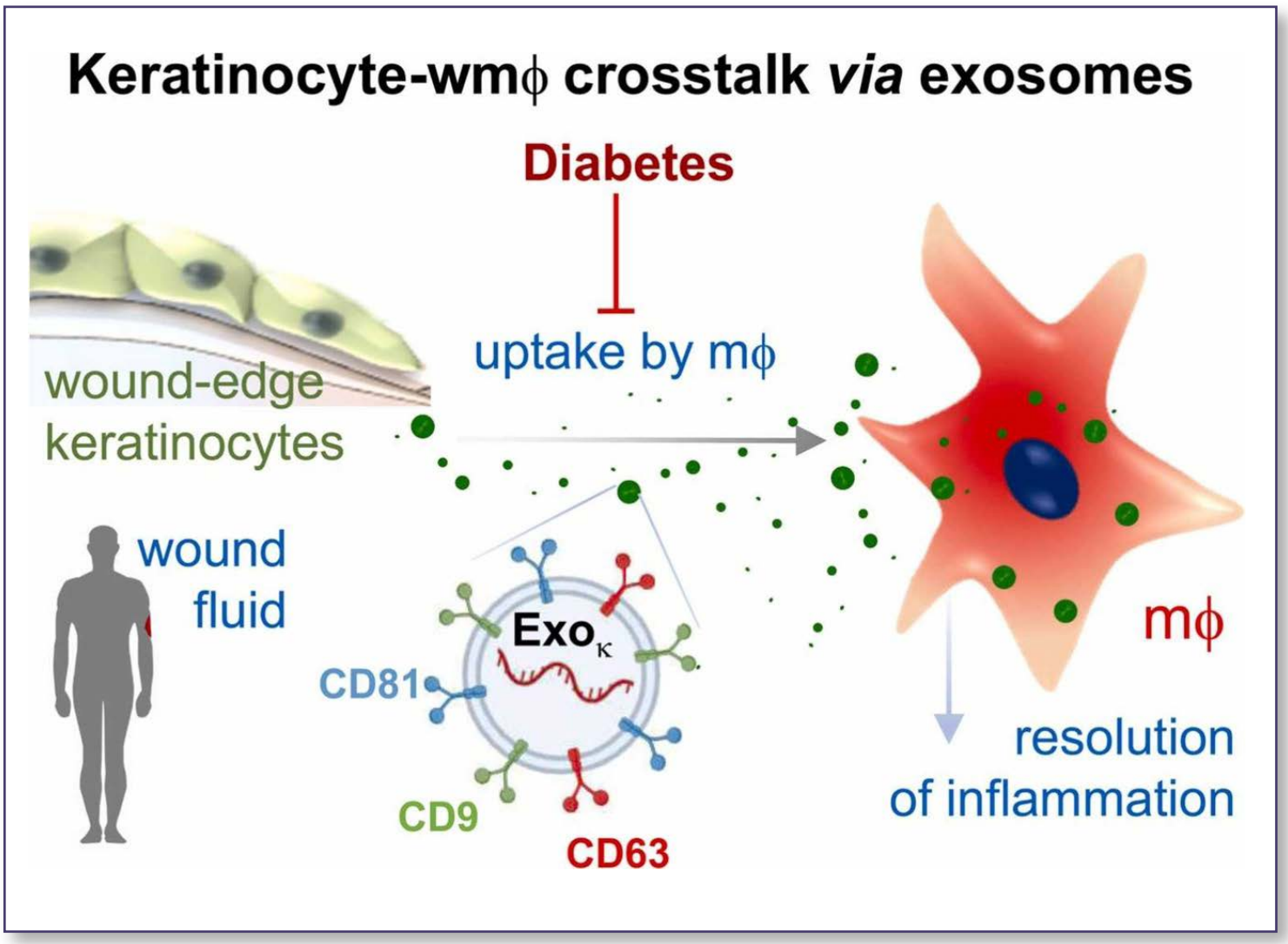

The team first developed a process to isolate keratinocyte-derived exosomes in wound fluid. This process was based primarily on marker proteins that are uniquely found in keratinocytes. The researchers found that their new method could distinguish exosomes released by keratinocytes from other exosomes with very high accuracy. Using the new method, the team calculated that exosomes from keratinocytes made up about a quarter of the total exosomes in chronic wound fluid.

Further experiments revealed that these exosomes differed substantially in the chronic wounds of people with and without diabetes. Fewer exosomes were isolated from people with diabetes, and these were dysfunctional. They contained less RNA than normal and were deficient in proteins and fats needed for the exosomes to function normally.

The researchers next tested the exosomes in laboratory experiments with macrophages, a type of immune cell needed for wound healing. Macrophages exposed to the keratinocyte exosomes from non-diabetic patients showed signs of the resolution of inflammation. In contrast, macrophages exposed to those from people with diabetes stayed in a persistent inflammatory state, similar to that seen in people with diabetic ulcers. These exosomes also attracted additional macrophages toward them – this would lead to persistent inflammation and a breakdown in the healing process.

"If incoming keratinocyte signals contained within exosomes are correct, the macrophage knows how to resolve inflammation in the wound," Sen explains. "In diabetes, crosstalk between keratinocytes and macrophages is compromised, so macrophages keep driving inflammation and the wound can't heal."

The researchers are planning future studies to see if exosomes can be engineered to restore the ability to promote wound healing in people with diabetes.

Source: *Guda PR, Sharma A, Anthony AJ, et al. Nanoscopic and functional characterization of keratinocyte-originating exosomes in the wound fluid of non-diabetic and diabetic chronic wound patients. Nano Today. 2023;52: 101954. https://doi.org/10.1016/j.nantod.2023.101954.*

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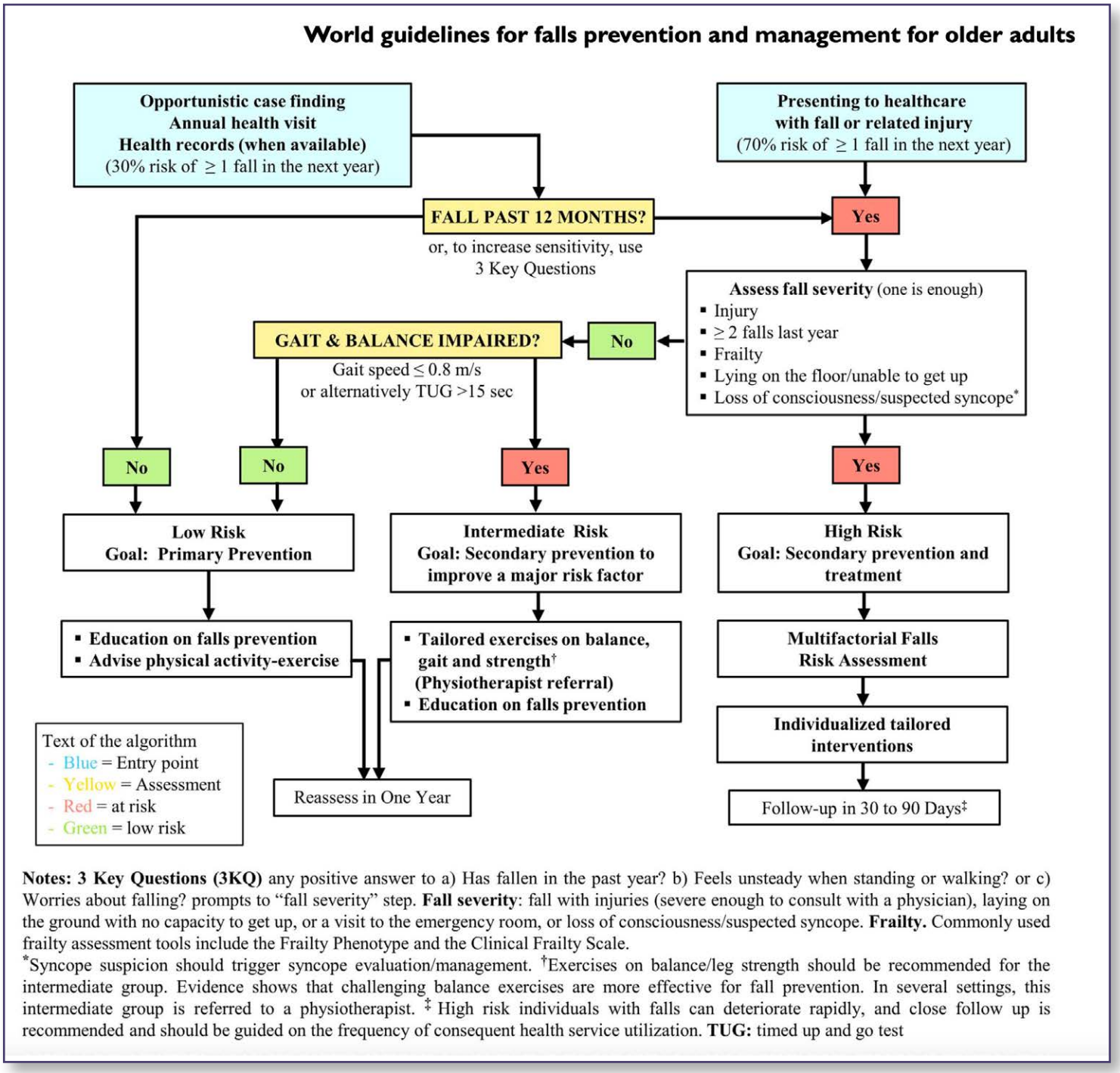
WORLD GUIDELINES FOR FALLS PREVENTION AND MANAGEMENT FOR OLDER ADULTS

'It takes a child one year to acquire independent movement and 10 years to acquire independent mobility. An old person can lose both in a day'

– Professor Bernard Isaacs (1924–1995)

Falls and fall-related injuries are common in older adults, have negative effects on functional independence and quality of life and are associated with increased morbidity, mortality and health-related costs. Current guidelines are inconsistent, with no up-to-date, globally applicable ones present.

To fill that gap, the Task Force on Global Guidelines for Falls in Older Adults worked to create a set of evidence- and expert consensus-based falls prevention and management recommendations applicable to older adults for use by healthcare and other professionals that consider: (i) a person-centered approach that includes the perspectives



Notes: 3 Key Questions (3KQ) any positive answer to a) Has fallen in the past year? b) Feels unsteady when standing or walking? or c) Worries about falling? prompts to "fall severity" step. **Fall severity**: fall with injuries (severe enough to consult with a physician), laying on the ground with no capacity to get up, or a visit to the emergency room, or loss of consciousness/suspected syncope. **Frailty.** Commonly used frailty assessment tools include the Frailty Phenotype and the Clinical Frailty Scale.
*Syncope suspicion should trigger syncope evaluation/management. †Exercises on balance/leg strength should be recommended for the intermediate group. Evidence shows that challenging balance exercises are more effective for fall prevention. In several settings, this intermediate group is referred to a physiotherapist. ‡ High risk individuals with falls can deteriorate rapidly, and close follow up is recommended and should be guided on the frequency of consequent health service utilization. **TUG:** timed up and go test

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of older adults with lived experience, caregivers, and other stakeholders; (ii) gaps in previous guidelines; (iii) recent developments in e-health; and (iv) implementation across locations with limited access to resources such as low- and middle-income countries.

To create the guidelines, a steering committee and a worldwide multidisciplinary group of experts and stakeholders, including older adults, were assembled. Using a modified Delphi process, recommendations from 11 topic-specific working groups (WGs), 10 ad-hoc WGs and a WG dealing with the perspectives of older adults were reviewed and refined. The final recommendations were determined by voting.

Published in *Age and Ageing*, the recommendations encourage that all older adults be advised on falls prevention and physical activity. Opportunistic case finding for falls risk is recommended for community-dwelling older adults. Those considered at high risk should be offered a comprehensive multifactorial falls risk assessment with a view to co-design and implement personalized multi-domain interventions. Other recommendations cover details of assessment and intervention components and combinations, and recommendations for specific settings and populations.

In its conclusion, the authors write that the core set of recommendations provided will require flexible implementation strategies that consider both local context and resources.

Source: *Montero-Odasso M, van der Velde N, Martin FC, et al, for the Task Force on Global Guidelines for Falls in Older Adults. World guidelines for falls prevention and management for older adults: a global initiative. Age Ageing. 2022;51(9):afac205. doi: 10.1093/ageing/afac205.*

SEDENTARY TIME AND POLYPHARMACY

Increased sedentary time is associated with an increased risk of polypharmacy according to a recently published large national study of adults (≥20 yrs) in the United States.

