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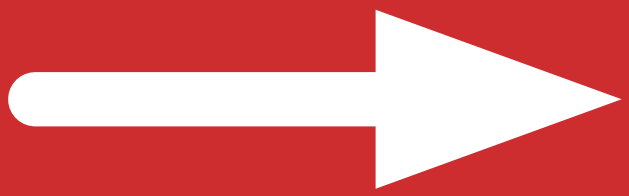

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Lower Extremity Review

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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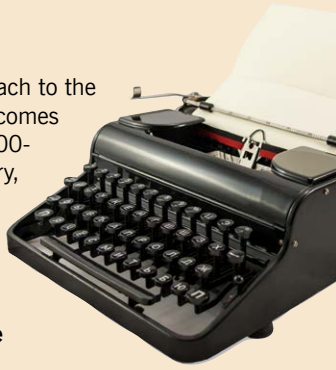

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Guest **Perspective**

Change the Way You Think

Stemming the Rising Tide of Senior Falls

By Jason Kraus, BS

As we celebrate Older Americans Month, it's essential that we ask ourselves what we can do to help stem the deeply troubling and seemingly intractable issue of senior falls. As it turns out, there's a great deal we can do.

The human toll of falls among seniors is substantial, resulting in numerous injuries, disabilities, hospitalizations, and deaths each year, significantly impacting quality of life and independence. According to the Centers for Disease Control and Prevention (CDC), about 36 million older Americans experience a fall each year.[1] One in 4 older adults falls each year in the United States. One out of 5 of these falls causes a serious injury such as broken bones or a head injury. As a result, falls are the leading cause of injury and injury death among adults age 65 and older. Many older adults who fall become less active and independent, requiring more long-term care and support services. This places strain on family members and other caregivers and increases the likelihood of nursing home admission. Additionally, fear of falling can cause some seniors to limit their activities, leading to social isolation, depression, and further physical decline.[2]

The financial toll of senior falls is no less staggering. Falls cost the U.S. healthcare system $50 billion annually,[3] with three-quarters of those costs borne by Medicare and Medicaid. Beyond the direct medical expenses, falls can lead to a cascade of other hidden costs including patient monitoring, lost wages, and lost productivity in the work force.

Virtually every medical practice whose patient population regularly includes seniors see patients at risk for falls on a near daily basis. Typically, however, fall risk is not part of the conversation as these patients are appointed for myriad other issues and fall risk is simply not top of mind. Even patients who struggle as they move from reception room to treatment room or who require assistive devices are likely to leave their appointment without any mention of fall risk management.

Ironically, the recent implementation of Merit-based Incentive Payment System (MIPS) measure 318 – in which patients are assessed for fall risk and asked about falls – has done little to move the needle. First, there is no required, or even preferred, method of assessment. Only a list of options is provided. Nor is there any guidance for clinical recommendation beyond that a referral may be necessary. Refer to whom? Based on what criteria?

The science is clear regarding the single greatest fall risk factor that seniors face: a history of previous falls.[4] Despite this commonly accepted reality, there continue to be missed opportunities between patients who have suffered a fall – and are at a high risk to fall again – and those who treat the consequences of those falls. Consider the more than 300,000 seniors who fall and break a hip each year in the U.S:[1] They're rushed to an emergency room, x-rayed, the fracture repaired or the hip replaced, followed by weeks or months of physical therapy. Patients are then discharged and the falls cycle often continues. What would seem to be more appropriate is a referral rather than a discharge, and lower extremity specialists should establish themselves as the destination for these patients.

What we know is that to move the needle, a holistic, multidisciplinary approach is necessary.[5] Every specialty has a role to play whether as an active participant in a patient's fall risk care, or as an informed and proactive referral source. In a sense, the rest of team is presently on the field, but the quarterback is missing.

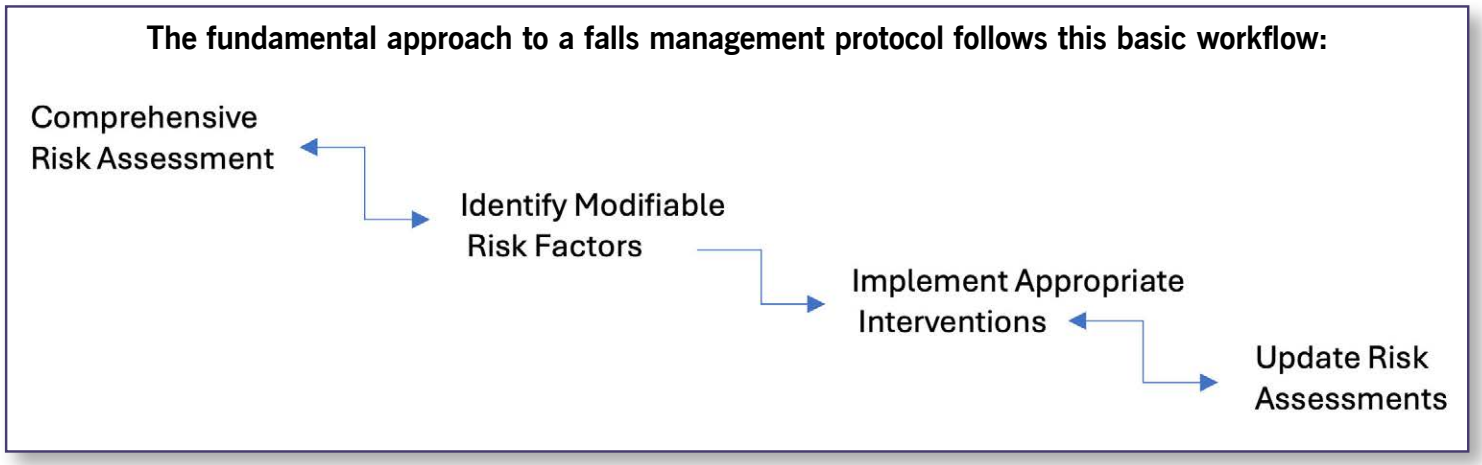
Arguably, the logical specialty to suit up as quarterback is podiatry. In its exhaustive, systematic review of literature on lower-limb factors associated with balance and falls, Neville et al (writing for the National Council on Fall Risk Awareness and Prevention) found 6 highly correlated direct links to lower-limb-related influences on fall-risk in older adults.[6] These included:

- range of motion
- orthoses
- strength
- footwear
- pain
- deformity

They found 2 additional links that they determined to be indirect. These included plantar skin/soft-tissue and sensory-loss. In another ground-breaking study, Wylie et al also established a definitive link between podiatric care and falls management.[7] Logically, and according to the science, Podiatry is best positioned to lead a revolution in senior falls awareness and prevention.

So where to begin? By changing the way you think. Instead of narrowly defining a patient by their chief complaints, broaden the view to include the whole person and their long-term wellbeing. Be open to identifying the unseen or unsaid. (At least half of seniors who have fallen never reveal it to their friends, family or physician.) Be willing to discover more substantial ways in which you can be of service to your patients. If you redefine your role from fixing foot pain to ensuring that patients move comfortably throughout their lives, you can unlock multiple opportunities for preventing life changing injuries.

There are exciting new tools available to



practitioners to easily implement this protocol. Following both CDC and CMS guidelines, Orthotica recently launched its Life in Balance fall risk management program. Anchored by an evidence-based and reimbursable assessment, this straightforward tool helps providers evaluate all primary fall risk factors, establishes a baseline fall risk score, and generates a risk reduction framework exclusive to each patient. Additionally, specially designed AFOs have been shown to be a highly effective intervention for elderly patients who present with muscle weakness or unsteady gait.[8]

The leadership vacuum around senior falls prevention is so colossal that the opportunity for practitioners interested in filling that void is equally vast. Simply raise your hand, and your practice can easily become the destination for preventing and lowering the risk of falls in your community. Much as our cholesterol is regularly checked, all senior patients should be assessed for falls at least annually, and more often for those at high risk. Alert primary care physicians and other potential referrers in your area of your new focus. Reach out to local journalists who write about health and let them know that falls in our senior population are not inevitable and that you have the expertise and commitment to help stem the tide of senior falls in your community. Even if you do nothing more than train your staff to be aware of fall risk and establish a falls protocol for your existing patient population, you will be making a meaningful contribution to the health and wellbeing of hundreds, if not thousands, of older Americans. ler

Jason Kraus, BS, has held executive management positions in the healthcare industry for more than 40 years. Prior to co-founding Orthotica Labs in 2022, Jason served as Chief Revenue and Strategy Officer and Director of OHI, was a Partner in the practice consulting firm S.O.S. Healthcare Management Solutions, LLC, and Co-founder of Benefoot Orthotic Laboratory. In addition to serving on numerous professional boards, Jason is a frequent lecturer at medical conferences world-wide on a wide range of marketing and management topics, and has authored numerous practice management articles that have appeared in professional journals and trade publications.

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BLOOD BIOMARKERS FOR KNEE OSTEOARTHRITIS

Osteoarthritis occurs when tissues in joints break down over time. The disease has become more common worldwide over the past few decades. Diagnosis usually involves finding signs of joint damage on an x-ray. But the disease likely begins long before this damage can be seen.

The early stages of osteoarthritis may offer the best opportunity to stop disease progression and repair joint damage. Thus, there is a need for ways to predict whether people will develop osteoarthritis before damage becomes detectable in medical images.

Earlier, a research team led by Virginia Byers Kraus at Duke University found a set of protein biomarkers in blood serum that could predict the progression of knee osteoarthritis once it appeared in imaging. In a new study funded by the National Institutes of Health, the team looked at whether these proteins could predict the development of osteoarthritis before it could be diagnosed via x-ray. Results appeared in a recent issue of *Science Advances*.

The researchers analyzed serum samples from 200 White women, ages 45–65, who were part of a large study in the United Kingdom. All were at low risk of osteoarthritis based on traditional risk factors. Half of the women were diagnosed with knee osteoarthritis within 10 years, while the other half were not. Women were matched between the groups by age and body mass index (BMI).

As few as 6 biomarkers in the serum samples could distinguish those who developed knee osteoarthritis from those who did not. Furthermore, they could do so up to 8 years before a clinical diagnosis was made. Predictions using these biomarkers were much more accurate than those based on age and BMI, knee pain, or preexisting osteoarthritis in the hip. Many of the biomarkers the team identified were from proteins involved in acute inflammation.

These results provide evidence that the damage to joint tissue that causes osteoarthritis begins at the molecular level, long before any damage can be seen by imaging. This damage may ultimately result from an acute inflammatory response that fails to shut off.

"Currently, you've got to have an abnormal x-ray to show clear evidence of knee osteoarthritis, and by the time it shows up on x-ray, your disease has been progressing for some time," Kraus says. "What our blood test demonstrates is that it's possible to detect this disease much earlier than our current diagnostics permit."

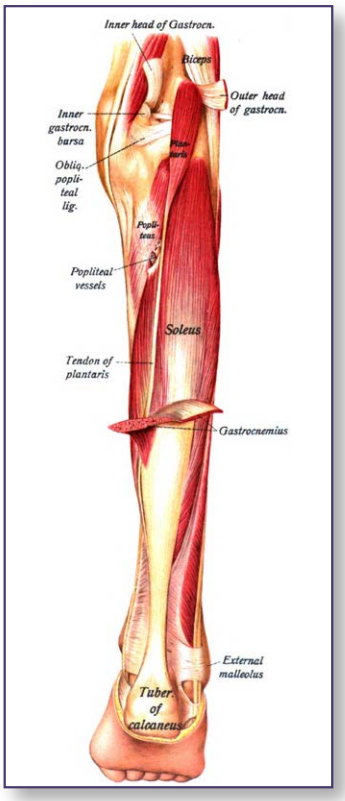
More than half of the biomarkers the team identified also predict osteoarthritis progression after diagnosis. Thus, both the initial development and progression of osteoarthritis may share a similar physiological mechanism. Earlier detection could ultimately allow interventions to slow disease development before it becomes debilitating. ler

Sources: *Kraus VB, Sun S, Reed A, et al. An osteoarthritis pathophysiological continuum revealed by molecular biomarkers. Sci Adv. 2024;10(17):eadj6814. doi: 10.1126/sciadv.adj6814.*

FAILING CONSERVATIVE ACHILLES TENDON MANAGEMENT? CHECK PLANTARIS

Painful midportion Achilles tendinopathy affects athletes at all levels as well as sedentary individuals. While the majority of patients will respond to conservative management therapy, surgery may be required for a sub-group of patients. This study investigated the presence of a normal Achilles tendon, but a tendinopathic plantaris tendon, in a large and consecutive prospective sample of patients referred to a specialized tendon clinic for midportion Achilles tendon pain not responding to non-surgical treatment.

A total of 105 consecutive tendons were operated on in 81 patients (62 males) suffering from painful midportion Achilles tendon pain. Clinical examination, ultrasound (US), and color Dop-



The plantaris is visible under the gastrocnemius.

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pler (CD) examination, and wide-awake local anesthetic no tourniquet (WALANT) surgery were performed in all patients.

For 19/105 (18%) tendons from 14 patients, clinical examination suspected plantaris tendinopathy alone as there was a distinct tenderness on the medial side, but no thickening of the Achilles tendon. US examination followed by surgery confirmed the diagnosis.

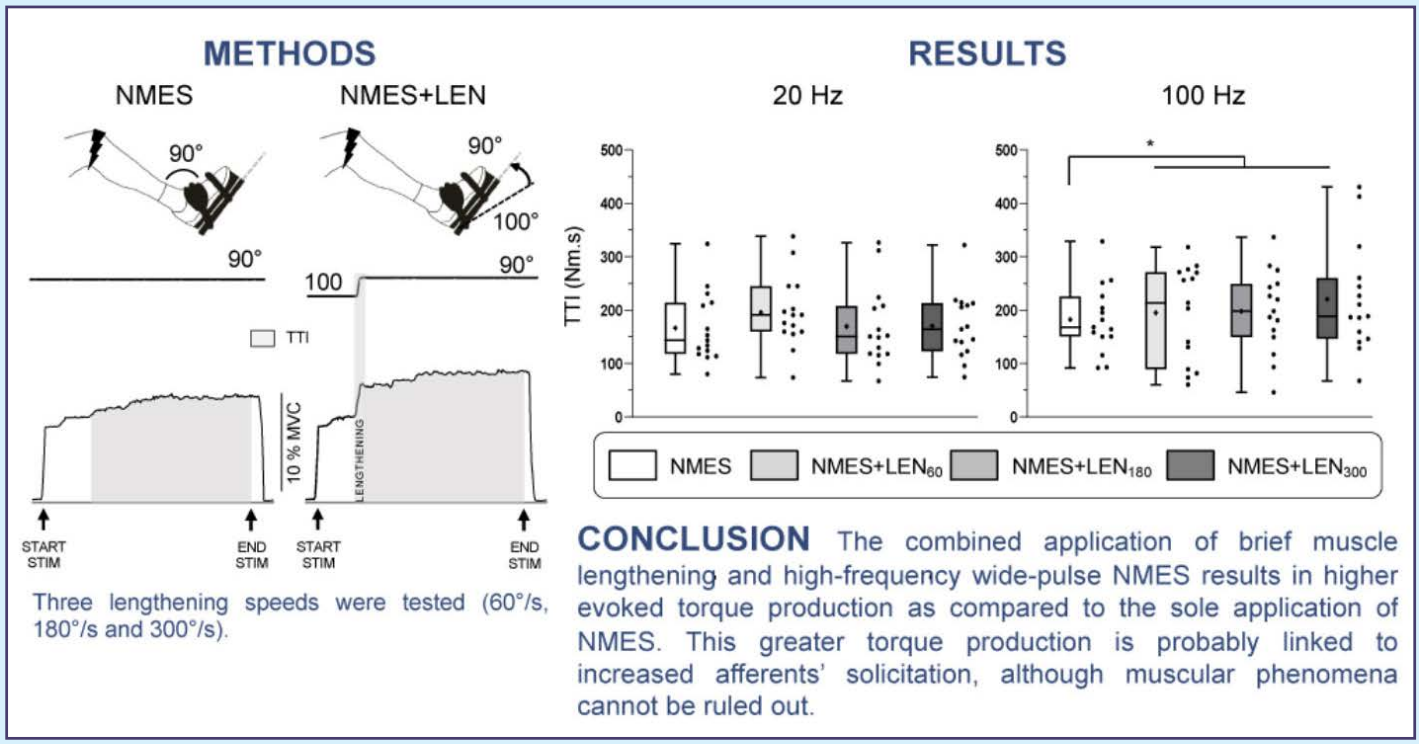
The authors concluded midportion Achilles tendon pain is not always related to Achilles tendinopathy since pain related to the plantaris tendon alone was found in almost every fifth patient. Consequently, there is an obvious need for proper examination to identify the pain source and establish a correct diagnosis before treatment.

Sources: *Alfredson H, Waldén M, Roberts D, Spang C. Tendinopathic plantaris but normal Achilles tendon found in about one-fifth of patients not responding to conservative Achilles tendon management — results from a prospective WALANT surgical case series on 105 tendons. Open Access J Sports Med. 2024 Apr 10;15:41-45. doi: 10.2147/OAJSM.S456389.*

SKIN TEST DETECTS EVIDENCE OF PARKINSON'S AND RELATED DISORDERS

Alpha-synuclein is a protein found in brain and nerve cells. Its normal functions are poorly understood. But when an abnormal form of this protein accumulates in the brain and nervous system, it can lead to serious neurodegenerative disorders. These are collectively known assynucleinopathies. Parkinson's disease is the most common. Others include dementia with Lewy bodies, multiple system atrophy, and pure autonomic failure.

EFFECT OF COMBINED ELECTRICAL STIMULATION AND BRIEF MUSCLE LENGTHENING ON TORQUE DEVELOPMENT



This study showed, for the first time, that the combined application of a brief muscle lengthening and wide-pulse neuromuscular electrical stimulation (NMES) delivered over the posterior tibial nerve can entail increased torque production as compared with the sole application of NMES. This observation, present only for high stimulation frequencies (100 Hz) and independently of the lengthening speed, is attributed to neural mechanisms, most probably related to increased afferents' solicitation, although muscular phenomena cannot be excluded. This finding has potential clinical relevance, especially when it comes to finding ways to enhance torque production to optimize the effectiveness of NMES training programs.

Source: *Pineau A, Martin A, Lepers R, Papaiordanidou M. Effect of combined electrical stimulation and brief muscle lengthening on torque development. J Appl Physiol. (1985). 2024;136(4):844-852. doi: 10.1152/japplphysiol.00671.2023.*

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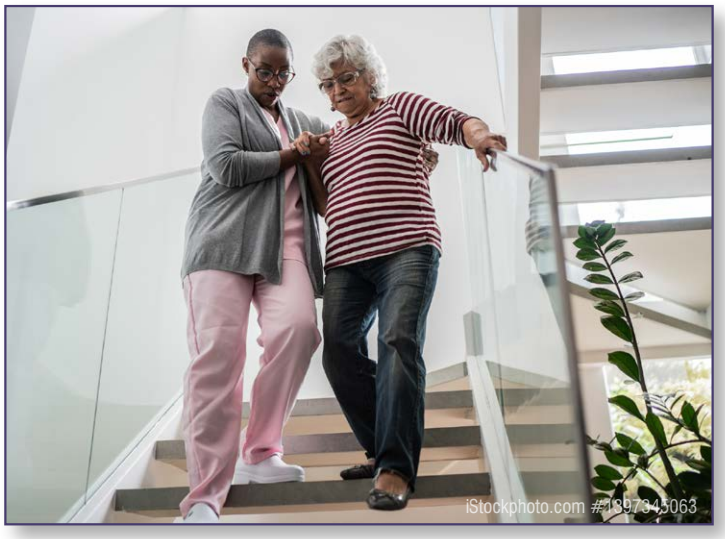

These 4 disorders have some similarities. Common symptoms include tremors, cognitive changes, and progressive disability. There's been no reliable and quantitative way to detect these conditions and measure their severity. Diagnosis often depends on assessment by specialists in movement or cognitive disorders.

A research team led by Christopher Gibbons, MD, of Beth Israel Deaconess Medical Center has been working to identify accessible biomarkers that could aid in the diagnosis of synucleinopathies. They and other scientists had previously found that abnormal forms of α-synuclein (phosphorylated, or P-SYN) could be detected in a variety of body tissues, including skin nerve fibers. They designed a study to test whether the presence of P-SYN in simple skin biopsies could identify people with synucleinopathies. The study was conducted at 30 sites that included both academic and community-based neurology practices.

More than 400 participants were enrolled in the study between February 2021 and March 2023. This included 277 people who had been diagnosed with 1 of the 4 synucleinopathies based on clinical criteria. Another 151 people with no history of neurodegenerative disease served as controls. There were near-equal numbers of males and females.

All participants underwent an expert panel review to confirm their diagnoses. They had small skin biopsies (3 mm) taken from 3 locations: the neck, knee, and ankle. These were then tested for the presence of P-SYN. Results were recently reported in the *Journal of the American Medical Association*.

The team found that skin biopsies could detect a high proportion of participants with synucleinopathies. P-SYN was found in 93% of those with clinically confirmed Parkinson's disease (89 of 96 people). Biopsies were even more successful for the other conditions, identifying 98% of those with multiple system atrophy (54 of 55) and 96% of those with dementia with Lewy bodies (48 of 50). In addition, the biopsies recognized all of the 22 participants clinically diagnosed with pure autonomic failure. In contrast, P-SYN was detected in only 3% of control participants.