Research has shown that there is an inverse relationship between participation in physical activity and polypharmacy (use of 5 or more medications). Researchers from the University of North Florida in Jacksonville wanted to better understand the relationship between sedentary time and polypharmacy. Their study sample included 2,879 nonpregnant adults who participated in the 2017–2018 National Health and Nutrition Examination Survey. Self-reported minutes per day of sedentary time were converted to hours per day.

The analysis found that for every hour of sedentary time, there was 4% greater odds of polypharmacy (odds ratio, 1.04; 95% confidence interval, 1.00-1.07, P = 0.4) after adjustments.

Source: *Boyne CA, Johnson TM, Toth LP, et al. Sedentary time and prescription medication use among US adults: 2017–2018 National Health and Nutrition Examination Survey. J Phys Act Health. 2023;20(10):921-925. https://doi.org/10.1123/jpah.2023-0022.*

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Lower Extremity Injuries While Skydiving

By Mathias B. Forrester, BS

Background: Skydiving is a popular activity; however, there is a risk of serious injury. Skydiving injuries most often involve the lower extremities and lumbar spine. The objective of this study was to characterize lower extremity injuries while skydiving.

Methods: Cases were lower extremity injuries among skydiving incident reports collected by the United States Parachute Association (USPA). The distribution of cases by injury characteristics, circumstances of the injury, and demographics was determined.

Results: Of 130 cases with one or more lower extremity injuries, the affected body part was 37% ankle, 25% upper leg, 23% lower leg, 10% knee, 6% foot, and 12% leg (not otherwise specified). The most frequently reported injuries were 77% fracture, 6% dislocation, and 6% sprain. The most common incident categories were 58% Landing Problem (No Turn), 12% Unintentional Low Turn, and 5% Intentional Low Turn. The age distribution of the injured persons with known age was 32% 20-29 years, 27% 30-39 years, 24% 40-49 years, 12% 50-59 years, and 5% 60 years or older. Of the injured persons with a known sex, 71% were male, and 29% were female.

Conclusion: Lower extremity injuries while skydiving reported to the USPA most often involved the ankle followed by the upper leg and lower leg, and the most common injury was a fracture. Most of the injuries occurred while landing. The majority of injured persons were aged 20-39 years, and most were male.

Skydiving, jumping from an aircraft and free-falling before landing by parachute, is a popular activity in the United States. In 2022, approximately 42,000 United States Parachute Association (USPA) members made about 3.9 million jumps at more than 208 USPA-affiliated skydiving centers in the United States – an average of 92 jumps per member.[1]

Studies have reported skydiving injury rates between 0.03% to 0.17% during a jump. The differences in rates depend, in part, on whether minor injuries, which often do not require medical treatment, are included.[2-5] In a 2021 survey of USPA members, 6% reported experiencing an injury that required treatment at a medical facility, with the rate ranging 5–7% during 2016–2020.[6] The most common skydiving injuries are fractures, strains and sprains, contusions, abrasions and lacerations, ligament tears, and dislocations.[3,5] Skydiving injuries most often involve the lower extremities and lumbar spine.[2,3,5,7,8]

> The distribution of lower extremity injuries while skydiving was determined for body part, diagnosis, whether a fatality was known to have occurred, injured person's age and sex, and category of the incident.

The objective of this study was to characterize skydiving injuries specifically involving the lower extremity.

Methods

The USPA collects reports on skydiving incidents. According to the USPA website, incidents that should be reported include any event that requires medical attention or raises a safety concern, noteworthy malfunctions, unsafe procedures, unusual or ethically unacceptable

Continued on page 25

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Table 1. Affected body part and diagnosis of lower extremity injuries while skydiving, United States Parachute Association

Variable	Number	% of total cases
Affected body part*		
Ankle	48	36.9
Upper leg	33	25.4
Lower leg	30	23.1
Knee	13	10.0
Foot	8	6.2
Leg (not otherwise specified)	16	12.3
Diagnosis**		
Fracture	100	76.9
Dislocation	8	6.2
Sprain	8	6.2
Contusion or abrasion	5	3.8
Laceration	4	3.1
Pain	3	2.3
Amputation	1	0.8
Edema	1	0.8
Inflammation	1	0.8
Ligament tear	1	0.8
Thermal burn	1	0.8
Unspecified	11	8.5
Most common body part and diagnosis		
Ankle fracture	32	24.6
Upper leg fracture	31	23.8
Lower leg fracture	28	21.5
Leg (not otherwise specified) fracture	10	7.7
Ankle sprain	8	6.2
Ankle dislocation	7	5.4
Foot fracture	7	5.4
Total	**130**	

A case may involve multiple injuries of one or more diagnoses affecting one or more body parts.
*Cases with multiple different injuries of the same body part were counted only once.
**Cases with the same injury of multiple body parts were counted only once.

Continued on page 27

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skydives, or other extraordinary occurrences concerning skydiving operations. Further reporting criteria include, but are not limited to, fatalities, injuries requiring medical attention more than local first aid, any injuries of a solo or tandem student, reserve deployments, automatic activation device (AAD) activations, off-field landing or obstacle landings, emergency exits from an aircraft, freefall or canopy collisions, premature deployments in aircraft or freefall, harness or canopy damage during a jump, unplanned dropping of equipment during a jump, and anything filed on an insurance claim. Anyone can voluntarily submit an anonymous report online, and the submission is handled confidentially. All reports are studied, printed in *Parachutist*, published online, and then destroyed, although the USPA keeps a brief summary on record.[9]

USPA incident report summaries are available on their website (https://www.uspa.org/searchincidentreports?pagesize=50). The following information is provided for each incident: Published Report Date, Category, Age, Gender, Time in Sport, Total Number of Jumps, Skydives Within the Last 12 Months, Fatality, Cause of Death, multiple fields providing details about the equipment used, Description (a brief description of the incident), and Conclusions. All variables are not available for all reports. The reports do not include identifying information. The information is publicly available, so institutional review board (IRB) approval is not required.

On August 1, 2023, there were 504 incident reports available on the USPA website with a report date of July 2008–April 2023 (n=494) or no report date (n=10). All incident reports were individually examined to identify those reports that mention the occurrence of lower extremity injuries while skydiving. The incident reports do not include a data field for injuries, so the Description and Conclusion fields were reviewed to identify any lower extremity injuries. Those reports with lower extremity injuries were included in the study. For each study case, the part of the lower extremity injured and the type of injury were documented.

The distribution of lower extremity injuries while skydiving was determined for body part, diagnosis, whether a fatality was known to have occurred, injured person's age and sex, and category of the incident. A person may have experienced lower extremity injuries involving more than one body part and/or more than one type of injury. For the body part analysis, multiple injuries to the same body part were grouped together. Similarly, for the diagnosis analysis, the multiple body parts involving the same injury were grouped together. For example, if a person experienced a lower leg fracture and a lower leg laceration, it would be counted once in the body part analysis (lower leg) but twice in the diagnosis analysis (fracture and laceration). If a person experienced a lower leg fracture and a foot fracture, it would be counted twice in the

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Table 2. Incident category of lower extremity injuries while skydiving, United States Parachute Association

Incident category	Number	% of total cases
Landing Problem (No Turn)	76	58.5
Unintentional Low Turn	15	11.5
Intentional Low Turn	6	4.6
Equipment Problem	4	3.1
Collision (Aircraft)	3	2.3
Collision (Freefall)	3	2.3
Collision (Canopy)	2	1.5
Main - Reserve Entanglement	2	1.5
Medical Problem	2	1.5
Low Cutaway - Reserve Deployment	1	0.8
Low Main Deployment	1	0.8
Other	2	1.5
Uncategorized	13	10.0
Total	**130**	

body part analysis (lower leg and foot) but once in the diagnosis analysis (fracture).

Results

Of the 504 reports, 130 (25.8%) indicated a lower extremity injury occurred while skydiving. Table 1 provides the distribution of lower extremity injuries while skydiving by affected body part and diagnosis. The most frequently affected body parts were the ankle, reported in over one-third of the cases, followed by the upper leg and lower leg. The most common reported diagnosis was a fracture, reported in over three-fourths of the cases. All other diagnoses were reported in a small number of cases. When the affected body part and diagnosis were examined together, the most common injuries were ankle fracture, upper leg fracture, and lower leg fracture. A fatality was reported in 13 (10.0%) of the cases.

Table 2 presents the distribution of lower extremity injuries while skydiving by incident category. The most common incident category was Landing Problem (No Turn), reported in almost 60% of the cases. All other incident categories were reported in a much smaller proportion of the cases.

The injured person's age was known in 92 of the cases. The age distribution of the persons with known age was 29 (31.5%) 20-29 years, 25 (27.2%) 30-39 years, 22 (23.9%) 40-49 years, 11 (12.0%) 50-59 years, and 5 (5.4%) 60 years or older. The mean injured person's age was 38 years (range 21–72 years). The injured person's sex was reported in 127 of the cases. Ninety (70.9%) of the injured persons with a reported sex were male, and 37 (29.1%) were female.

Discussion

This study characterized lower extremity injuries while skydiving. Skydiving is a popular activity. However, injuries may occur while participating in the activity, and most injuries involve the lower extremities and lumbar spine.[2,3,5,7,8] Detailed analysis of lower extremity injuries while skydiving may provide useful information to manage and prevent such injuries in the future.

Of the 504 USPA incident reports examined, 26% involved lower extremity injuries while skydiving. Previous studies reported that 47%–64% of skydiving injuries involved the lower extremity.[3,5,7,8] The lower proportion of lower extremity injuries observed in the present study may be due, in part, to the USPA incident report inclusion criteria. The USPA includes reports of a variety of incidents, some of which do not require the presence of an injury.[9]

The most frequently affected body part was the ankle, followed by the upper leg and lower leg. In a previous study of Swedish skydiving over a five-year period (1999–2003), the most frequently affected lower extremity body part was the lower leg followed by the foot, ankle, upper leg, and knee.[3] Differences between the two studies may be due to differences in the study populations and inclusion criteria.

The most commonly reported diagnosis was a fracture, reported in over three-fourths of the cases. The next most common diagnoses,

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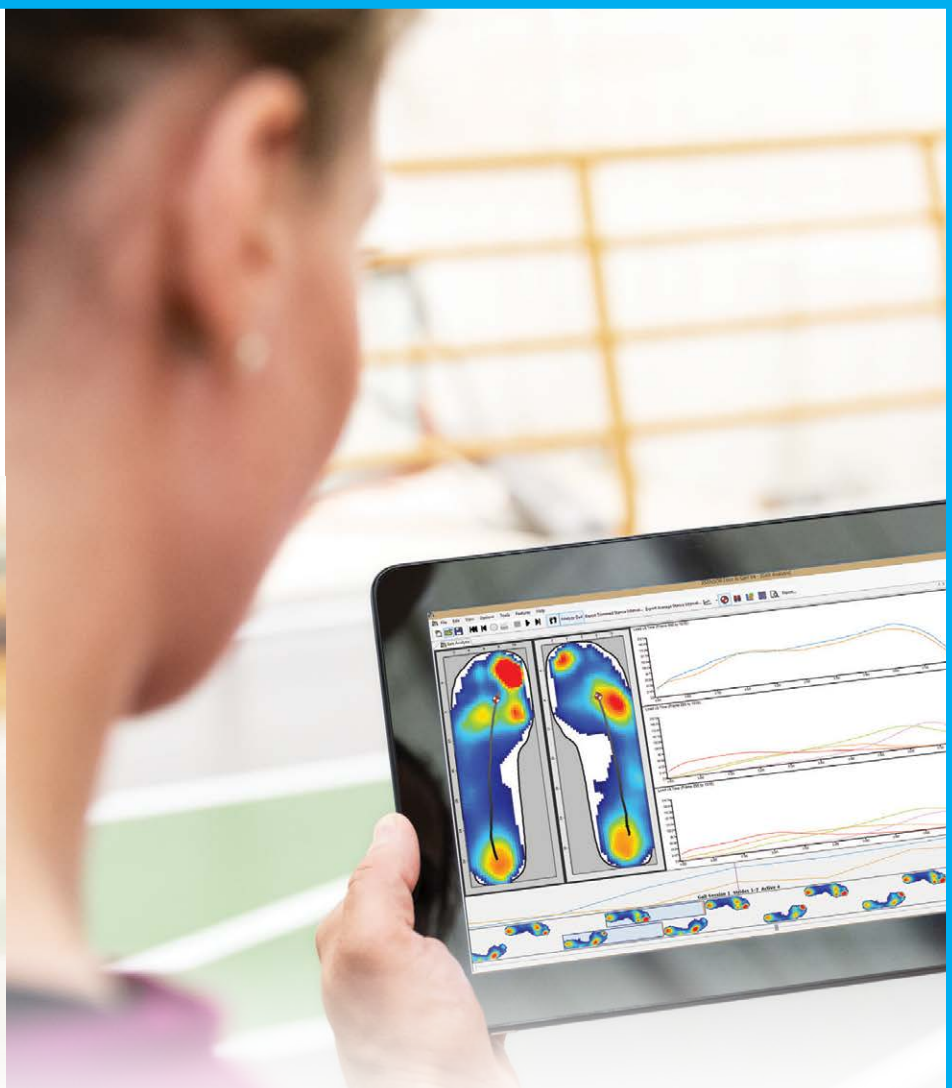

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although reported in only a much lower fraction of the cases, were dislocation, sprain, contusion or abrasion, and laceration. In the Swedish skydiving study, the most commonly reported injury of the lower extremity was fracture, followed by strain or sprain, contusion, and abrasion or laceration.[3] The USPA incident reporting criteria specifically mention that injuries requiring medical attention more than local first aid are to be reported.[9] Fractures are likely to require medical attention more than local first aid. Other injuries such as sprains, contusions and abrasions, and lacerations may be less likely to require medical attention more than local first aid – and thus less likely to have an incident report submitted or be mentioned in an incident report that is submitted.