Levels of P-SYN in biopsies also correlated with disease severity. The skin biopsies were well tolerated and did not lead to infections or other serious complications.

"Too often, patients experience delays in diagnosis or are misdiagnosed due to the complexity of these diseases," Gibbons says. "With a simple, minimally invasive skin biopsy test, this study demonstrated how we can more objectively identify the underlying pathology ofsynucleinopathies and offer better diagnostic answers and care for patients."

Further study will be needed to validate these findings in patient populations not included in the study and explore how this approach could best be used in the clinic.

Sources: *Gibbons CH, Levine T, Adler C, et al. Skin biopsy detection of phosphorylated α-synuclein in patients with synucleinopathies. JAMA. 2024;331(15):1298-1306. doi: 10.1001/jama.2024.0792.*

IMPROVING CARE FOR SARCOPENIA

Sarcopenia denotes the progressive loss of skeletal muscle mass and strength, typical in older adults. This condition is critical given its association with adverse outcomes like falls, fractures, and increased mortality. Although awareness of sarcopenia has grown, early diagnosis remains challenging due to its gradual onset and non-specific nature until the advanced stages. Understanding the intricacies of sarcopenia, from its evolving definitions to its clinical implications, is fundamental for improving health outcomes in the aging global population. A recent publication from Ooi and Welch looked at the challenges to early diagnosis of sarcopenia including its symptoms, causes, diagnosis, and current treatment strategies.

Limitations of Current Diagnostic Criteria: The diagnosis of sarcopenia currently relies on the identification of muscle strength, size, or quality falling below specific thresholds—a binary approach that can obscure early detection. These diagnostic criteria are often based on muscle strength measurements like grip strength or chair stand tests, confirmed by reduced muscle mass. However, sarcopenia progresses

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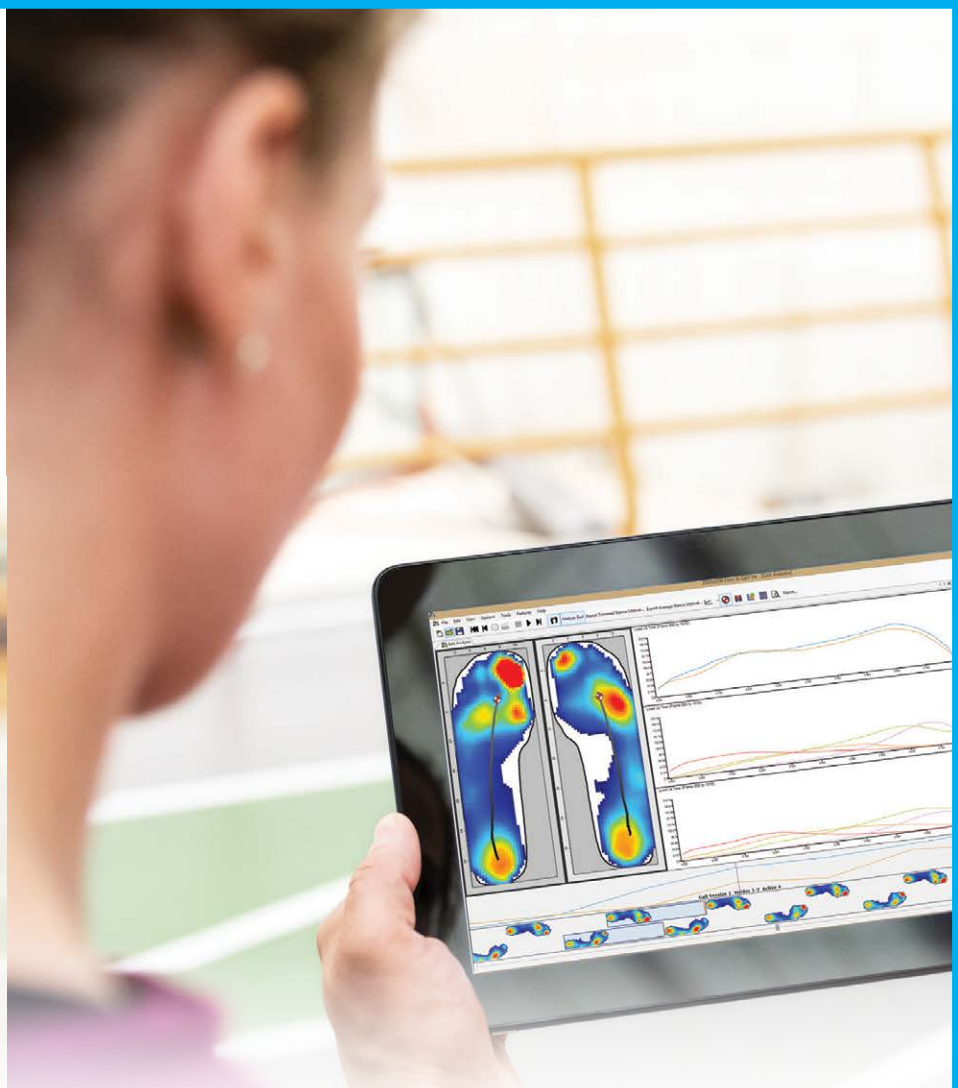

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gradually, making it difficult to catch in its early stages using these static, single-timepoint assessments. Moreover, diagnostic cutoffs vary between different international regions and working groups, leading to potential inconsistencies in diagnosis rates and timing.

Practical & Logistical Issues in Diagnosis: Multiple practical challenges hinder effective sarcopenia diagnosis. Clinically, sarcopenia screening is not routinely integrated into standard assessment processes outside of specialized settings. This lack of routine screening means early-stage sarcopenia can often go unrecognized until more severe symptoms appear. Additionally, the equipment necessary for standard diagnostic tests, like dynamometers for grip strength, is not universally available. This equipment scarcity, alongside the time constraints and varying levels of clinician awareness, impairs consistent and early diagnosis.

Lack of Clinical Awareness & Therapeutic Nihilism: Many healthcare providers lack clinical training in sarcopenia, its implications, and management strategies, which stymies proactive treatment. This situation is compounded by therapeutic nihilism—where clinicians might perceive that the outcomes of intervention are limited, thereby dampening motivation to diagnose or aggressively treat the condition early. Such nihilism is particularly prevalent in the context of conditions related to aging, where inevitable decline is often (mistakenly) assumed to limit the efficacy of interventions.

Complexities in Implementing Treatment Strategies: Implementing effective treatment strategies for sarcopenia involves coordination across multiple healthcare services and specialties, which can be complex and disjointed. Customized exercise regimens and nutritional plans need to be tailored to individual patient needs, requiring input from dieticians, physiotherapists, and often geriatric specialists. Creating a cohesive management plan that accommodates the variations in patient health status, motivation levels, and access to resources further complicates this process.

Availability of Pathways for Interventions: The lack of standardized, accessible intervention pathways is a significant hurdle. There is a stark disparity between the growing body of research suggesting effective sarcopenia interventions and the actual practices institutionalized within healthcare systems. Most healthcare settings lack integrated, streamlined pathways to manage sarcopenia effectively, leading to delays in treatment initiation after diagnosis. Furthermore, the existing infrastructure is often inadequate to support the recommended interventions, such as resistance training programs or comprehensive nutritional support, which limits the practical delivery of care to sarcopenic patients.

Recommendations

Recommendations on sarcopenia focus on enhancing diagnosis, management, and overall care quality. Although there have been significant advances in understanding and treating sarcopenia, the condition often remains under-recognized and undiagnosed in clinical settings, which in turn affects timely management and treatment.

Diagnostic Criteria: To improve sarcopenia care, the integration of standardized diagnostic measures is crucial. The implementation of simple, yet effective diagnostic tools like the SARC-F questionnaire and routine measurements of muscle strength (e.g., handgrip strength) could be incorporated into primary care settings to identify individuals at risk early. As outlined by the European Working Group on Sarcopenia in Older People (EWGSOP2), robust emphasis on muscle strength over muscle mass could lead to early interventions which may prevent the progression to more severe stages of sarcopenia. Providing training for healthcare professionals to utilize these tools effectively can bridge the gap in care.

Leveraging Technology: Utilizing technology such as electronic health records to track indicators of sarcopenia can enhance patient outcomes through better monitoring and personalized treatment plans. Furthermore, developing a standard protocol for the assessment of muscle function and mass using accessible technology such as ultrasound or Bioelectrical Impedance Analysis can aid in more accurate and consistent diagnostic practices across various healthcare settings.

Collaborative Care: A cohesive multidisciplinary approach should be established to manage sarcopenia effectively. Resistance training and nutritional supplementation should be cornerstone interventions. Training healthcare providers to recognize sarcopenia and refer patients to the appropriate services will ensure that interventions are utilized efficiently.

Public Health Initiatives: Targeted public health campaigns and educational programs could focus on preventive strategies incorporating nutritional guidance and physical activity, specifically resistance and strength training exercises suitable for older adults.

Research and Continuous Improvement: Ongoing research into the pathophysiology of sarcopenia, genetic markers, and innovative treatments is vital. ler

Sources: *Ooi H, Welch C. Obstacles to the Early Diagnosis and Management of Sarcopenia: Current Perspectives. Clin Interv Aging. 2024;19:323-332. https://doi.org/10.2147/CIA.S438144*

ANALYZING THERMAL CHARACTERISTICS OF ORTHOTICS LINING MATERIALS

The choice of materials for covering plantar orthoses or wearable insoles is often based on their hardness, breathability, and moisture absorption capacity, although more due to professional preference than clear scientific criteria. An analysis of the thermal response to the use of these materials would provide information about their behavior; hence, the objective of this study was to assess the temperature of 3 lining materials with different characteristics after a 3-h period of use in a clinical setting.

Materials and Methods: The temperature of 3 materials for covering plantar orthoses was analyzed in a sample of 36 subjects (15 men and 21 women, aged 24.6 ± 8.2 years, mass 67.1 ± 13.6 kg, and height 1.7 ± 0.09 m). Temperature was measured before and after 3 h of use in clinical activities, using a polyethylene foam copolymer (PE), ethylene

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Table. Comparison of temperature increments among the three materials.

ROI'S	M1	M2	M3	W Mauchly (Sig)	Pillai's Trace	*p*
	Mean Increase °C					
Hallux	0.36	1.49	0.58	0.932 ($p = 0.302$)	0.213	0.017
1st MTH	1.31	2.43	1.64	0.959 ($p = 0.488$)	0.165	0.047
3rd MTH	1.40	2.54	1.77	0.948 ($p = 0.406$)	0.163	0.049
5th MTH	1.85	2.73	2.16	0.958 ($p = 0.479$)	0.107	0.147
Styloid Process	1.07	2.14	1.48	0.986 ($p = 0.787$)	0.184	0.031
Heel	1.04	2.35	1.00	0.923 ($p = 0.255$)	0.284	0.003
Mean	1.17	2.28	1.43			

vinyl acetate (EVA), and PE-EVA copolymer foam insole with the use of a FLIR E60BX thermal camera.