Ten percent of the persons with lower extremity injuries died. In many of these instances, the fatality was probably due to injuries other than those to the lower extremity. The number of lower extremity injuries involving a fatality is likely to be higher than 10% because many of the incident reports of fatalities did not provide details of the person's injuries.

In almost 60% of the incidents involving lower extremity injuries, the incident category was Landing Problem (No Turn). Skydiving injuries can occur during three different phases of a jump. In the exit phase, exiting the airplane can result in lacerations and contusions. In the opening phase, after deploying the parachute, the skydiver experiences average decelerations of 3–5 times the Earth's gravity. In the landing phase, landing on the ground is affected by speed, flying technique, type of parachute, weather, and geographical conditions.[2] Previous studies reported that injuries most often occurred during the landing phase.[2,3,5,7]

Of the injured persons with a reported age, the mean age was 38 years, with almost 60% aged 20–39 years. Of the injured persons with a reported sex, 71% were male. In a Danish study of 110,000 sports jumps, the mean age of injured persons was 29 years,[5] lower than in the present study. The difference in mean age between the two studies could be due to differences in study design and/or study population.

Ten percent of the persons with lower extremity injuries died. In many of these instances, the fatality was probably due to injuries other than those to the lower extremity.

Moreover, the previous study was published over 35 years ago, and the demographics of skydivers may have changed since then. In the 2021 survey of USPA members, 52% were aged 20–39 years.[6] Prior studies also reported a preponderance of injured persons being male.[3,5,8] In the 2021 survey of USPA members, 86% of the members were male.[6] The demographic patterns of the injured persons in the present study may reflect the general demographics of skydivers. Alternately, persons in certain age groups or of a particular sex may be more likely to be injured while skydiving and/or more likely to have an incident report submitted to the USPA.

This study is subject to limitations. Reporting of skydiving injuries to the USPA is voluntary, and the incident reports do not collect injury information in a consistent manner, i.e., using specific data fields. In addition, there may be bias in the reporting of particular types of injuries; the USPA reporting criteria includes injuries requiring medical attention more than local first aid.[9] Incident reports might not have been submitted for injuries considered less serious or not requiring more extensive medical attention or less serious injuries might not have been documented in reports that were submitted. Relatively few variables are included in the incident reports; information such as the date and location of the incident are not available, so temporal and geographic analysis cannot be performed.

In conclusion, lower extremity injuries while skydiving reported to the USPA most often involved the ankle followed by the upper leg and lower leg, and the most common injury was a fracture. Most of the injuries occurred while landing. The majority of injured persons were aged 20–39 years, and most were male.

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

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Surgical Treatment of Ingrown Toenails Part 1: Recurrence and Relief

By Victoria Exley, Katherine Jones, Grace O'Carroll, Judith Watson, and Michael Backhouse

Ingrown toenails are a common nail pathology, yet there is a lack of good quality evidence to guide practice.

An ingrown toenail, or onychocryptosis, is a common nail pathology that occurs when the nail plate punctures the periungual skin causing substantial pain, inflammation, discomfort, and increased risk of infection if left untreated. Several factors have been proposed as contributory to the occurrence or worsening of ingrown toenails with varying degrees of evidence. These include poor nail cutting technique, hyperhidrosis, ill-fitting footwear, nail deformity, trauma, obesity, and peripheral edema.

Conservative approaches have all been advocated in the literature for use in mild to moderate stages (stage I and II) with varying success rates and quality of evidence. However, when conservative treatment fails, where there is nail deformity, or in more severe cases (stage II and III), a surgical approach is often recommended aiming to remove the problem part of the nail and destroy the underlying matrix to avoid recurrence. Despite recent narrative reviews, there is a need for an up-to-date and rigorous systematic review of surgical methods for treating ingrown toenails. The aim of this study, therefore, was to systematically search and synthesize the literature relating to the effectiveness/efficacy of surgical methods for treating ingrown toenails.

Methods

Five databases (MEDLINE, Embase, CINAHL, Web of Science and CENTRAL) and two registers (Clinicaltrials.gov and ISRCTN) were searched to January 2022 for randomized trials evaluating the effects of a surgical intervention(s) for ingrown toenails with a follow-up of at least 1 month. Two independent reviewers screened records, extracted data, assessed risk of bias and certainty of evidence.

Results

The systematic search identified 1,641 potential publications which, after screening, enabled 36 studies with 3,756 (62.7% males) participants covering a range of techniques that were included in the review. Of these, 31 were included in the meta-analysis for recurrence (Figure 1) and 5 were reported narratively. In addition, synthesis of evidence for relief of symptoms was reported narratively due to the small number of studies reporting this outcome. Recurrence was reported in all but 1 study. The definition of recurrence varied between studies and 2 studies were unclear and reported the "number of successes/number of failures" and "number symptom-free," respectively. Therefore, these studies were reported narratively. Follow-up ranged from 1 to 24 months.

Interventions

Chemical matrixectomy vs conservative management

Two studies found that phenol matrixectomy did not significantly decrease the rate of recurrence when compared to a conservative approach such as nail tube splinting or nail elevation and flexible tubing (RR 0.55 [95% CI 0.19 to 1.61], I2 0%; $P = 0.280$).

This article has been excerpted from "A systematic review and meta-analysis of randomized controlled trials on surgical treatments for ingrown toenails part I: recurrence and relief of symptoms." J Foot Ankle Res 16, 35 (2023). https://doi.org/10.1186/s13047-023-00631-1. Editing has occurred, including the renumbering of tables, and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

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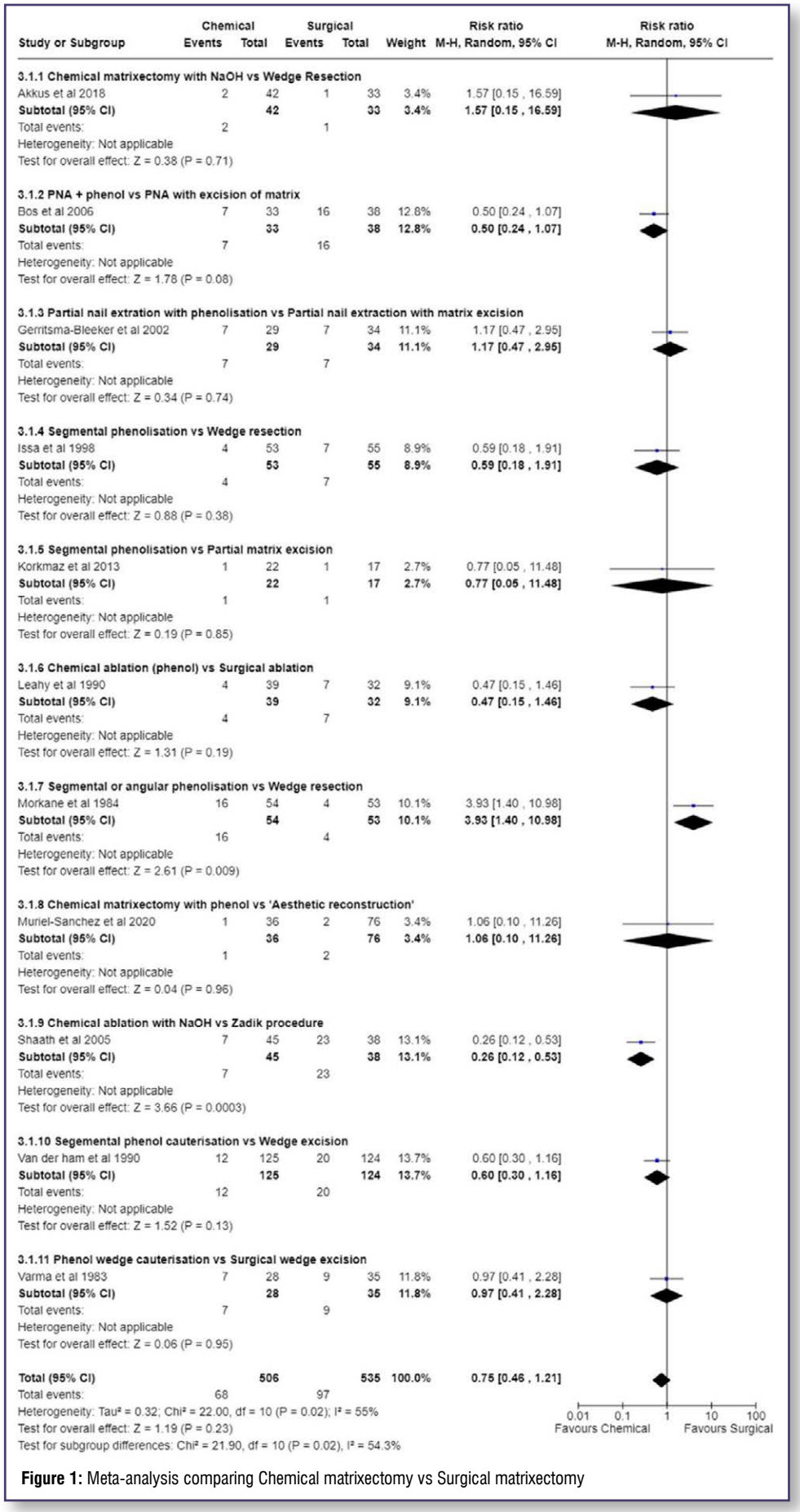

Figure 1: Meta-analysis comparing Chemical matrixectomy vs Surgical matrixectomy

Surgical matrixectomy vs conservative management

Two studies compared surgical matrixectomy to a conservative approach, however neither method was significantly more effective at preventing recurrence (RR 0.72 [95% CI 0.33 to 1.56] I2 34%; *P* = 0.410).

Chemical matrixectomy vs surgical matrixectomy

Combining the 11 studies where chemical matrixectomy was compared to surgical matrixectomy, found no significant difference in their ability to prevent recurrence (RR 0.75 [95% CI 0.46 to 1.21] I2 55%; *P* = 0.230) (Fig. 1).

Chemical matrixectomy vs chemical matrixectomy

Two studies compared phenol to trichloroacetic acid, however neither chemical proved to be more effective at preventing recurrence (RR 0.19 [95% CI 0.01 to 3.80] *P* = 0.280).

Surgical matrixectomy vs other (eg, CO2 laser, electrocautery)

In 3 studies, a surgical intervention (partial nail matrixectomy or curettage) did not significantly decrease the rate of recurrence when compared to an alternative method of matrixectomy such as electrocautery or CO2 laser (RR 1.61 [95% CI 0.88 to 2.95] I2 37%; *P* = 0.120).

Chemical matrixectomy vs other (e.g., CO2 laser, electrocautery)

When comparing chemical matrixectomy to an alternative method of matrixectomy in 2 studies, there was no significant difference in prevention of recurrence (RR 0.58 [95% CI 0.25 to 1.37] I2 0%; *P* = 0.220).

Avulsion vs avulsion + chemical matrixectomy

Avulsion with phenol matrixectomy was compared with nail avulsion alone in 2 studies. There was a significant reduction of recurrence in favor of phenol matrixectomy (RR 0.13 [95% CI 0.06 to 0.27] I2 0%; *P* < 0.001).

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Surgical matrixectomy vs surgical matrixectomy
One study compared the Winograd procedure using a new suturing technique to the same surgical intervention using a traditional suturing technique. After 12 months, the new suturing technique was found to be more effective at preventing recurrence compared to the traditional technique (RR 0.42 [95% CI 0.21 to 0.85]). Another compared central toenail resection to wedge toenail resection. After 6 months, the central toenail resection was considered more effective at preventing recurrence (RR 0.05 [95% CI 0.0 to 0.79]).

Surgical matrixectomy vs surgical + chemical matrixectomy
Two studies compared a surgical intervention, either nail bed excision or wedge resection, with the same surgical intervention plus the addition of phenol. However, addition of phenol was not significantly more effective at preventing recurrence (RR 3.68 [95% CI 0.20 to 67.35] I2 76%; $P = 0.380$).

Chemical matrixectomy vs surgical + chemical matrixectomy
In 2 studies, surgical matrixectomy plus phenolization did not significantly decrease the rate of recurrence when compared to phenolization alone (RR 1.92 [95% CI 0.06 to 62.30] I2 62%; $P = 0.710$).

Local anesthetic vs local anesthetic + adrenaline (epinephrine)
Two studies compared local anesthetic (4 mL solution of 2% mepivacaine; 2% lidocaine, respectively), with a combination of the same local anesthetic plus adrenaline (epinephrine). The use of adrenaline did not significantly decrease the rate of recurrence (RR 1.03 [95% CI 0.22 to 4.86] I2 0%; $P = 0.970$).

Chemical application time: 30 s vs 60 s
Of the 1 study that was included in the meta-analysis, the study authors compared the recurrence rate between phenol applications of 30 s or 60 s, finding the 60-s application was more effective at preventing recurrence (RR 2.00 [95% CI 0.19 to 21.41]).

Antibiotics vs no antibiotics
Of the 1 study included in the meta-analysis, it was shown that after 12 months the use of topical antibiotics alongside a chemical or surgical matrixectomy did not significantly decrease the rate of recurrence (RR 0.54 [95% CI 0.12 to 2.52] I2 58%; $P = 0.430$).

Relief of symptoms
Five studies assessed relief of symptoms. Two studies assessed symptoms using a visual analogue scale ranging from 0 to 10; the remaining 3 studies did not specify the instrument used. No definitions were provided for relief of symptoms.

Chemical procedures
In 2 studies, no statistically significant differences were identified between patients receiving 3 min application of 80% phenol, 2

min of 10% sodium hydroxide, and 1 min of 10% sodium hydroxide.

Chemical and surgical procedures
No significant differences were found between partial nail extraction with phenolization and partial nail extraction with matrix excision at 1, 3, or 12 months ($P = 0.130$, $P = 0.270$, $P = 0.290$, respectively).

Surgical procedures
Central toenail resection was shown to be significantly better in relieving symptoms compared to wedge toenail resection after 4 and 8 weeks (both $P = 0.001$).

Surgical and conservative procedures
Following either partial nail extraction with partial matrix excision or orthonyxia, no differences were noted after 12 months.

Conclusion

This paper presents the co-primary outcomes from a systematic review with meta-analysis that should be interpreted in conjunction with its second paper, which will appear in a coming issue. Despite the high number of publications on this topic, the quality of research was poor and the conclusions that can be inferred from existing trials is limited. Phenolization of the nail matrix reduces the risk of recurrence following nail ablation, and 1 min appears to be the optimum time for application. Despite this being a widely performed procedure there remains a lack of good quality evidence to guide practice. ler

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Falls and Related Injuries Due to Chronic Ankle Symptoms

By Munira M. Al Mahrouqi, Bill Vicenzino, David A. MacDonald, and Michelle D. Smith

Falls and falls-related injuries are a problem in individuals with chronic ankle symptoms.

Falls are a significant health concern especially among older adults. While falls are associated with osteoarthritis (OA) and persistent pain at the hip and knee, falls have not been investigated in people with chronic ankle symptoms. According to qualitative research on individuals with ankle OA, this population has concerns about falling and reports instability as a key symptom of their condition. Thus, this study aimed to compare self-reported history of falls between adults with and without chronic ankle symptoms. Secondary aims were to compare concern about falling and balance confidence between groups, and to identify factors associated with falling.

Methods

A total of 226 individuals (134 with chronic ankle pain and/or stiffness and 92 controls) participated in this cross-sectional case–control study. Inclusion criteria included ankle joint pain rated as ≥ 2 out of 10 on an 11-point numerical rating scale (NRS) anchored with the 'No pain' at 0 and 'Worst pain imaginable' at 10, and/or stiffness or reduced movement of ankle in the morning on most days for > 3 months.

Using an online questionnaire, participants provided information on their age, sex, function, comorbid health conditions, ankle pain severity, and pain in bodily locations. Falls in the last 12 months was determined by the question: "In the last 12 months, have you had any falls?" The Falls Efficacy Scale-International (FES-I) was used to measure concern about the possibility of falling when performing 16 different physical and social activities. The Activities-Specific Balance Confidence (ABC) scale was used to measure balance confidence during activities of daily living. The 21-item Activities of Daily Living subscale of the Foot and Ankle Ability Measure (FAAM-ADL) was used to assess function. Severity of ankle pain was measured using an 11-point NRS with 0 anchored with "no pain" and 10 anchored with "worst pain imaginable." A modified version of the Self-Administered Comorbidity Questionnaire was used to collect data on multimorbidity.

Results

There were 186 falls reported among the chronic ankle symptoms group and 34 falls reported by controls. In the chronic ankle symptoms group, there were significantly more fallers (64%; n = 86) (individuals with 1 or more falls; $p < 0.001$), more participants who reported multiple (> 1) falls ($p = 0.005$), and more participants who sustained an injury from falling ($p = 0.002$) than the control group (26%; n = 24) (Table 1). Twenty-seven percent of participants (n = 60) reported more than 1 fall. The most reported injury type was bruises, cuts, and grazes (46%). All injury types, including serious injuries (eg, fractures/dislocations) and hospitalizations, were more common in fallers with ankle symptoms than fallers in the control group.

This article has been excerpted from "Falls and falls-related injuries in individuals with chronic ankle symptoms: a cross-sectional study" J Foot Ankle Res. 2023 Aug 16;16(1):49. doi: 10.1186/s13047-023-00649-5. Editing has occurred, including the renumbering or removal of tables, and references have been removed for brevity.

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Table 1

	Chronic ankle symptoms	Controls	Effect size
Fallers, n (%)	86 (64%)	24 (26%)	38% [26, 50]
Fallers with multiple (> 1) falls, n (%)	53 (40%)	7 (8%)	0.3% [0.2, 0.4]
Injured fallers, n (%) [b]	41 (31%)	3 (3%)	35% [18, 52]
Bruises/cuts/grazes, n (%) [b]	47 (55%)	3 (13%)	42% [25, 59]
Sprains/strains, n (%) [b]	16 (19%)	1 (4%)	14% [3, 26]
Fractures/dislocations, n (%) [b]	14 (16%)	0 (0%)	16% [7, 26]
Hospitalisations, n (%) [b]	13 (32%)	0 (0%)	32% [4, 67] ^
High concern about falling, n (%)	44 (33%)	1 (1%)	32% [24, 40]
Moderate concern about falling, n (%)	52 (39%)	12 (13%)	26% [15, 37]
Low concern about falling, n (%)	38 (28%)	79 (86%)	-58% [-68, -47]
FES-I, 16–64[a]	24.3 (7.9)	21.4 (8.2)	2.9 [0.5, 5.2]
ABC, %[a]	78.4 (19.9)	88.4 (20.7)	-10.0 [-15.9, -4.1]

ABC The Activities-Specific Balance Confidence Scale, *FES-I* The Falls Efficacy Scale-International

Data are presented as number (%) and risk difference (RD) (95% CI), and analysed using chi-squared tests unless otherwise stated

[a] Data presented as mean (standard deviation) and mean differences (MD) and 95% confidence interval (CI), and analysed using ANCOVA (age, sex, and severity of pain in body in areas other than the ankle as covariates)

[b] Percentage is calculated from the number of fallers in each group (e.g., # hospitalized/# fallers)

Participants with chronic ankle symptoms were 32% more likely to report high concern about falling, and 26% more likely to report moderate concern, than the control group. There were small effect sizes for higher concern about falling (FES-I; SMD (95% CI) = 0.4 (0.1, 0.6; P = 0.017) and lower balance confidence (ABC scale; SMD (95% CI) = 0.5 (0.8, 0.2); P = 0.001) in participants with ankle symptoms compared to controls (Table 1). Fallers had greater concern about falling and were more likely to have chronic ankle symptoms than non-fallers.

Discussion

The data indicate that falls, and becoming injured or hospitalized because of a fall, are more prevalent in individuals with chronic ankle symptoms than those without. Individuals with chronic ankle symptoms had a greater concern about falling and lower balance confidence than controls. Among the participants, falls status was related to concern about falling and whether an individual had chronic ankle symptoms.

Impairments in muscle strength, ankle range of motion, balance, and ambulatory function have been identified in individuals with chronic ankle symptoms. As these characteristics have been linked to falls in other populations, it is possible that they may contribute to an increased risk of falling in individuals with chronic ankle symptoms. Many health conditions reported by the participants with ankle symptoms, such as back pain and depression, are associated with an increased risk of falls. Research has identified a relationship between the number of falls risk factors an individual possesses and increased risk of falling.

Exercise management may address risk factors, such as impaired balance and ankle muscle weakness, that are common in people with chronic ankle problems. Implementation of cognitive-behavioral therapies to reduce concern about falling and improve self-efficacy has been shown to be effective in reducing falls in other populations and may be beneficial for individuals with chronic ankle symptoms.

Exercise management may address risk factors, such as impaired balance and ankle muscle weakness, that are common in people with chronic ankle problems.

Conclusion

Falls and sustaining an injury from a fall are more prevalent in individuals with chronic ankle symptoms compared to individuals with no ankle symptoms. Findings from this study suggest that healthcare professionals should ask patients presenting with chronic ankle symptoms and ankle osteoarthritis about their falls history and any concerns they have about falling. Clinicians may want to assess falls risk factors in these patients to identify impairments that can be targeted in management.

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Do the Fasciae of the Soleus Have a Role in Plantar Fasciitis? Part I

By Larisa Ryskalin, Gabriele Morucci, Paola Soldani, and Marco Gesi

Plantar fasciitis is a chronic and painful disabling condition affecting the inferomedial aspect of the heel, usually extending toward the metatarsophalangeal joints. These authors examined the anatomical and biomechanical substrates of plantar fasciitis with special emphasis on the emerging, though largely neglected, fascial system.

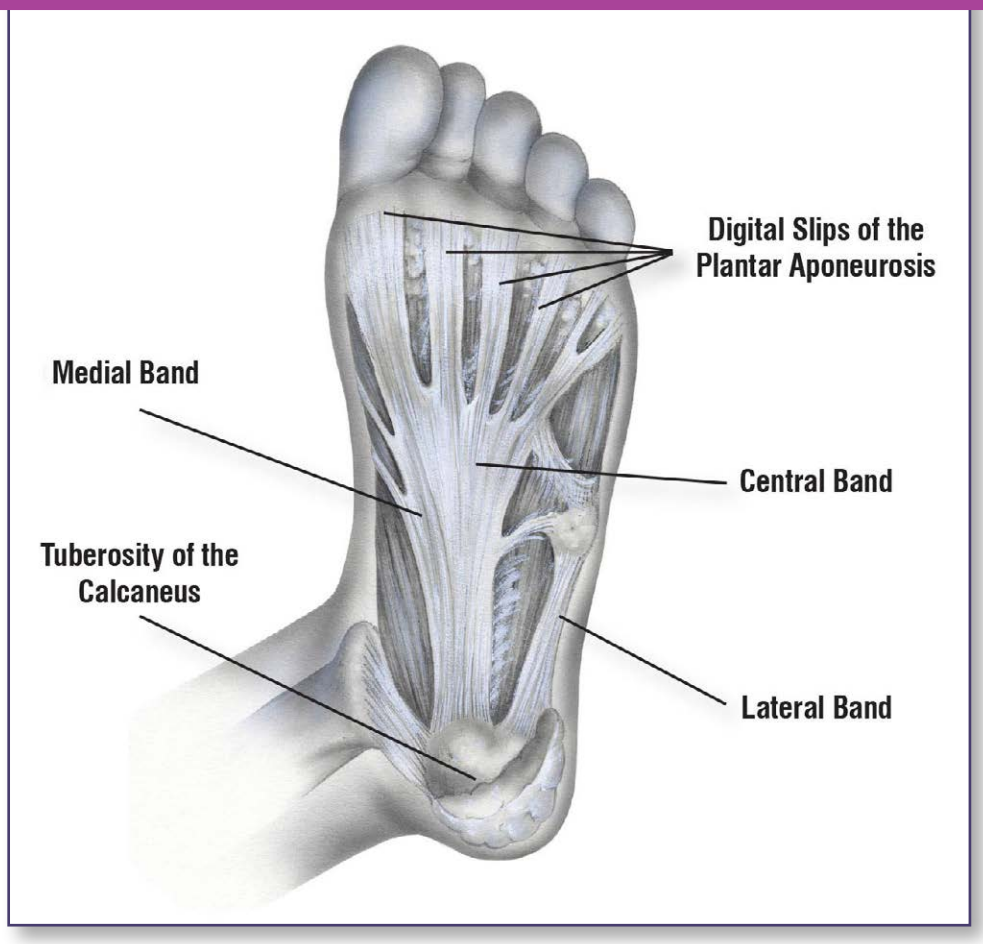

Figure 1. Schematic representation of the anatomy of the plantar aponeurosis.