Results: In the PE copolymer (material 1), temperature increases between 1.07° and 1.85°C were found after activity, with these differences being statistically significant in all regions of interest ($P < 0.001$), except for the first toe (0.36°C, $P = 0.170$). In the EVA foam (material 2) and the expansive foam of the PE-EVA copolymer (material 3), the temperatures were also significantly higher in all analyzed areas ($P < 0.001$), ranging between 1.49° and 2.73°C for EVA and 0.58° and 2.16°C for PE-EVA. The PE copolymer experienced lower overall overheating, and the area of the fifth metatarsal head underwent the greatest temperature increase, regardless of the material analyzed.

Conclusions: PE foam lining materials, with lower density or an open-cell structure, would be preferred for controlling temperature rise in the lining/footbed interface and providing better thermal comfort for users. The area of the first toe was found to be the least overheated, while the fifth metatarsal head increased the most in temperature. This should be considered in the design of new wearables to avoid excessive temperatures due to the lining materials.

Sources: *Querol-Martínez E, Crespo-Martínez A, Gómez-Carrión Á, Morán-Cortés JF, Martínez-Nova A, Sánchez-Rodríguez R. Analyzing the thermal characteristics of three lining materials for plantar orthotics. Sensors (Basel). 2024;24(9):2928. doi: 10.3390/s24092928.*

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Rodeo-Related Lower Extremity Injuries Treated at Hospital Emergency Departments

By Mathias B. Forrester, BS

Background: Rodeo is an extreme sport that has higher injury rates than most other sports. This study described rodeo-related lower extremity injuries treated at United States (US) emergency departments (EDs).

Methods: An analysis was performed of rodeo-related lower extremity injuries using data from the National Electronic Injury Surveillance System of the US Consumer Product Safety Commission during 2000-2022. National injury estimates were calculated for selected variables.

Results: An estimated 10,831 rodeo-related lower extremity injuries were treated at US hospital EDs during 2000-2022, representing 21.3% of the 50,879 total estimated rodeo-related injuries. The affected body parts were 31.2% knee, 25.9% lower leg (not including knee or ankle), 23.1% ankle, 9.3% upper leg, 8.5% foot, and 2.0% toe. The most common types of injuries were contusion or abrasion (32.9%), fracture (26.6%), and strain or sprain (24.1%). The most common mechanisms of injury to the lower extremity were 33.2% stepped on by an animal, 22.5% fell off or thrown by an animal, and 14.3% contact with a structure. The patient age distribution was 8.2% 0-12 years, 43.7% 13-19 years, 25.7% 20-29 years, 15.5% 30-39 years, and 6.9% 40 years and older. Patients were 83.2% male. The patient was treated or examined at the ED and then released in 90.9% of the estimated injuries.

Conclusions: The most common types of rodeo-related lower extremity injury were contusion or abrasion followed by fracture and strain or sprain. Rodeo-related lower extremity injuries occurred because of a variety of mechanisms, the most common being stepped on by an animal and fell off or thrown by an animal. The highest proportion of patients were adolescents, and most patients were male. The majority of patients were treated or examined in the ED and released.

Table 1. Patient demographics of rodeo-related injuries treated in United States emergency departments, National Electronic Injury Surveillance System, 2000-2022

Variable	Lower extremity (LE) injuries		All injuries		LE/total injuries
	Estimate	%	Estimate	%	%
Patient age (years)					
0-12	890	8.2	4,789	9.4	18.6
13-19	4,731	43.7	19,709	38.7	24.0
20-29	2,789	25.7	15,109	29.7	18.5
30-39	1,676	15.5	6,014	11.8	27.9
40+	745	6.9	5,259	10.3	14.2
Patient sex					
Male	9,016	83.2	44,111	86.7	20.4
Female	1,814	16.8	6,767	13.3	26.8
Total	**10,831**		**40,048**		**21.3**

Estimate = Weighted estimate (sum of the Weight numeric field in the National Electronic Injury Surveillance System database). The numbers in the Weight field are not whole numbers but include decimals. As a result of rounding to whole numbers when performing analyses, the sum of the estimates for a given variable might not equal the total. The Consumer Product Safety Commission considers an estimate unstable and potentially unreliable when the number of records used is <20 or the estimate is <1,200.

Rodeo is an extreme sport. It involves powerful forces created by large and often uncooperative or unpredictable animals, including bulls and horses.[1] The Professional Rodeo Cowboys Association (PRCA) sanctions approximately 650 rodeos in about 38 states in the United States (US) and multiple Canadian provinces each year; other rodeos operate independently.[2] Rodeos involve 2 types of event categories: (1) rough stock events include bull (steer), saddle bronc, and bareback riding; and (2) timed events include team roping, tie-down roping, steer wrestling, and barrel racing.[1]

With reports of injury densities of 14.7-16.6 injuries per 1,000 competitive exposures among all events,[3,4] rodeos have higher injury rates than most other sports.[5] Rodeo events differ in risk and mechanisms of injury. Injuries most often result from impact with the ground after falling from or being bucked off the animal or impact with the animal itself, such as being stepped on, kicked, or hit by the animal. Injuries also may occur by impact with the ground when dismounting, being caught in the gear, and contact with rodeo infrastructure (e.g., gate, chute).[3,6-11]

Tracking injuries among rodeo participants is difficult because the participants often travel and compete independently and usually do not have the equivalent of a coach as in traditional sports.[9] The objective of this study was to describe rodeo-related lower extremity injuries managed at US hospital emergency departments (EDs).

Methods

This study used data from the National Electronic Injury Surveillance System (NEISS) available at https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx. Operated by the US Consumer Product Safety Commission (CPSC), the NEISS collects data on consumer product-related injuries from the EDs of a stratified random sample

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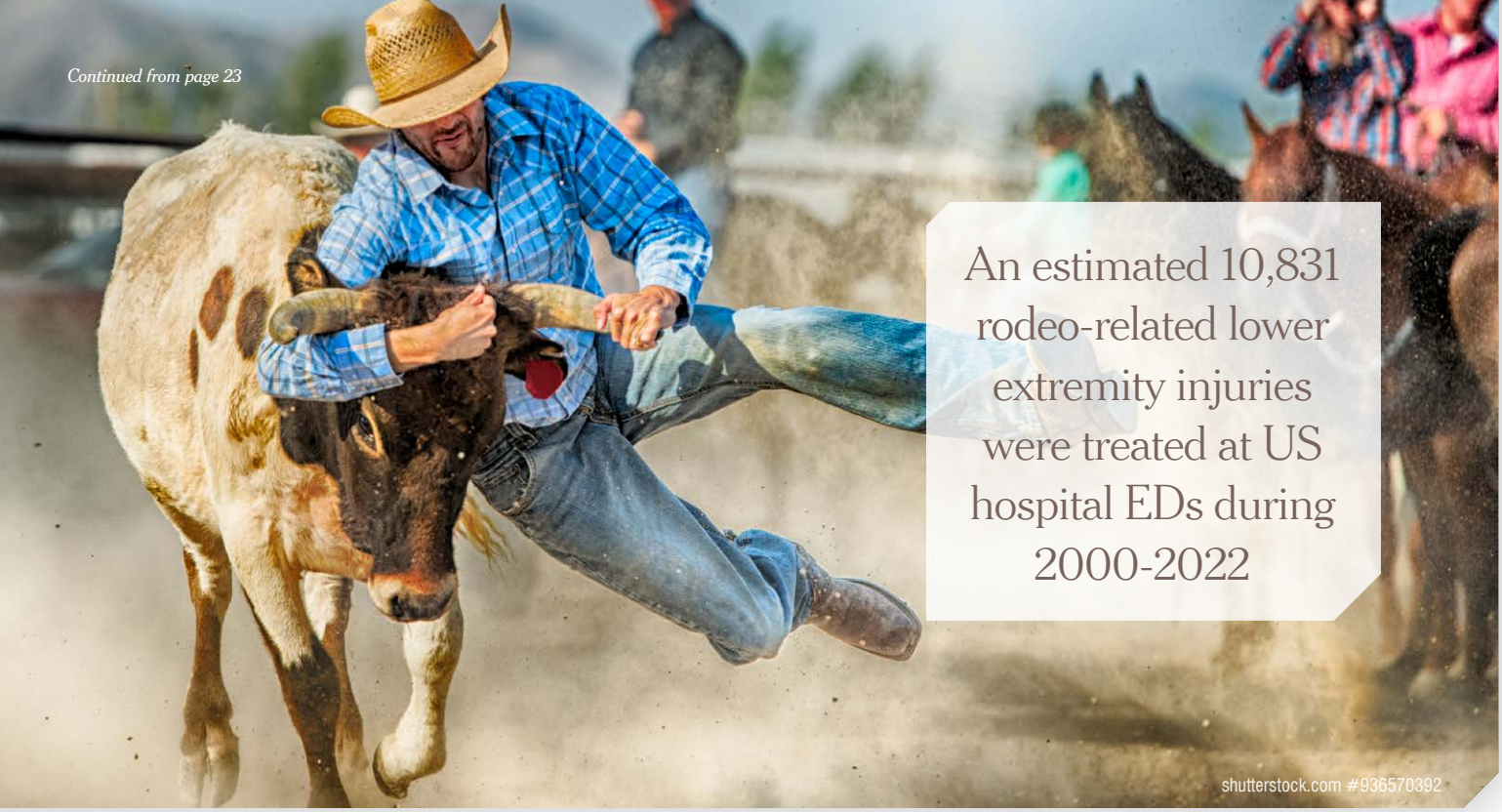

An estimated 10,831 rodeo-related lower extremity injuries were treated at US hospital EDs during 2000-2022

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of 100 hospitals from the more than 5,000 hospitals in the US. The random sample is stratified by hospital size, geographic location, and hospital type (general and pediatric hospitals). Professional NEISS coders view the medical charts at participating hospitals and, for patients with injuries that meet NEISS inclusion criteria, collect and code information such as treatment date; patient age, sex, and race; injury diagnosis and body part injured; discharge disposition; consumer product(s) involved in the injury; type of location where the incident occurred; and a brief narrative describing the incident.[12,13] Data are publicly available and de-identified, so the study is exempt from institutional review board approval. A previously published study used NEISS data to examine rodeo-related injuries among adolescents.[6]

Cases were rodeo-related lower extremity injuries reported to the NEISS database during 2000-2022. The publicly available NEISS database contains three numeric fields for coding the product (or the sports activity) involved in the injury (Product_1, Product_2, Product_3). However, there is no product code specific to rodeos. The NEISS database contains a text field (field name Narrative) that provides a summary of the circumstances of the injury. The NEISS database was searched for all records that included the word "rodeo" in the Narrative field. The Narrative fields of the resulting records were individually examined, and any records that appeared to involve a rodeo-related injury were included in the study. That the injury involved a lower extremity was based on the Body_Part numeric field (a field that documents the injured body part) containing codes for a lower extremity (upper leg, knee, lower leg, ankle, foot, toe). The NEISS database contains another numeric field for documenting whether a second body part was injured (Body_Part_2); however, this field was only added in 2018,[13] although this field does not appear to have been used until 2019. For consistency over the entire study period, only the Body_Part field was examined.