The plantar aponeurosis (PA) is a broad and thick band of connective tissue that arises from the calcaneus and runs longitudinally to attach to the plantar aspect of the forefoot in 3 distinct sites, thus creating 3 distinct components (i.e., medial, central, and lateral bands). The central aponeurotic band is the thickest component. It divides distally into 5 longitudinal digitations, which insert at the level of each metatarsophalangeal joint capsule (Figure 1). Even from a biomechanical viewpoint, the central band of the PA is often cited as the key supporter of the longitudinal arch of the foot, acting like a windlass and preventing arch flattening. Furthermore, it assists subtalar joint supination during propulsion. This band of the PA is therefore the 1 most often involved in the development of plantar fasciitis.

Plantar fasciitis is the most common cause of adult heel pain, accounting for over 1 million physician visits per year in the United States. It primarily affects the PA enthesis and leads to a chronic, painful, and self-limiting condition. It is the most prevalent running-related musculoskeletal disorder among athletes, but it also affects both physically active and sedentary middle-aged and older adults as well as workers whose activity impacts the foot strongly.

Patients usually complain of persistent inferior heel pain. The classic clinical presentation is a sharp stabbing heel pain, usually more intense during the first steps following long non-weight bearing periods (i.e., first standing after rest; typically, the first steps in the morning or after being seated for a long time). The pain tends to reduce gradually once the patient starts walking. However, it can worsen at the end of the day

This article has been excerpted from "Do the fasciae of the soleus have a role in plantar fasciitis?" from Clin Anat. 2023 Aug 4. doi: 10.1002/ca.24102, by the same authors. Editing has occurred, including the renumbering or removal of tables, and references have been removed for brevity. Part II, which focuses on the critical coordination between the Triceps surae muscle, Achilles tendon, and plantar aponeurosis and the structural and functional coupling between muscles and fascia, will appear next month.

Continued on page 45

Peripheral Artery Disease

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

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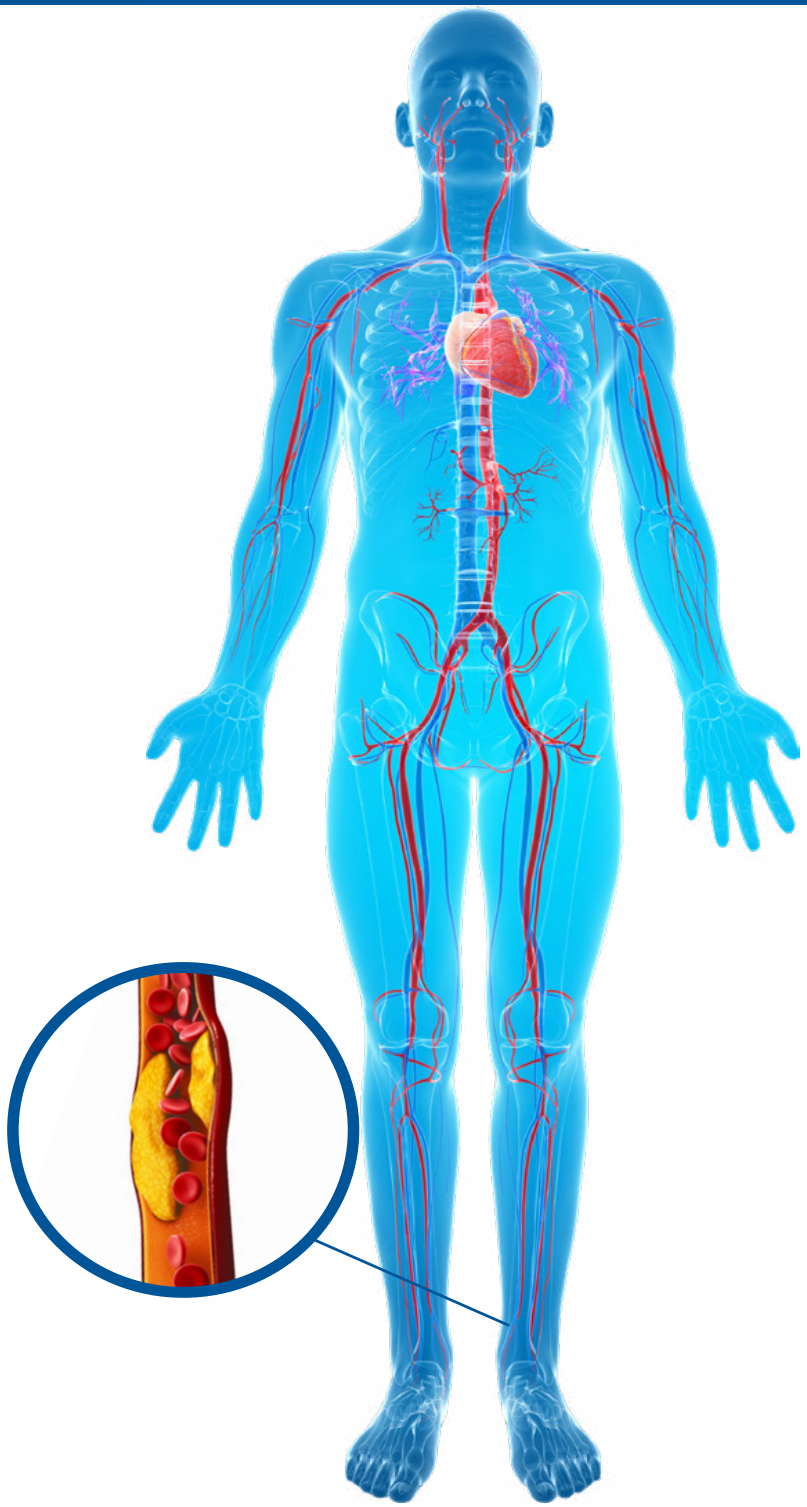

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Continued from page 43

or be exacerbated by prolonged weight-bearing activities.

Despite its high prevalence, the exact etiology and pathological mechanisms underlying plantar heel pain remain unclear. Plantar fasciitis is classically considered an "overuse injury." Among extrinsic factors, mechanical overload is considered a major contributor to the development of plantar heel pain, presumably because excessive and repetitive tensile strain causes PA micro-traumas. Although the previous literature indicated that micro-tears can result in chronic inflammation, histological evidence does not reveal inflammatory cell invasion or inflammatory markers. Thus, the term "fasciitis" seems misused. Nowadays, PA can more appropriately be deemed "plantar fasciosis," implying that its pathological signs are more consistent with a chronic degenerative process and tissue degeneration than with an inflammatory response.

Increased tension on the Achilles tendon (AT) resulting from intense muscle contraction is a major mechanical factor in PA overstraining. Previous studies reported a positive correlation between AT loading and PA tension. As a proof of concept, AT tightness is found in almost 80% of patients affected by plantar fasciitis. There was a strong statistically significant correlation in this condition between isolated gastrocnemius contractures or increased gastrocnemius-soleus complex tightness and heel pain severity. Increased tightness in other posterior leg muscles (eg, hamstring) can also induce prolonged forefoot loading and increase repetitive injury to the PA through the windlass mechanism.

Conversely, if AT flexibility is increased through stretching exercises, the pain symptoms of plantar fasciitis decrease. Similarly, restoring muscle strength and flexibility has reduced the symptoms associated with this condition. Both gastrocnemius and soleus muscle stretching exercises are recommended most often in the current literature.

However, the biomechanical importance of the fascial system cannot be neglected. Indeed, fascial tissue cannot be considered a passive bystander in musculoskeletal dynamics, merely enveloping the muscles. Current literature indicates that the central importance of the fasciae in movement and postural control systems is being recognized. Increasing amounts of experimental evidence demonstrate that the fascial system provides a pathway for force transmission, transmitting, and receiving mechano-metabolic information and thus influencing movement perception, peripheral motor coordination, and proprioception. Thus, one can expect that biomechanical abnormalities within the myofascial unit place excessive stress on the PA and ultimately contribute to heel pain and plantar fasciitis.

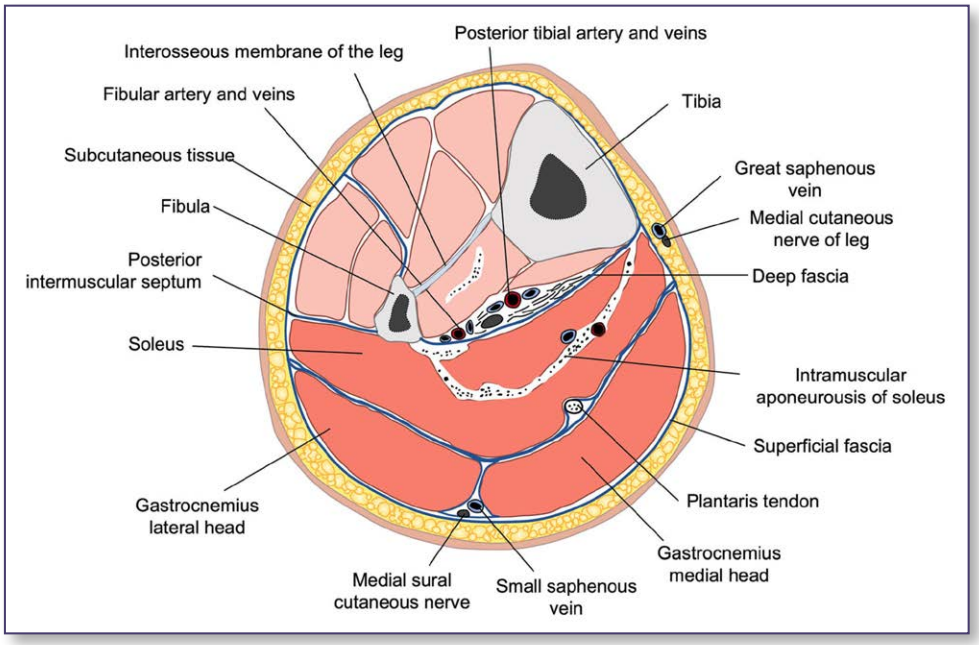

Figure 2. Schematic representation of a cross-section of the lower leg showing all four compartments: anterior, lateral,deep posterior, and superficial posterior. Blue lines indicate the fascial network. Triceps surae muscle components (i.e., medial and lateral heads of the gastrocnemius and the soleus), located within the superficial posterior compartment of the leg, are highlighted in a more intense red.

Therefore, in the present review, after a brief overview of the anatomy of the suro-Achilles-calcaneal-plantar complex of the superficial posterior compartment of the leg, we discuss the complex structural and functional coupling between muscles and fascial tissue, and the possible correlation between myofascial abnormalities, muscle/tendon tightness, and heel pain severity in plantar fasciitis.

FUNCTIONAL ANATOMY OF ACHILLES TENDON

A brief overview of Achilles tendon anatomy

Also termed the calcaneal tendon owing to its attachment to the calcaneus, the AT is one of the thickest, largest, and strongest tendons in the human body. Nevertheless, because it serves as the primary plantar flexing mechanism of the ankle, it is at the greatest risk of rupture, accounting for nearly 20% of all large tendon injuries. Indeed, AT injuries are a very common clinical picture in sports medicine, and they have also become significantly more common within the middle-age, physically active population (i.e., 40–59 years) during the last decade, probably because of the growing popularity of competitive and recreational sports.

Both comparative and ex vivo studies demonstrate the architectural complexity of this tendon. For instance, variations in its twisting structure and the degree of rotation near its insertion on the calcaneal tuberosity have been reported. Reports of the arrangements of the attachments of the AT fascicles to the facets of the calcaneal tuberosity are inconsistent. Also, the relative contributions of the medial and lateral heads of the gastrocnemius and the soleus to the AT can differ among subjects, making the internal AT force distribution even more complicated to understand.

Anatomically, the AT represents the

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conjoined junction of the triceps surae muscle, which is located at the superficial posterior compartment of the leg (i.e., the calf). This complex consists of the soleus and the medial and lateral heads of the gastrocnemius (Figure 2).

The gastrocnemius comprises 2 heads at its origin, medial, and lateral, which insert proximally in the posterosuperior region of the corresponding femoral condyle. The soleus lies deep to the gastrocnemius and superficial to the muscles of the deep posterior compartment of the leg. It originates from 2 heads, tibial and fibular, which are united by a tendinous arch from which additional fibers arise. The tibial origin is at the inferior border of the soleal line, while the fibular origin is on the posterior aspect of the head and about the upper fourth of the diaphysis. Besides the posterior margins of the tibia and fibula, the soleus can also arise from the surrounding deep fascia of the leg. The medial and lateral intramuscular aponeuroses (originating from the tibia and the fibula, respectively) are continuous with the epimysium of the soleus muscle and penetrate distally into the main muscle belly. Distally, from the thickest point of the muscle belly, a central aponeurotic tendon arises within the soleus. These latter fibers then contribute to the AT, along with those of the gastrocnemius, generally inserting on to the most distal part of the AT while the gastrocnemius fibers insert more proximally (Figure 3).

Anatomical dissection studies show that the AT comprises 3 distinct bundles of tendon fascicles (i.e., subtendons), which are distinguishable at the level of the proximal end of the AT, where the distal aponeuroses of the muscles can be separated from each other. One subtendon arises from the soleus and lies deep, and 2 independent subtendons, which lie superficial, originate from each of the 2 heads of the gastrocnemius. The full incorporation of the tendinous portions of the gastrocnemius and soleus is evident almost 10 cm above the AT calcaneal insertion. However, it has been reported that the soleus can remain separated from the gastrocnemius as far down as the calcaneal insertion. Sometimes there is also a small contribution from the tendon of the plantaris muscle (PM). Often dismissed as a vestigial (accessory) muscle, the PM consists of a small, thin muscle belly and originates from the popliteal surface of the femur. A close connection between the PM tendon and the mid-portion of the calcaneal tendon has been reported in 65% of the adult population.

Unlike other tendons, such as those of the wrist and the hand, the AT lacks a true synovial sheath, but is surrounded by a thin sheath of dense connective tissue called a "paratenon." Besides providing a certain degree of tendon gliding, the paratenon is an important source of blood supply and nutrition to the tendon. Histologically, Golgi tendon organs, free nerve endings, and Pacinian-like corpuscles were identified in AT tissue samples from healthy pigs, suggesting a role for the tendon in proprioception.

The paratenon is a thick fibrous layer with few elastic fibers, continuous with the crural fascia, as evidenced by an anatomical study of non-embalmed legs from cadavers. The deep investing crural fascia is a layer of connective tissue enclosing the posterior structures of the calf and connected to the paratenon and AT. However, another magnetic resonance imaging (MRI) study suggested that the fascia cruris and the paratenon exist as 2 separate layers around the AT, though they appear less demarcated toward the AT calcaneal insertion, where they seem to fuse with the posterior subcutaneous structures. Another anatomical and radiological study revealed that the mean distance to the confluence of the AT paratenon and the fascia cruris from the postero-superior calcaneal tubercle is 37.3 mm.

Achilles tendon pathophysiology

As part of Achilles tendinopathy, tendinosis and tendinitis are defined as clinical pictures of tissue degeneration and inflammation, respectively. Although the term tendinosis is universally accepted since the disease has commonly been described as "degenerative," the role of inflammation in tendinopathy is controversial and is still much debated. Some authors argue that the term "tendinitis" could be inaccurate and misleading because infiltration and inflammatory cells (such as neutrophils and macrophages) are not found in chronic tendon disorders. In contrast, other studies have demonstrated macrophages, T and B lymphocytes, and increased levels of inflammatory markers such as interleukin-1 (IL-1), IL-6, cyclooxygenase- 1 (COX-1), COX-2, and TGF-β in chronic Achilles tendinopathy. Tissue biopsies from AT patient cohorts show a complex inflammation signature, expressing target molecules from the interferon, NF-κB, STAT-6, and GCR activation pathways, which suggests established (chronic) inflammation and ongoing tissue repair. Recent data suggest that excessive/pathological levels of force can constitute the mechanical stress that triggers tissue microinjury and a local immune system–mediated tendon repair response. This mechanotransduction-mediated dysregulation of the immune response, which ultimately leads to failed healing, is typical of chronic tendinopathic lesions.

Ultrasonography of subjects complaining of Achillodynia demonstrated that AT symptoms could also be associated with increased paratenon thickness with no sign of tendon tissue involvement. Histological examination of the affected tissue showed that metabolic and inflammatory changes within the Achilles paratenon could precede or parallel those within the tendon tissue itself. Acute exercise or excessive loading can result in alterations of AT paratenon structures known as "paratendinitis," featuring edema, swelling, and lymphocyte infiltration. These alterations result in increased paratenon thickness, which is clearly detectable as increased signal intensity in both sonography and MRI investigations.

Anatomical and structural continuity between the plantar aponeurosis and Achilles paratenon

Functionally, the AT is pivotal in transmitting the contractile forces generated from the triceps surae muscle and producing the ankle plantar flexion torque required for load distribution in the foot. The elastic spring-like properties of the tendon also allow it to store and release energy explosively during walking and running. These functions are closely tied to the morphological and biomechanical relationship between the AT and PA.

A number of randomized control trials have

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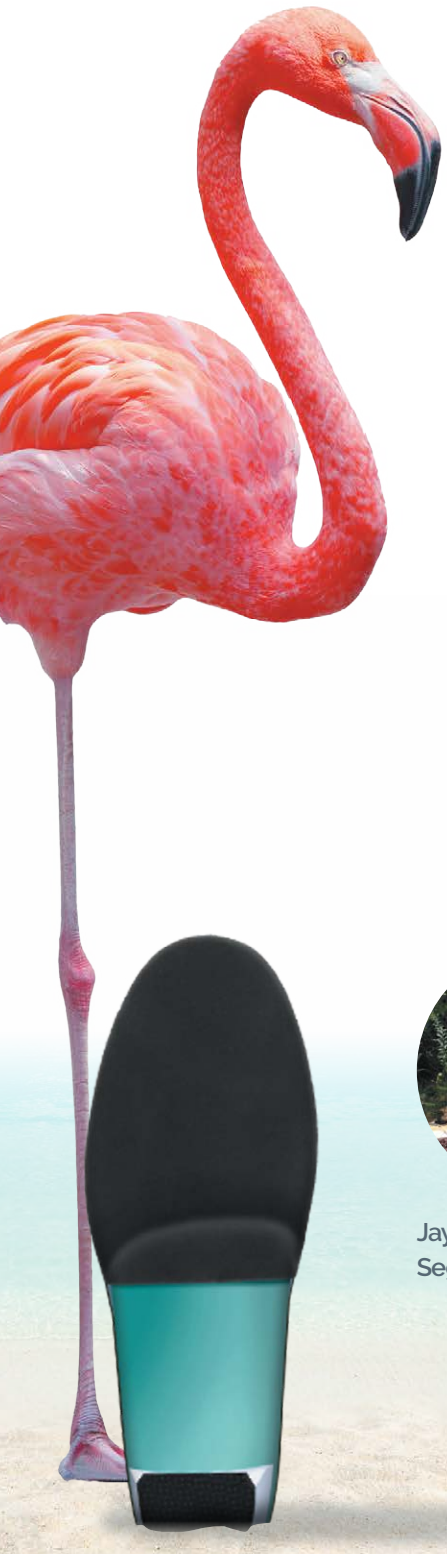

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revealed that AT- or calf muscle–stretching exercises can reduce plantar heel pain and increase the range of ankle motion. In 2003, DiGiovanni et al reported statistically significant pain relief at 8-week follow-up in patients affected by plantar fasciitis who were managed with a standard AT-stretching protocol. Another study reported long-term improvement in symptomatic pain following an AT-stretching program in patients with chronic plantar fasciitis. Similarly, patients without previous treatments for plantar fasciitis obtained significant short-term pain relief by using night splints, which keep the foot in a neutral or slightly dorsiflexed position at rest.

Although the effectiveness of AT/calf-stretching exercises and night splints for treating plantar heel pain substantiates a functional link between the AT and PA, anatomical continuity between these structures is still a matter of debate.

In 2002, Milz et al demonstrated a conspicuous bundle of highly oriented trabeculae in the postero-inferior part of the calcaneus. These trabeculae, which were clearly visible in thick resin sections of hindfeet removed from fresh cadavers, appeared as regularly aligned structures oriented along the lines of force transmission from the AT toward the proximal attachment of the PA. Further morphological and histological examination of plastinated slices revealed a band of calcaneal trabeculae running between the AT paratenon and the superficial posterior and inferior calcaneus toward the PA, surrounded by collagens and adipocytes. Continuity of the PA with the AT paratenon was also confirmed in an anatomical dissection study of unembalmed human leg specimens, which revealed a thin layer of periosteal fibers in the heel.

In line with this, MRI data obtained from patients complaining of Achilles tendonitis and from healthy people highlighted a strong correlation between the thickness of the AT paratenon and that of the PA, further strengthening the anatomical and structural relationship between those structures. There is also evidence of a strong statistically significant correlation between cross-sectional measurements of the AT and PA at their calcaneal insertion. Other studies have argued instead for partial contiguity between AT and PA fibers. This could be because anatomical continuity between these collagenous structures seems to vary with age; it is particularly evident in neonates and younger adults but diminishes during adulthood. The number of AT superficial fibers that become continuous with PA fibers seems to decrease with increasing age, along with calcaneal ossification of the tendon into the bone, which further separates these 2 structures.

Biomechanically, there is increasing evidence for a strong correlation between the AT and PA. Thus, the AT-calcaneus-PA-complex can be seen as a part of a broader myofascial system, where adjacent structures collaborate to spread and transmit the load force. If we consider each of these structures as representing respectively the proximal, intermediate, and distal parts of the conjoined tendon of the calf muscles (i.e., the gastrocnemius and soleus), then it can assumed that even triceps surae structures are involved in the development of plantar fasciitis.

Part II, which focuses on the critical coordination between the triceps surae muscle, Achilles tendon, and plantar aponeurosis and the structural and functional coupling between muscles and fascia, will appear next month.

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Podiatric Pathology in Women with Breast Cancer Undergoing Chemotherapy

By Raquel Veiga-Seijo, Sonia Pertega-Diaz, Maria Eva Perez-Lopez, Lourdes Calvo Martinez, Silvia Antolin Novoa, and Cristina Gonzalez-Martin

Chemotherapy is one of the most widely used therapies for breast cancer. However, little research has been undertaken about podiatric adverse effects.

Chemotherapy—1 of the most widely used therapies for breast cancer—and its effects have been widely studied, including fatigue, nausea, vomiting, changes in appetite, nervous and muscular problems, weight changes, and emotional consequences. Taxane chemotherapy plays a fundamental role in the treatment of breast cancer, and it stands out because it produces side effects that affect body organs in which the foot is involved. Yet little is known about how these therapies impact people's foot health and, consequently, their quality of life (QoL).

To that point, this research aimed to determine the prevalence of podiatric pathology developed in people with breast cancer who receive chemotherapy. Specific objectives are: a) To estimate the prevalence of podiatric pathology (nail, skin, and biomechanical conditions); b) To explore peripheral neuropathy (symptoms of neuropathic origin and sensitivity alteration); and c) To determine foot and general health-related QoL, as well as the functionality and pain of the foot.

Methods

Observational, descriptive, and cross-sectional study was conducted in the Breast Unit and the Oncology Service of the A Coruña University Hospital (northwest Spain). Women with breast cancer who had received more than 2 cycles of chemotherapy or who had completed treatment in the last 4 months (adjuvant, neoadjuvant, or palliative metastatic chemotherapy) and age 18 or older were included. The sample size allowed the study authors to determine the prevalence of podiatric pathology with an accuracy of ± 9% using a 95% confidence interval. As published prevalence estimates are not available, calculations were made using an estimated prevalence of 50% to maximize the sample size.

Sociodemographic, comorbidity, disease and foot health variables, as well as 2 self-administered questionnaires (Foot Health Status Questionnaire (FHSQ) and Foot Function Index (FFI)) were studied.

Results and Discussion

Sociodemographic and clinical characteristics

The patient cohort comprised 117 women (mean age 53.3(12.1) years). Of the 117, 41% had a normal weight, 29.9% were overweight, and 25.6% had obesity. Regarding previous comorbidities, 36.8% had cardiovascular diseases, 23.1% neurological, and 11.1% oncological.