The variables examined were patient age and sex, treatment year and month (grouped into three-month periods), animal involved in and mechanism of the injury, type of injury (diagnosis), affected body part, and disposition. The publicly available NEISS database does not have specific data fields for the type of animal involved in the injury or the mechanism of the injury. For these variables, the Narrative fields of the records were individually examined, and the type of animal involved in the injury and the mechanism of the injury were noted.

For the type of animal, the species of animal was noted except for cattle, where whether the animal was a bull (steer), cow, or calf was grouped separately. This was done because different rodeo events may involve cattle of different sexes and ages, and rodeo events differ in risk and mechanisms of injury.[3,6-11] Records where the patient was injured by rodeo infrastructure (eg, fence, barrel) and no animal was involved were included in the analysis. Previous studies have indicated that rodeo injuries may occur when the person was not actively competing or was not due to interaction with an animal.[6-11]

For the mechanism of the injury, the records were grouped into the following categories based on those included in a previous study:[9]

- Fell/thrown from animal– includes bucked. If the person subsequently experienced another mechanism of injury, such as being stepped on or other contact with the animal, only the latter mechanism of injury was assigned
- Stepped on by animal
- Kicked by animal

Table 2. Circumstances of rodeo-related injuries treated in United States emergency departments, National Electronic Injury Surveillance System, 2000-2022

Variable	Lower extremity (LE) injuries		All injuries		LE/total injuries
	Estimate	%	Estimate	%	%
3-month period					
December-February	1,729	16.0	7067	13.9	24.5
March-May	2,405	22.2	12713	25.0	18.9
June-August	4,140	38.2	20593	40.5	20.1
September-November	2,557	23.6	10506	20.6	24.3
Animal involved					
Bull/steer	5,617	51.9	26783	52.6	21.0
Horse	3,557	32.8	16273	32.0	21.9
All other*	1,656	15.3	7822	15.4	21.2
Mechanism of injury					
Fell/thrown by animal	2,438	22.5	20,788	40.9	11.7
Stepped on by animal	3,592	33.2	9,434	18.5	38.1
Other contact with animal	628	5.8	4,211	8.3	14.9
Contact with structure	1,547	14.3	3,339	6.6	46.3
Caught in gear attached to animal	303	2.8	2,904	5.7	10.4
Kicked by animal	480	4.4	2,539	5.0	18.9
Animal fell on	353	3.3	697	1.4	50.7
During ride on animal	5	0.0	466	0.9	1.0
Wrestling animal	87	0.8	460	0.9	18.8
Dismount from animal	209	1.9	304	0.6	68.8
Dragged by animal	137	1.3	272	0.5	50.3
Other	297	2.7	1,809	3.6	16.4
Unknown	755	7.0	3,656	7.2	20.7
Total	**10,831**		**50,879**		**21.3**

*Includes calf, cow, goat, horse and goat at same time, sheep, animal not involved, unknown. Please see footnote in Table 1.

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- Other contact with animal – excludes being stepped on or kicked by animal; includes being gored by animal
- Contact with infrastructure – includes being caught between an animal and the infrastructure or the animal pushed the person into the infrastructure
- Caught in gear– includes rope cuts and burns
- Other
- Unknown

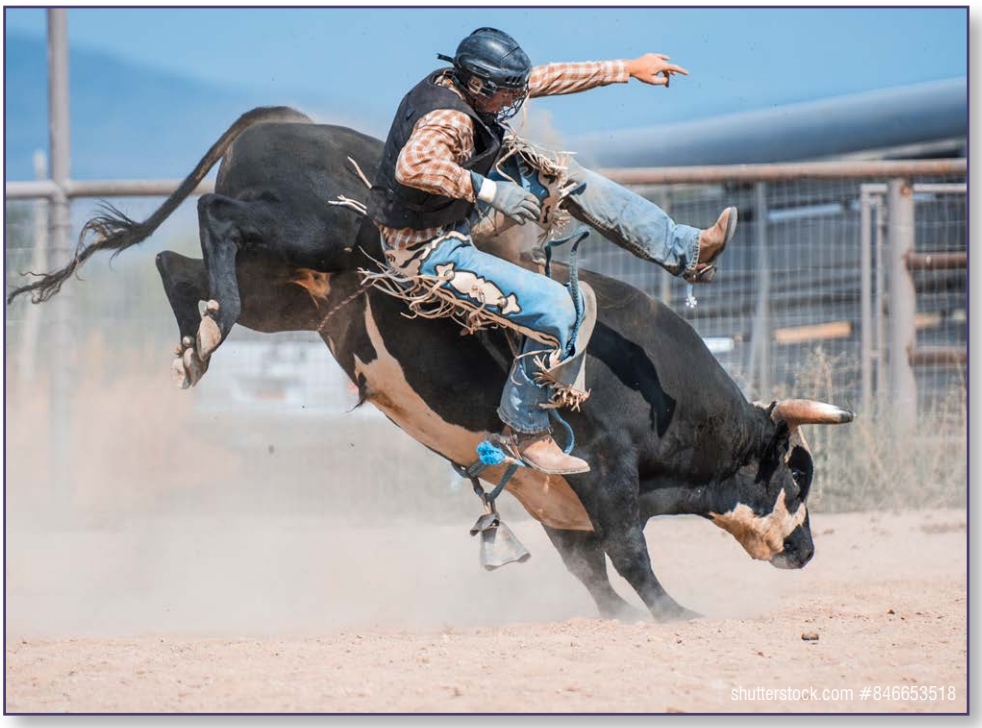
Analyses were performed using Microsoft 365 Access and Excel (Microsoft Corporation, Redmond, Washington, US). For the selected variables, the distribution of the national injury estimates was determined for both total rodeo-related injuries affecting any body part and the subset of rodeo-related lower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

Results

An estimated 10,831 rodeo-related lower extremity injuries were treated at US hospital EDs during 2000-2022, representing 21.3% of the 50,879 total estimated rodeo-related injuries. The distribution of lower extremity injuries by body part was 3,382 (31.2%) knee, 2,805 (25.9%) lower leg (not including knee or ankle), 2,497 (23.1%) ankle, 1,009 (9.3%) upper leg, 924 (8.5%) foot, and 213 (2.0%) toe.

For both lower extremity injuries and total injuries, the highest proportion of patients were age 13-19 years followed by 20-29 years, and most patients were male (Table 1).

There was no clear annual trend in either lower extremity or total rodeo-related injuries (data not shown). Table 2 presents the distribution of rodeo-related injuries by the circumstances of the incident. The highest proportion



of injuries occurred during June-August and the lowest proportion during December-February. Over half of the injuries involved a bull or steer and over 30% a horse. This pattern was observed for both lower extremity and total injuries. For total injuries, the 4 most common mechanisms of injury in descending order were fell or thrown by the animal, stepped on by the animal, other contact with the animal, and contact with a structure. For lower extremity injuries, the 4 most common mechanisms of injury in descending order were stepped on by the animal, fell or thrown by the animal, contact with a structure, and other contact with the animal.

Table 3 shows the distribution of rodeo-related injuries by the type of injury and patient disposition. Total injuries most often involved fractures while lower extremity injuries most often involved contusions or abrasions, and lower extremity injuries were over 75% more likely to involve lacerations. Most patients with lower extremity and total injuries were treated or examined at the ED and released.

Discussion

This study describes rodeo-related lower extremity injuries treated at US EDs over a 23-year period. Rodeo has higher rates of injury than most other sports.[5] Rodeo-related lower extremity injuries might be of particular interest because the current study found that over 20% of total rodeo-related injuries involved the lower extremity.

Eighty percent of the lower extremity injuries involved the knee, lower leg, and ankle, with over 30% involving the ankle alone. This may be due to the particular mechanisms of the injuries, where these body parts were more likely to be injured than other parts of the lower extremity.

Rodeo-related injuries, both total injuries and lower extremity injuries, tended to involve younger individuals. The highest proportion of patients were age 13-19 years followed by age 20-29 years. In addition, most of the patients were male. The high proportion of patients being adolescents may be due to people this age being less experienced and thus more likely to be injured. At least at the high school level, some rodeo events, particularly those involving bulls, are typically available only for male participants (bull riding, bareback, saddle bronc, steer wrestling, tie-down roping), some are available for female participants (barrel racing, team roping, goat tying, breakaway roping, pole

Table 3. Type of injury and disposition of rodeo-related injuries treated in United States emergency departments, National Electronic Injury Surveillance System, 2000-2022

Variable	Lower extremity (LE) injuries		All injuries		LE/total injuries
	Estimate	%	Estimate	%	%
Type of injury*					
Fracture	2,881	26.6	12,775	25.1	22.5
Contusion or abrasion	3,561	32.9	12,502	24.6	28.5
Strain or sprain	2,613	24.1	6,954	13.7	37.6
Laceration	931	8.6	5,256	10.3	17.7
All other/unknown**	844	7.8	6,912	13.6	12.2
Disposition					
Treated or examined and released	9,848	90.9	44,601	87.7	22.1
Treated and transferred to another hospital	418	3.9	2,988	5.9	14.0
Treated and admitted for Hospitalization	560	5.2	2,904	5.7	19.3
Held for observation	5	0.0	294	0.6	1.7
Left without being seen/against medical advice	0	0.0	92	0.2	0.0
Total	**10,831**		**50,879**		**21.3**

*Type of injury includes only the diagnosis listed in the first of two diagnosis fields in the National Electronic Injury Surveillance System database. The second diagnosis field was only used for records during 2019-2022.

**Includes burns, amputation, concussion, crushing, dislocation, hematoma, dental injury, internal organ injury, puncture, other/not stated, unknown.