Most of the women were in stage IIA (27.4%) or IIB (22.2%), with 16.2% in stage IV. The most frequent Nottingham Scale classi-

This article has been excerpted from "Foot health and quality of life in women with breast cancer undergoing chemotherapy: a cross-sectional study." J Foot Ankle Res 16, 52 (2023). https://doi.org/10.1186/s13047-023-00650-y. Editing has occurred, including the renumbering of tables, and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

Continued on page 53

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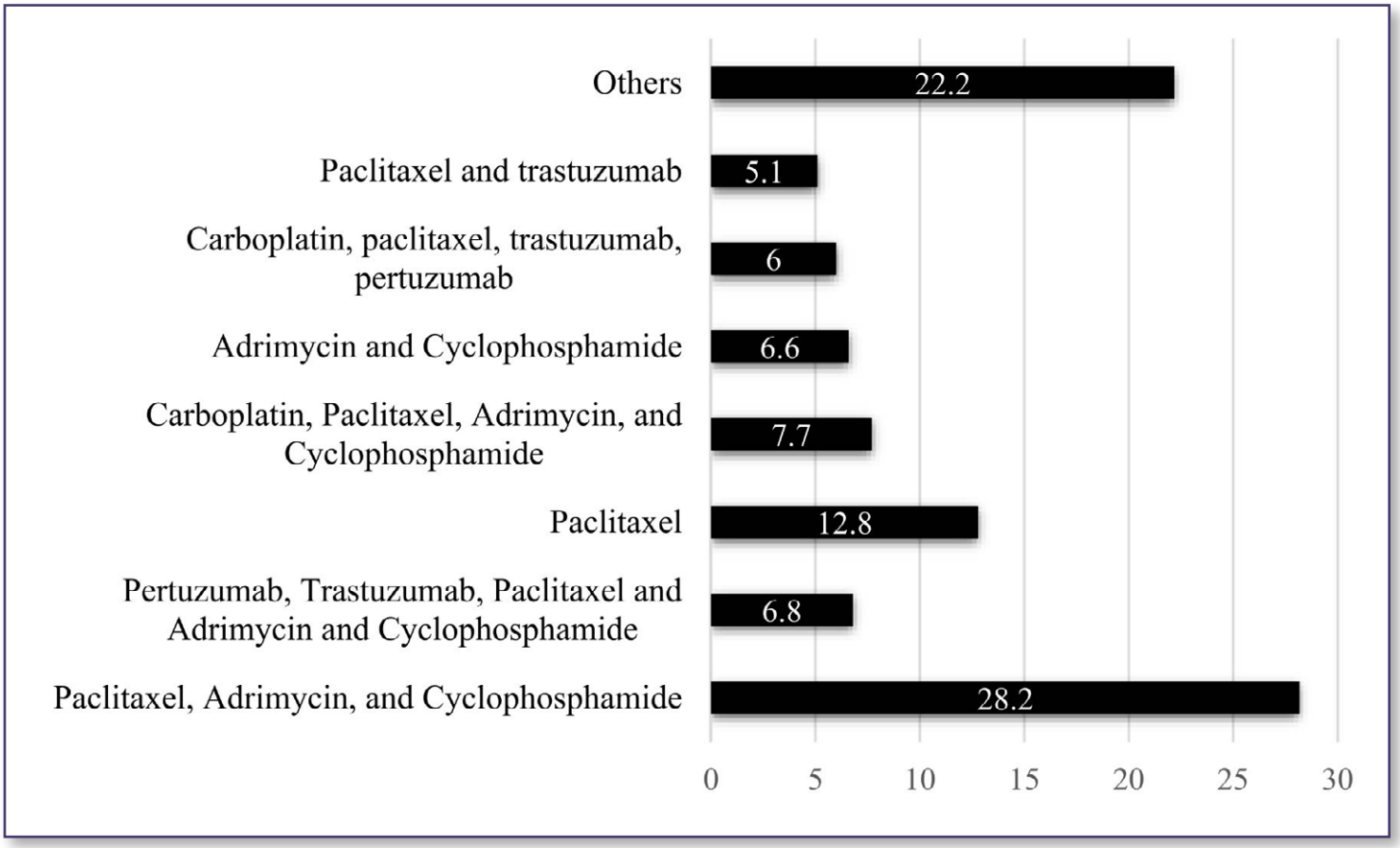

Figure 1. Most common chemotherapy treatment (%).

fication was grade 3 (51.3%) and 2 (45.3%). Regarding the Eastern Cooperative Oncology Group (ECOG) Performance Status, 77.8% presented a score 1. Almost all women (97.4%) reported asthenia (68.4% grade 2; 28.9% grade 3). The treatment plan was mostly neoadjuvant (62.4%). The mean number of cycles received at the time of the visit was 6.8(4.1). In addition, 91.5% received surgery for their disease process and 61.5% radiotherapy.

Foot health problems: structural, nail, skin, and neuropathic origin

Results: At least 1 structural pathology of the forefoot was found in 85.5% of the participants—hallux valgus was most prevalent (74.4%), followed by claw toes (53%). Regarding the hindfoot, 12.8% developed plantar fasciitis. Most of the participants had at least 1 nail pathology (91.5%) and/or skin pathology (88%). Color change in the nail plate was the most prevalent (59.8%), such as diffuse melanonychia (41.9%). Regarding skin pathology, it is worth highlighting problems associated with dryness and higher-pressure points, such as xerosis (62.4%) and hyperkeratosis (65.8%). Additionally, 35.9% of the participants presented with hand-foot syndrome.

Discussion: Different toxicities of chemotherapy have been well studied in the literature and present implications on QoL, and most of them have repercussions on foot health This is the case of hand-foot syndrome, described as the adverse effect that most strongly impacts QoL among the cutaneous effects described. It is essential to identify and manage skin problems, not only to ensure QoL in this patient population, but also so that treatment dose modifications are minimal.

Results: Regarding peripheral neuropathy and associated symptoms, 56% reported having tingling in the feet, 25.6% stiffness, and 7.7% a feeling of imbalance because of chemotherapy treatment. According to the World Health Organization Scale for the study of peripheral neuropathy, 38.5% presented a grade 2, which implies that the pain interfered with the person's functionality. Sensitivity assessment using monofilament showed that about 25% had no sensitivity in any of the points studied.

Discussion: There is a lack of research that attempts to discover how peripheral neuropathy triggers biomechanical or other problems, as well as a lack of research regarding structural and/or biomechanical foot pathologies in this patient population.

Results: The Foot Posture Index revealed the majority had a pronated foot position (67.5% left, 66.7% right). According to the Clarke and Chippaux-Smirak angle, the footprints were mostly normal (62.9% left, 62.1% right; 62.1% left, 71.6% right, respectively). Considering the Staheli Index, the majority were cavus (56.4% left, 49.1% right).

Foot health, health-related QoL, foot func-

Continued on page 55

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Continued from page 53

tionality, and pain were studied with the FHSQ and FFI. Regarding pain, 77.8% presented some degree of pain in their feet. Usually, the pain was at nail level (15.4%), at plantar and nail level (14.5%), in the forefoot (12.8%), at plantar level (11.1%), and metatarsal (9.4%).

According to the FHSQ, the domains with the highest and lowest average scores were foot function (76.0(22.8)) and footwear (30.6(33.5)), respectively. In total, 20.5% received pharmacological treatment for neuropathic pain, 17.1% received topical foot creams, and 6.8% required oral antibiotics due to foot infections. It is important to note that 45 people needed to delay or stop chemotherapy and 2 had to reduce their dose. Of this number, 17 people had these treatment changes due to foot health problems.

Another highlighted point was that 50.4% presented difficulties in finding shoes that do not trigger pain. Likewise, 56.4% participants identified their foot health as fair or poor, and felt limited in walking (65.8%). Finally, the majority had limitations to carry out intense efforts (90.6%) and activities such as cleaning, walking, and day-to-day activities (88.9%).

Discussion: The deterioration of foot health and its corresponding QoL is also associated with aging, yet the patient population studied has a young average age in which no podiatric problems are expected. However, it is known that in the general population, women have a higher risk of experiencing foot health problems. Further, because other studies have already indicated the association of poor foot health with psychological and emotional problems, increasing scores of stress and depression, it is important to consider the significant effect that physical activity has on the emotional and psychological health of people with breast cancer

Conclusion

A better understanding of the importance of this topic starts from being aware that adequate foot health allows for walking and leading an active lifestyle, and is therefore a determinant of health. Podiatric problems represent an important health problem in women with breast cancer who receive chemotherapy treatment. The high prevalence of nail, skin, biomechanical, and neuropathic disorders is striking, being the cause in over a third of the sample of the reduction or suspension of treatment. The results presented call for further research to contribute to the care and wellbeing of people with cancer undergoing treatments such as chemotherapy. Thus, this line of research is a new path to be developed by the podiatry community. ler

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TRANSTIBIAL INNER SOCKET

Xtremity's uniquely crafted flexible inner socket (FIS), the XtremityTT™ FLEX, was designed for patients with transtibial limb loss. This product offering provides a more adaptive socket fit and increases patient comfort within the prosthetic device and along the socket brim. It is compatible with the company's XtremityTT Socket System and other traditional laminated prosthetic sockets. The XtremityTT FLEX can be rapidly fabricated with its initial novel socket system innovation for expedited patient delivery and comes in 3 sizes to cover the company's full socket system range. It also easily conforms to adjustments and changes made to the outer socket shape, even as the patient's residual limb changes. The product requires minimal lab space or equipment when fabricated with the XtremityTT Socket System and has undergone successful studies, verifying its material waste reduction and uniform wall thickness compared to other traditional flexible inner sockets on the market.

Xtremity
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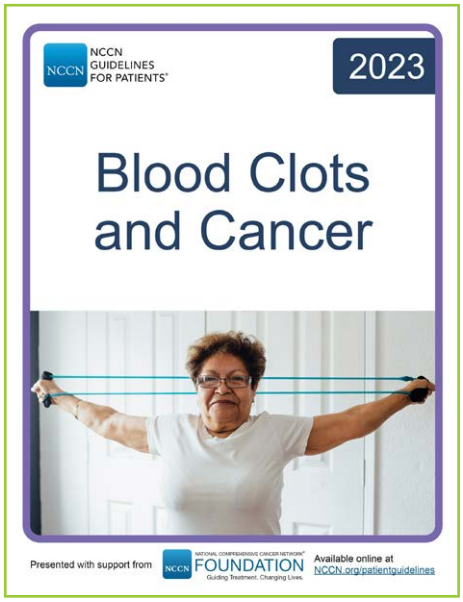
NEW RESOURCE PROVIDES EDUCATION ON CANCER-RELATED VTES

The National Comprehensive Cancer Network (NCCN®) announced the recent publication of a new supportive care patient guideline focused on preventing and treating cancer-associated blood clots, also known as venous thromboembolism (VTE). Research shows that people with cancer are 9 times more likely to experience blood clots than those without cancer. Studies show that blood clots are a leading cause of death for people with cancer, second only to the direct effects of the cancer itself.



This gold-standard resource synthesizes the latest evidence and expert consensus to recommend the best options for patient care. It is regularly updated by a multi-disciplinary panel that includes cardiologists, radiologists, surgeons, pharmacists, and other cancer care professionals from leading centers across the country. Their recommendations are based on over 600 peer-reviewed research articles. This new patient guideline puts NCCN's medical recommendations into easy-to-understand terms, including images, charts, and suggested questions to ask.

The book is available to download for free at NCCN.org/patientguidelines, or via the NCCN Patient Guides for Cancer App, thanks to funding from the NCCN Foundation®. Printed versions are available for a nominal fee at Amazon.com.

COMPRESSION SLEEVES

COMPRESSPORT®'s R2 3.0 sleeves have an exclusive seamless design with multi-gradual compression. The fabric is quick-drying and the specially designed K-Protect band reduces impact. The new 3D weave activates the proprioceptors to improved balance and stability, especially downhill, and targeted areas stimulate microcirculation and reduce inflammation to limit the risk of tendonitis and periostitis and improve lymphatic circulation. The targeted compression on the calves helps to absorb shock and reduce vibration for less muscle fatigue, tiredness, and cramping. Available in 8 colors and 4 sizes.

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ADAPTIVE ANKLE BRACE

The BetterGuard ankle brace uses an intelligent mini-piston to provide stabilization and flexible compression to protect against common ankle injuries without restricting

movement. Developed over 9 years by German engineers and designed for elite athletes, it delivers precision engineering unlike traditional rigid or semi-rigid ankle braces. The world's first adaptive ankle brace offers a full range of motion, providing freedom of movement in an ultra-lightweight design. The system is only activated when a critical situation arises. In the event of sudden ankle twisting or rolling, the adaptive technology inside the BetterGuard will instantly stabilize the joint at the moment of impact. When the danger is over, the adaptive support is automatically released, allowing the wearer to move their foot naturally again within milliseconds. The brace is designed to be worn in games, practice, and training to protect against injury, or for use during injury recovery to return to play.

BetterGuard Technology
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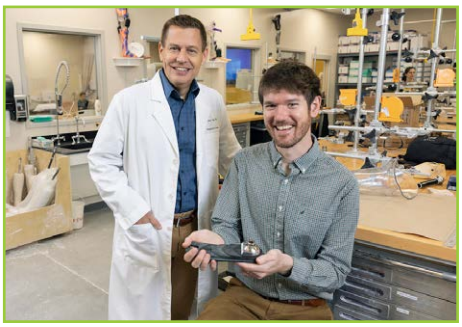
PROFESSOR HELPS LOCAL COMPANY TEST A BETTER PROSTHETIC FOOT



From left, Geil and Bartlett showcase the prototype prosthetic foot that is under development.

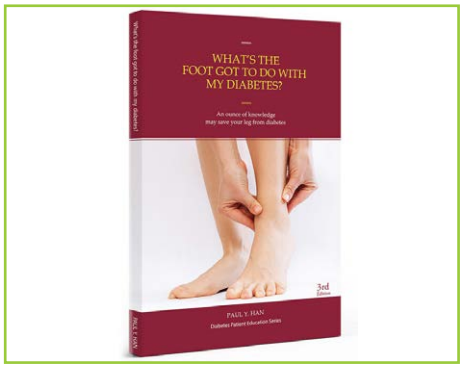
A Kennesaw State University (KSU) researcher is partnering with a local company to refine and test a new type of prosthetic foot that enhances function for people with long residual limbs. Professor of exercise science Mark Geil, PhD, received a grant from the National Institutes of Health's (NIH's) Small Business Innovation Research (SBIR) program to fund the work.

Geil, who is also associate dean for research in the Wellstar College of Health and Human Services, along with 2 students in the Master of Science in Prosthetics and Orthotics (MSPO) program, will work with Little Room Innovations, an Atlanta-based company that creates prostheses and orthoses. Little Room co-founder Harrison Bartlett, PhD, contacted him several months ago, and while Geil said the initial contact surprised him, his background in engineering as well as his successful track record in research no doubt helped lead company officials to seek him out.

Geil and Little Room are testing a prototype that improves upon the traditional rigid prosthetic foot by using a triangular keel inspired by the suspension used in pickup trucks. That keel will make the new foot more flexible and versatile for people with longer residual limbs. Geil said KSU's MSPO fabrication lab has a couple of different slopes and a set of stairs that are useful for testing the new prosthetic foot in everyday activities.

In addition to development of the device, the grant will pay people with limb loss to participate in studies, as well as pay for a high school student with an interest in biomedical engineering to participate on Geil's team.

BOOK OUTLINES SIGNS, SYMPTOMS TO PREVENT DIABETIC FOOT COMPLICATIONS



Paul Han, MS, DPM, DABFAS, DABPM, a renowned podiatrist and diabetes expert with over 30 years of experience, has published a book—"*What's the Foot Got to Do with My Diabetes?*"—that offers an insightful and practical guide for managing diabetic foot complications, aiming to help individuals worldwide to lead healthier lives, free from debilitating complications. Understanding the hidden link between diabetes and foot health is crucial in preventing severe complications, yet it often remains under-emphasized. Through his innovative work, Dr. Han illuminates this critical aspect, offering key insights and practical advice from his vast clinical experience. This book seeks to equip those living with diabetes with knowledge on early detection and preventative care, effectively averting serious health and economic implications that can occur due to late diagnosis. The book is written in a style that speaks to both medical professionals and the general public.

Diabetes Guardians
diabetesguardians.com

NIH GRANT TO BE USED TO DEVELOP ADVANCED TREATMENT FOR DFUS

A team of researchers from the Terasaki Institute for Biomedical Innovation (TIBI) and the University of Nebraska Medical Center (UNMC) has been awarded a $2.2 million grant from the National Institutes of Health (NIH) to develop a superior, multi-pronged wound treatment for diabetic foot ulcers (DFUs).

"The microarchitecture of the dressing plays a pivotal role in rapid wound healing," said TIBI scientist and principal investigator Johnson V. John, PhD. A more porous microstructure accelerates the migration of cells to the wound site to regenerate tissue and promote vascularization, or formation of blood vessels, for fast wound repair and closure. TIBI's treatment approach contains a specific microarchitecture that accelerates wound healing, as well as novel small protein molecules, or peptides, to improve vascularization and infection control.

According to TIBI's Director and CEO,

Ali Khademhosseini, PhD, the dressing will be a more effective, versatile, less costly, and self-administered treatment which will not only increase compliance, but will greatly improve patients' quality of life.

EQUINUS BRACE

Thrive Orthopedics has added the Equinus Brace™ to its portfolio, for which it has been granted exclusive distribution, manufacturing, and patent rights, along with the exclusive lifetime license of all associated intellectual property, from IQ Med LLC, the product's holding company. The brace was invented by Patrick A. DeHeer, DPM, to address the simple problem of night splints and other stretching devices not extending above the knee to engage the gastrocnemius muscle. The tightness of this muscle is associated with many foot and ankle pathologies. To stretch the gastrocnemius muscle, the knee must be locked into full extension. The product will also be available through Thrive's international portfolio as associated regulatory requirements are met.

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WILLOWWOOD UNVEILS NEW BRAND IDENTITY

WillowWood® launched a new brand identity to mark its expansion into multiple new product lines and technologies. The company's new brand identity is a promise to keep pushing the forefront of the orthotics and prosthetics (O&P) industry.

"Our new brand reflects the dramatic progress we have made in broadening our prosthetic solutions for individuals with limb difference, while still honoring our rich 115-year history," said Mahesh Mansukhani, CEO. "It's time for our brand to properly reflect the game-changers that our organization has been launching and will continue to bring to the O&P community."

ORGAN-ON-A-CHIP COULD ACCELERATE DEVELOPMENT OF ARTHRITIS TREATMENTS

Hopkins holding an organ-chip in the lab. Image courtesy of Hopkins.

Researchers at Queen Mary University of London have developed a new organ-on-a-chip model of the human synovium, a membrane-like tissue that lines the joints. The model could help researchers to better understand the mechanisms of arthritis, such as knee osteoarthritis, and to develop new treatments for this group of debilitating diseases.

The new synovium-on-a-chip model is a 3D microfluidic device that contains human synovial cells and blood vessel cells. The device is subjected to mechanical loading, which mimics the forces applied to the synovium during joint movement. The developed synovium-on-a-chip model was able to mimic the behavior of native human synovium, producing key synovial fluid components and responding to inflammation. This suggests that the new platform has immense potential to help researchers understand disease mechanisms and identify and test new therapies for arthritic diseases.

"Our model is the first human, vascularized, synovium-on-a-chip model with applied mechanical loading and successfully replicates a number of key features of native synovium biology," said Timothy Hopkins, PhD, Versus Arthritis Foundation Fellow. "The model was developed upon a commercially available platform (Emulate Inc.) that allows for widespread adoption without the need for specialist knowledge of chip fabrication. The vascularized synovium-on-a-chip can act as a foundational model for academic research, with which fundamental questions can be addressed, and complexity (further cell and tissue types) can be added. In addition, we envisage that our model could eventually form part of the drug discovery pipeline in an industrial setting. Some of these conversations have already commenced."

AERODYNAMIC CYCLING SOCKS

DeFeet's EVO Jet™ sock has undergone extensive wind tunnel testing and results have concluded that the product demonstrates market leading aerodynamics. Test results showed that at 38mph the Evo Jet saves a cyclist 24 watts over shaved, bare legs without socks. Bare legs test results are shown to be more efficient than typical, flat knit non-aero fabric cycling socks. Exactly why socks are so critical in aerodynamics is because they have exposed, front-facing drag surfaces that rotate directly into the wind

with significant turbulence in the area. Wind tunnel testing of the EVO Jet took place at the A2 Wind Tunnel in Charlotte, NC, and was conducted under the watchful eye of renowned cycling aerodynamicist Heath Dotson. Evo Jet was tested using a human rider with yaw angles.

DeFeet
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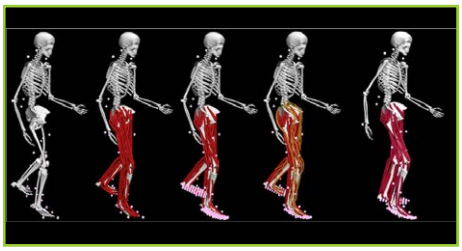
SOFTWARE DESIGNS PERSONALIZED TREATMENTS FOR MOVEMENT IMPAIRMENTS



Schematic of the 4 steps involved in the model personalization process, from personalizing joint models, to muscle-tendon models, to ground contact models, to neural control models, resulting in a final personalized model that can be used to predict the patient's posttreatment walking function. Image courtesy of the Fregly group/Rice University.

A team of Rice University engineers has launched a first-of-its-kind, open-source software that constructs and uses personalized computer models of how individual patients move to optimize treatments for neurologic and orthopedic mobility impairments. Funded by a grant from the National Institutes of Health, the Neuromusculoskeletal Modeling (NMSM) Pipeline software developed by B.J. Fregly, PhD, and collaborators in the Rice Computational Neuromechanics Lab is now available to clinician/engineer teams that would like to utilize computer-aided engineering for clinical treatment design.

The software could be used to design orthopedic surgical plans, neurorehabilitation interventions, physical therapy regimens, and prosthetic devices that maximize recovery of lost function for patients with movement impairments caused by stroke, osteoarthritis, cerebral palsy, Parkinson's disease, spinal cord injury, traumatic brain injury, limb amputation, and even some forms of cancer.

"Our software makes it easy to create a personalized computer model of a patient's neuromusculoskeletal system using the patient's pretreatment movement data, and it then uses that model to predict—and even optimize—the patient's functional outcome for various treatment designs that a clinician wants to explore," Fregly said. "Instead of relying on implicit, subjective predictions of a patient's post-treatment function, clinicians working with engineers could use our software to make explicit, objective predictions, which could not only weed out ineffective or harmful treatments, but also generate highly effective unforeseen ones."

The physics-based software integrates several different physiological models, including models of central nervous system control, muscle force generation, and metabolic energy expenditure. To encourage the research community to use the software, Fregly and his team are running a 4-year competition at the American Society of Biomechanics annual conference. The competition will challenge researchers to develop personalized treatments that improve walking function for 4 individuals who have had a stroke.

To access the software and learn more about the competition, visit https://nmsm.rice.edu/.

PERFORMANCE SHOES FOR FEMALE VOLLEYBALL ATHLETES

The Avoli Low-Top Volleyball Shoe is designed specifically for the demands of women's volleyball and the shape of the female foot. Key features include a higher instep and spread forefoot design to provide ample space for toes to splay and flex, and a thinner and cushioned heel that provides a better fit and prevents slippage and injury. A "hug band" over the top of the foot offers stability and security in the shoe. The proprietary VoliCush Engineered Forefoot Cushioning System combines high-rebound and soft cushioning foams, for spring and impact protection. The VoliVent Ventilation Cooling System features a unique active ventilation system with openings that run through the entire bottom of the shoe. Even the sock liners are equipped with moisture-exhaust holes. Avoli created proprietary sticky soft OctoLug Traction on the outsole that works like the suction cups on an octopus, gripping the playing surface.

Avoli
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Source: Sams L, Langdown BL, Simons J, Vseteckova J. The effect of percussive therapy on musculoskeletal performance and experiences of pain: a systematic literature review. Int J Sports Phys Ther. 2023;18(2):309-327. doi: 10.26603/001c.73795.

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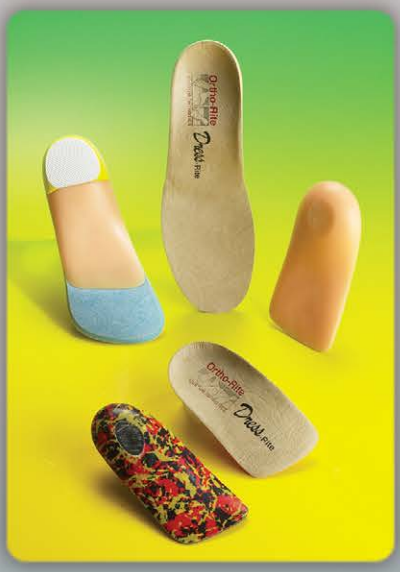

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