Please see footnote in Table 1.

bending), and some are co-ed events (team roping, reined cow horse, cutting).[1] Thus, the lower proportion of females with rodeo-related injuries may result from females being less likely to participate in events that have higher risk of injury.[8,9,14]

Rodeo-related injuries were seasonal, with the highest proportion of injuries treated in June-August and the lowest proportion during December-February. Although rodeo events occur throughout the year, the highest proportion take place during the summer months.[1]

Over half of the injuries involved a bull or steer, and over 30% involved horses. Specific rodeo events could not be examined in the study. However, this finding was consistent with the literature that report a higher proportion of rodeo injuries occur in rough stock events, particularly bull or steer riding, than in timed events.[8,14]

The pattern of injury mechanism and

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type of injury for rodeo-related lower extremity injuries differed from that for total injuries. Lower extremity injuries were more likely than total injuries to result from being stepped on by the animal and less likely from falling or being thrown from the animal. Lower extremity injuries also were more likely than total injuries to result from contact with a structure. Furthermore, total injuries most often involved fractures while lower extremity injuries most often involved contusions or abrasions, and lower extremity injuries were over 75% more likely to involve lacerations. This might be expected considering that different mechanisms of injury are not equally likely to affect the same body part or result in the same type of injury.

There are various ways to reduce the risk of rodeo-related lower extremity injuries. Rodeo participants can be trained how to land safely and quickly move away from an animal, or to curl into a ball to minimize body area, when thrown or falling from the animal.[7,9] Matching the animal performance level with the age of the athlete also might reduce risk of injury.[1]

This study has various limitations. Cases were identified by searching for the word "rodeo" in the Narrative field. Thus, rodeo-related injuries where this word was not used would not have been included in this study. Furthermore, the selection of records to be included in the study and the assignment of the animal involved in the injury and the mechanism of injury were performed by a single person. Errors in the selection of records may have resulted in records being included or excluded erroneously. The NEISS database only includes injuries treated at an ED. Many injured rodeo participants may not seek treatment from healthcare providers.[4] Investigation of rodeo-related lower extremity injuries that include information from sources other than EDs might provide a more complete view of such injuries. Specific rodeo events could not be studied, only the animal involved in the injury. Also, injury rates based on the number of competitors or competitor exposures could not be calculated.

In conclusion, rodeo-related lower extremity injuries treated at hospital EDs occurred via a variety of mechanisms, the most common being stepped on by an animal or falling or being thrown from an animal. The highest proportion of patients were age 13-19 years, and most patients were male. The most common type of injury was contusion or abrasion, followed by fracture and strain or sprain. Most patients were treated or examined in the ED and released.

> Lower extremity injuries were more likely than total injuries to result from being stepped on by the animal

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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PROFESSIONAL BULL RIDING IS A GROWING SPORT

Move over pickleball! Professional bull riding is a growing sport across the United States and the world. Viewership of the events—topping 30 million at a time—increases weekly. The Professional Bull Riders (PBR, the leading association of riders) signed a 10-year broadcast deal in 2018 with CBS and another in 2023 with Spanish-language Univision.

Bull riding competitions typically include a bucking bull weighing 1,200-2,000 pounds. These animals are specially bred for their ability to leap, plunge, and spin when a rider is on its back. Their average daily diet includes 10-15 pounds of specially blended high-protein grain plus 15 pounds of high-quality hay per day.

Bucking bulls are treated as athletes, much like racing horses. While they start bucking as early as age 2, they are considered in their prime at age 5-6, with some able to compete even beyond age 10. How often a bull is bucked at any given competition depends on the length of the event and how well the bull performed in his first out of the event. The longer the bull had to work to buck off a rider, the longer the rest they receive.

In a case-control study, 78 bucking bulls were compared against 236 nonbucking controls for medical disorders. While the frequency of medical disorders did not differ between the 2 groups, musculoskeletal disorders were identified in 70.5% of bucking bulls compared to 46% of controls. 55% of the bucking bulls were examined because of lameness with the thoracic limb affected in 44%. Compared to nonbucking bulls, bucking bulls were 13.37 and 3.31 times as likely to have a musculoskeletal disorder of the vertebral region and pelvic limb, respectively.

Intense breeding has led to more aggressive and dangerous animals witnessed by the decline in the number of riders staying on the bull for the 8-second count: 75% in early 1990s down to 35% in 2014.

Professional Bull Riders' Safety Equipment

Helmet: Beginning with the 2013 season, any contestant born on or after Oct. 15, 1994 is required to wear a protective helmet. The Professional Bull Riders (PBR) group leaves the choice of headwear up to any of its riders born before this date. Over 50% of PBR riders choose to wear a helmet and/or mask to help protect them from threatening head blows and injuries to the face and jaw. The helmet is similar to those worn in hockey with some adaptations.

Protective Vest: The vest, invented by PBR Livestock Director and former bull rider Cody Lambert, is worn by the PBR athletes for protection. It serves 2 primary purposes: it absorbs shock and dissipates the blow to the body, while protecting the torso from threatening punctures caused by direct contact with the bull's hooves and horns.

Glove: Riders wear a glove only on their riding hand (the hand that grips the bull rope). This leather glove protects the hand and fingers and makes it easier to hold on to the bull rope.

Rosin: Rosin is used to help the glove adhere to the bull rope. It is a sticky substance that provides a little extra grip.

Chaps: Chaps are custom-made and often display the logo of a rider's sponsors, as well as various decorative elements. Chaps may be flashy, but they are part of the armor that adds a layer of protection for the rider against a bull's horns and hooves.

Bull Rope: The bull rope is a flat rope braided from nylon or grass that goes around the bull's girth area behind his front legs. The rope has a handle, constructed partially of leather that is braided into it and serves as the rider's only anchor for the duration of the ride.

Boots: The boots worn while riding have a special spur ridge on the heel which helps keeps spurs from riding up and resting on the Achilles tendon. Some riders wear the traditional pull-on boot and then add extra wrapping at the ankle, while others prefer those that lace up to fit the foot snugly.

Spurs: Spurs help the rider stay in position on a bull. The rowels are dull so they don't injure or cut the skin of the bull. The spurring action displays the level of complete control of the rider during the ride. ler

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Point of Care Diagnostic Ultrasound in the Evaluation of Patients with Patellar Tendinopathy

By Sarah L. Woelfel, MA, LAT, ATC and Adam B. Rosen, PhD, ATC

Point of care diagnostic ultrasound can be a useful tool for the evaluation, diagnosis, treatment, and risk identification of patellar tendinopathy. Measurements of the patellar tendon that may be useful include tendon thickness, stiffness, and biomarkers of tendon quality which can provide clinicians with a more comprehensive assessment of the histological and healing progress of the patellar tendon. However, for sports medicine clinicians, appropriate training to ensure reliability and proficiency is paramount.

Patellar tendinopathy is a highly prevalent condition that affects individuals of all ages, compromising their abilities to comfortably perform activities of daily living, as well as other physical and recreational activities. While patellar tendinopathy can develop in the general population — one study from a Dutch general medical practice found that lower extremity tendinopathies have prevalence and incidence rates of 11.83 and 10.52 per 1000 person-years[1] – the condition is common among physically active individuals, particularly those involved in running and jumping sports.[1–4] For example, one study showed prevalence of symptoms of patellar tendinopathy was 44.6% and 31.9% for volleyball and basketball athletes, respectively.[5] In a recreational running population, patellar tendinopathy was one of the top 3 most common pathological conditions along with patellofemoral pain syndrome and iliotibial band friction syndrome.[6]

Documented risk factors for patellar tendinopathy include being male, higher body mass index, taller height, younger age, playing surfaces, increased amount of training — including jumping and running, and sports participation.[2,5,7] If mismanaged, patellar tendinopathy can lead to activity restrictions, lengthy therapeutic rehabilitation, and even the end of athletic careers.[3]

An umbrella term for tendon degeneration and inflammation, patellar tendinopathy can lead to daily aggravating pain that requires activity restrictions and long-term rehabilitation and care to treat and manage symptoms.[3] Typically patients report pain that is localized to the anterior knee and can be related back to an increase in the frequency and intensity of physical activities that overload the patellar tendon; such overloading leads to micro-tears and the degeneration of tissue.[3] Signs or symptoms used in the clinical diagnosis of patellar tendinopathy include

- pain localization at the inferior pole of the patella and inferior toward the tibial tuberosity along the patellar tendon,
- load-related pain that escalates with increased intensity or plyometric exercises that stress the patellar tendon,
- little to no pain when resting,
- decreased pain after warming-up and continuing exercise,
- then increased pain the day after exercise.[4]

Diagnosis of patellar tendinopathy is typically clinical, but imaging is common for confirmation and to eliminate potential differential diagnoses and assess tendon integrity.[4]

Common imaging for the patellar tendon is magnetic resonance imaging (MRI) or diagnostic ultrasound (DU) to assess the integrity of the tendon and surrounding structures of the knee.[3] Currently, the accuracy for MRI in diagnosing patellar tendinopathy is approximately 70%, while the accuracy for correctly identifying patellar tendinopathy with DU is about 83%.[8] Compared to MRI, ultrasound also can provide significant real-time advantages to the practicing clinician.

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Diagnostic Ultrasound

Point-of-care DU has become increasingly popular due to its wide availability, cost, safety, speed, and accessibility of the procedure. With continued growth over the last few decades, DU at the point of care has the ability to evaluate tendons for elasticity, tissue stiffness and quality, and tendon health.[9] Typically, studies comparing individuals with patellar tendinopathy with healthy individuals have found differences in ultrasonographic measures, depending on the method used and the location of interest. Different ultrasonographic methods (eg, compression elastography, shear-wave elastography, spatial frequency analysis, etc.) can be utilized to evaluate a variety of tendon properties including anthropometrics, tendon integrity, tissue quality, and stiffness of the patellar tendon. Diagnostic ultrasound can be useful in sports medicine settings for early diagnosis of patellar tendinopathy or tendon abnormalities and has the potential to be used during tendon evaluations as an objective outcome for evaluating the effectiveness of treatment and rehabilitation protocols for patellar tendinopathy.

Tendon Anthropometrics

Basic measurements that can be obtained with DU include tendon length, width, and thickness. Tendon length and width primarily provide more information regarding the basic structure of the patellar tendon, with the potential of observing obvious tendon abnormalities (Figure 1). Some abnormalities may include increased or decreased tendon length due to limb length or subject height.[10] Other deformities that may be observed when measuring tendon length and width are obvious tears or partial tears in the tendon, but those abnormalities may require further evaluation via MRI.

Tendon thickness, meanwhile, may provide more information regarding the condition of the tendon that is clinically relevant. Pathological tendons present with tissue disorganization, which manifests upon evaluation and imaging as a thicker tendon compared to healthy tendons.[11] In addition, scanning the entire length of the patellar tendon may yield differences along the continuum of the patellar tendon, for example at the origin at the inferior pole of the patella or the insertion at the tibial tuberosity (Figure 2). One study that evaluated patellar tendons in athletes found that the proximal patellar tendon was significantly thicker in those with patellar tendinopathy.[12] While another study evaluated patellar tendons in beach volleyball players and noted that individuals with no tendinosis had an average patellar tendon thickness of 4.7/4.8 mm (dominant vs non-dominant knee) while symptomatic athletes demonstrated an average thickness of 7.6/7.0 mm(P <0.001 for dominant knee; P = 0.001 for non-dominant knee).[13] Therefore thickness may be an important metric for clinicians to capture.

Figure 1: Ultrasound image (ACUSON Redwood Ultrasound System, Siemens Medical Solutions USA, Inc., Issaquah, WA) of the patellar tendon with 2 observable deformities. On the right, there is a bony deformity at the distal end of the patellar tendon at the tibial tuberosity. On the left, there is a darkened spot on the patellar tendon at the inferior pole of the patella, indicating inflammation with potential disruption to the patellar tendon.

Figure 2: Ultrasound image (ACUSON Redwood Ultrasound System, Siemens Medical Solutions USA, Inc., Issaquah, WA) of the length of the patellar tendon. There are 3 locations where clinicians may choose to measure the thickness of the patellar tendon (proximal, middle, distal). Thickening of the tendon is a common pathological sequalae of patellar tendinopathy, particularly at the inferior pole of the patella.

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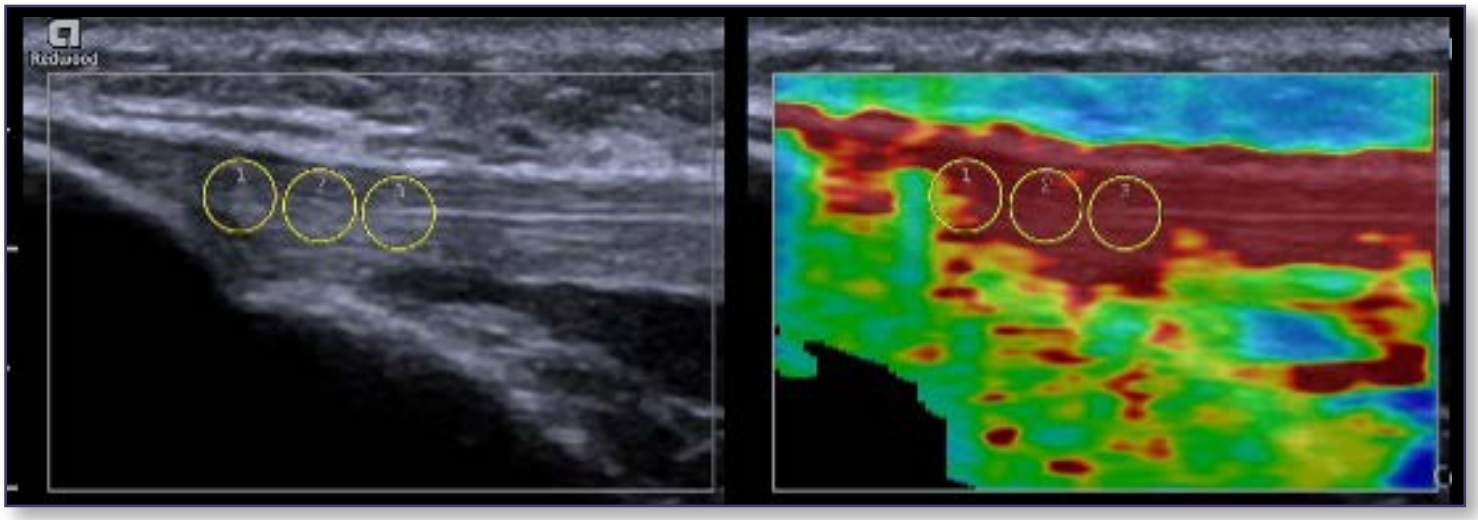

Figure 3: B-mode image of the patellar tendon (left) and an elastogram of the same region of interest (right). On the elastogram, areas of increased stiffness are indicted by dark red. Specific regions of interest can be assessed and quantified, demonstrated by the three diameter circles, which can provide different shear velocities for each region.

Ultrasound Elastography

Ultrasound elastography (USE), first introduced in the 1990's by Ophir et al,[14] has the ability to characterize tendon tissue and their response to stress.[15] Elastography measures the elastic modulus to quantify tendon elasticity. Compared to other imaging options, this measure provides a wide variation of parameters that allows for greater discrimination between tissues and pathologies.[15] Young's elastic modulus, a common metric used to reflect the elastic properties of the tendon, can be estimated by calculating the slope of the elastic portion of the stress-strain curve.[15] There are a few different categories of elastography, including compression elastography (CE) and sheer-wave elastography (SWE).

Compression Elastography

Compression elastography (CE) is characterized by the application of repeated manual compression on tissues by utilizing a hand-held US transducer to reproduce tissue displacements, or strain on the tendon, to exhibit relative elasticity.[15] Using rhythmic and regular compressions of the area, the evaluator is able to target a specific area of interest to observe qualitative strain on the tissue. These strains are collected, and a specialized software is used to display a color-coded elastogram, typically displayed next to the conventional ultrasound image on the screen. In the color-coded elastogram, red frequently indicates soft (high-strain), blue indicates hard (low-strain), green and yellow indicate intermediate stiffness (medium-strain).[16] More deformation is observable in softer tissues, which then experience larger strain than stiffer tissues which experience lesser strain.[15] Successful and accurate measurements with CE depend on the depth of the targeted tissues and probe position, which make this technique more difficult to execute and operator-dependent.[17] If the stress distribution within the tissue is not uniform or standardized during CE, this can affect the Young's elastic modulus measurement that describes the elasticity of the tissue.[15]

Compression elastography has been proven to differentiate between normal and pathologic tissues. In a study comparing CE evaluation of symptomatic and asymptomatic patellar tendons in 75 athletes (average age 33 yrs), symptomatic tendons (n = 38) showed higher strain scores compared to asymptomatic patellar tendons.[18] In addition, neovascularization was detected in 58% of the symptomatic tendons. Another study utilizing CE to investigate patellar tendons (N = 70 patellar tendons) in 35 volleyball athletes found that symptomatic patellar tendons were softer compared to asymptomatic.[19]

And according to Porta et al, CE showed good values for intra-observer and inter-observer agreement in patients with patellar tendinopathy and had an easy training curve.[20]

Shear-wave Elastography

Shear-wave elastography (SWE) can also be utilized to characterize absolute tissue elasticity of soft tissues. SWE involves a perpendicular stress applied to the tissue which produces shear-waves. These waves are then measured with radiofrequency images to create a colored tissue displacement map that is used to calculate shear-wave velocity and shear modulus.[17] Thus, we are allowed to assess the elastogram to evaluate the tendon tissue for elasticity in a more objective way compared to CE since there is no repeated manual compression utilized in this technique. The displacement will display different colors as noted above: red typically defines hard tissue consistency, blue as soft consistency, and green and yellow as in-between. Modifications on tissue elasticity can potentially be detected earlier than observable deformities with conventional ultrasound images most often termed B-mode images in the literature (Figure 3).[15] Studies that investigated SWE demonstrated increased stiffness in symptomatic tendons and increased stiffness in the proximal and mid-patellar region.[21,22]

Specifically for patellar tendinopathy, patients tend to have increased stiffness and have a significant correlation between the increased stiffness and intensity of pain and dysfunction.[23] This same study also demonstrated that symptomatic patellar tendons displayed higher

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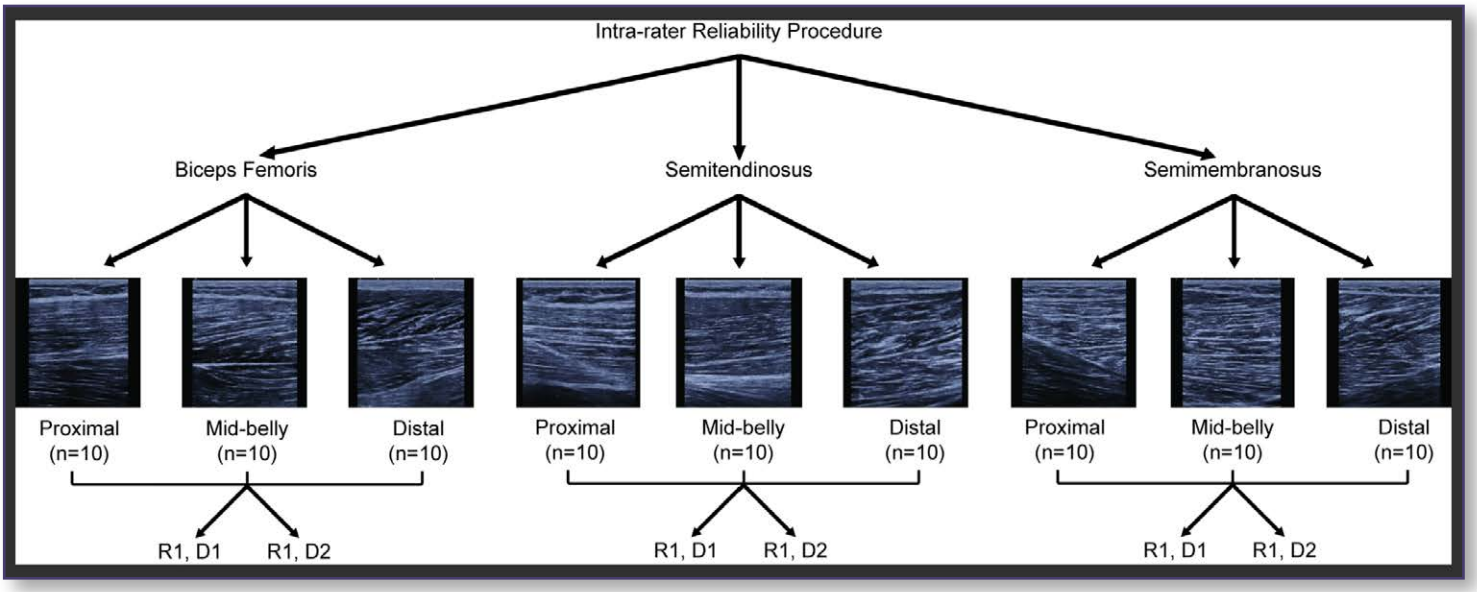

Figure 4: This SFA parameter extraction of the biceps femoris from Crawford et al[31] is an example of the spatial distribution of the acoustic scatters within select regions of interest. These authors noted that such analyses may provide objective determination of tissue organization as a result of injury and subsequent rehabilitation.

shear modulus and were larger and stiffer in patients with proximal patellar tendinopathy.[23,24] It has also been suggested that SWE can aid in the prediction of impeding tendon failure, thus helping clinicians make informed clinical decisions in implementing preventative rehabilitation protocols.[17] Hsiao et al discovered decreased elasticity (decreased elastic modulus) in the patellar tendon in an older age group (aged 60-70 years) compared to 2 younger age groups (20-30 and 50-60 years), thus suggesting the ability to detect aging tendons before visible abnormalities are observed using other imaging methods.[25]

According to several studies, SWE has been shown to produce excellent intra-observer and inter-day reliability and moderate to excellent inter-observer reliability.[23,26,27] Consequently, SWE has been considered more objective, quantitative, and reproducible when compared to CE, since CE requires a certain level of replicability of manual compression with measurements.[15,17] Some limitations of SWE involve sensitivity to angle, pressure, and orientation of the probe along with shallow depths of penetration or region of interests, depending on the specific transducer or ultrasound machine.

Spatial Frequency Analysis

Spatial frequency analysis (SFA) is a specific ultrasound method that can characterize musculoskeletal tissue organization from ultrasound images and distinguish between pathological and healthy tendon tissue.[28–31] SFA is relatively new and can potentially be used for the diagnosis of patellar tendon injury or as a helpful measure for tracking tendon tissue adaptation during the rehabilitation process post-injury.[28–31] Analyzing B-mode images of the patellar tendon will display a speckle pattern in which the brightness of the image depends on the spatial distribution of the acoustic scatters within the tendon.[32] The structure and alignment of the tendon tissues determines the characteristic pattern and intensity.[32,33] One study suggests that disruptions to the speckle pattern occurs with tendon damage and can be observed in patients with tendinopathy and was successful in classifying tendon tissues.[33] Typically higher SFA translates to a well-structured speckle pattern with bands containing mostly parallel fibrils while lower SFA has a less clear banded pattern and more disorganization.[34]

In a case report published by Crawford et al in 2021, a patient had a bilateral debridement of the patellar tendon, and the head researcher evaluated the patellar tendon regularly utilizing SFA ultrasound methods.[28] In this case, they measured the Peak Spatial Frequency Radius (PSFR) of the patellar tendon at four different knee joint angles over the course of the 12-month rehabilitation period and assessed pain and dysfunction via the Victorian Institute of Sport-P (VISA-P). Over the course of the study, they observed an increase in PSFR throughout the rehabilitation protocol, indicating an increase in collagen organization. In another study, Kulig et al analyzed patellar tendon tissue for spatial frequency parameters in volleyball players and determined that symptomatic athletes demonstrated greater collagen disorganization compared to non-athlete controls and asymptomatic volleyball athletes.[35] These authors suggested that painful symptoms are associated with degeneration rather than inflammation only and that assessing patellar tendons with DU can help track changes in tendon structure to determine the proper course of treatment and rehabilitation.

Clinical Implications

Diagnostic ultrasound is cost-effective, non-invasive, reliable, and efficient as an imaging tool that can assist clinicians with the evaluation and diagnosing of conditions like patellar tendinopathy at the point of care. Utilizing DU can provide information related to the intrinsic characteristics of the patellar tendon that can more accurately describe the current state of an abnormal patellar

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Table 1: Overview of Diagnostic Ultrasound Terminology, Definitions, Measures, and Clinical Implications.

Ultrasound Terminology	Definition	Measures	Clinical Implications
Tendon Anthropometrics	Using B-mode, diagnostic ultrasound images to measure general characteristics of the patellar tendon.	Tendon Width, Length, and Thickness	• Increased tendon thickness can indicate presence of patellar tendinopathy.[11] • Tendon length and width can characterize tendon abnormalities.[10]
Compression Elastography	Ultrasound method used to evaluate strain on the tissue to describe tendon stiffness, particularly using manual stress to evaluate the strain, thus describing the tissue elasticity.	Relative tissue Stiffness/Elasticity (Semi-Quantitative)	• Symptomatic patellar tendons tend to be softer, with higher strain.[15] • More difficult to do due to specific technique and operator dependency.[17]
Shear-wave Elastography	Utilization of shear waves applied perpendicular to the tissue to provide local stress and generate displacement of tissue that describes tissue elasticity.	Absolute tissue Stiffness/Elasticity	• Patients with symptomatic patellar tendinopathy tend to have increased stiffness in the patellar tendon.[23] • More objective than CE.[17] • Decreased elasticity with age noted in few studies.[25] • Excellent reliability in accessing stiffness using SWE.[23]
Spatial Frequency Analysis	Diagnostic ultrasound method evaluating speckle patterns in B-mode images that describe the structure and alignment of tendon tissues.	Tendon Quality and/or Pathologic Recognition	• High SFA = well structure/ parallel fibers (higher quality), indicating healthy tendon tissue.[34] • Low SFA = more disorganized fiber pattern (lower quality), indicating patellar tendon pathology.[34]

tendon (Table 1). These can be leveraged to provide guidance to clinicians in terms of understanding the pathology, creating treatment and rehabilitation protocols for altered tendon morphology, and informing clinical decision making.

Point of care DU use in the orthopedic and sports medicine field is rapidly developing. There are clear benefits to implementing this imaging tool to inform practice and improve patient care. But the use of DU is limited depending on settings, accessibility, and user proficiency. Clinicians seeking to implement ultrasound into their daily routine require proper training in the physical utilization of this technology and the ability to interpret images to maximize the benefits of DU at the point of care.

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Surgical Management of Chronic Achilles Tendon Rupture: Evidence-based Guidelines

By Shi-Ming Feng, Nicola Maffulli, Francesco Oliva, Amol Saxena, Yue-Feng Hao, Ying-Hui Hua, Hai-Lin Xu, Xu Tao, Wei Xu, Filippo Migliorini, and Chao Ma

Abstract: Chronic Achilles tendon ruptures (CATR) often require surgical intervention to restore function. Despite numerous treatment modalities available, the optimal management strategy remains controversial given the limited high-quality evidence available. This article aims to provide evidence-based guidelines for the surgical management of CATR through a comprehensive systematic review of the available data. The consensus reached by synthesizing the findings will assist clinicians in making informed decisions and improving patient outcomes.

Results: Nine statements and guidelines were completed regarding surgical indications, surgical strategies, and postoperative rehabilitation protocol.

Conclusion: Based on the findings of the systematic review, this guideline provides recommendations for the surgical management of CATR. The study authors are confident that this guideline will serve as a valuable resource for physicians when making decisions regarding the surgical treatment of patients with CATR.

Introduction

The Achilles tendon is the largest and strongest tendon in the human body, connecting the muscles of the gastrosoleus complex to the calcaneus. The Achilles tendon is important to maintain the standing posture, and during walking, running, and jumping. Tears of the Achilles tendon are classified as chronic after a 4- or 6-week period following the initial injury. Patients with chronic Achilles tendon rupture (CATR) report weakness, instability, increased dorsiflexion of the ankle, swelling, tenderness, and thickening of the tendon, and, at times, persistent pain.

In the 1970s, surgical interventions for Achilles tendon ailments gained popularity as they offered better outcomes and lower re-rupture rates compared to non-surgical methods. The traditional surgical technique involved an open repair, where the surgeon made an incision to directly access the ruptured tendon and suture it back together. This approach showed good clinical and functional outcomes, but it often required a relatively large incision, and resulted in increased scar tissue formation. Minimally invasive and percutaneous techniques have emerged as an alternative to open repair. These techniques reduce surgical trauma, minimize scarring, and allow faster recovery. Advances in surgical techniques have further refined the management of CATR. The use of endoscopic or arthroscopic methods has gained popularity enabling surgeons to visualize and repair the tendon through smaller incisions. These minimally invasive procedures offer advantages such as reduced postoperative pain, faster recovery, and improved cosmetic outcomes. Overall, the history of surgical management for CATR has witnessed a shift toward less invasive techniques, improved surgical outcomes, and the exploration of regenerative therapies.

Currently, the treatment of CATR is highly challenging, with many techniques and marked variations in treatment methods. There are also considerable differences among various surgical approaches, and consensus has not yet been reached. Therefore, to further provide a reference for clinicians in selecting surgical methods for CATR, the study authors have formulated this guideline through expert consultations and critical structured analysis of the published peer-reviewed literature. This guideline aims to comprehensively summarize the current research achievements and provide the most valuable information for the clinical practice of surgical treating CATR.

Methods

A group of 9 foot surgeons in 3 continents was consulted to gather their expertise on guidelines regarding the surgical management of CATR. Following the proposal of 9 clinical topics, a thorough and comprehensive search of relevant literature published since 1980 was conducted for each topic using electronic databases, including PubMed, MEDLINE, and Cochrane Library,

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to identify relevant studies published until October 1, 2023. All authors collaborated in drafting, discussing, and finalizing the recommendations and statements. The recommendations were then categorized into 2 grades: grade a (strong) and grade b (weak), following the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) concept. Additionally, feedback from 21 external specialists, who were independent from the authors, was taken into account to further refine and finalize the clinical guidelines.

Determination of evidence level and grading of recommendations

The determination of recommendation grades followed the GRADE (Grading of Recommendations Assessment, Development, and Evaluation) approach, which categorizes evidence levels according to different study types. Well-conducted randomized controlled trials (RCTs) or high-quality systematic reviews of RCTs were classified as high-quality evidence (A), while observational studies (lesser quality RCTs or strong evidence from observational studies) were regarded as having a moderate-quality evidence (B). RCTs with significant limitations, or evidence from observational studies with a high risk of bias, or cohort studies were classified as low-quality evidence (C). Case reports and expert opinions were considered to have very low-quality evidence (D).

GRADE assigns recommendations into 2 categories:

a. Strong recommendation: This indicates that the desirable effects of an intervention clearly outweigh the undesirable effects (or vice versa) for most patients. Most individuals would choose the recommended intervention.
b. Weak recommendation: This indicates that the desirable effects of an intervention likely outweigh the undesirable effects (or vice versa) for most patients, but the balance may vary depending on individual circumstances or patient preferences.

> When the defect is minimal, primary repair has the advantage of preserving the patient's native tissue and restoring the original anatomy of the Achilles tendon.

The strength of the recommendation is based on several factors, including the quality of evidence, the balance between benefits and harms, values and preferences, costs, feasibility, and resource implications. Hence, a recommendation grade of aA signifies strong and high-quality evidence, while a grade of bD indicates weak and very low-quality evidence.

Results and Discussion

What are the indications for surgical treatment of CATR?

Recommendation. In (1) patients who exhibit functional impairment (i.e., pain, inability to perform a single heel rise, disability in walking and climbing stars) after 6 months of conservative management; (2) athletes or active individuals; (3) physical physical examination that reveals positive calf squeeze and knee flexion tests; (4) MRI or ultrasound scans confirmed CATR, a surgical management is indicated (aC).

Statement. No investigations related to the surgical indications for CATR or a comparison between surgical and conservative treatments for CATR were identified. However, studies focusing on the surgical management of CATR were reviewed, specifically those with evidence levels A to D. The researchers carefully analyzed the inclusion criteria of the identified studies to observe and determine the surgical indications for CATR. Following the above search strategy, 16 studies were included, of which 1 study was grade A, 1 study was grade B, 6 studies were grade C, and 8 studies were grade D. The most common conditions for which surgical management is indicated were CATR patients exhibiting signs of functional limitation, such as pain or tenderness, inability to execute a single heel raise, or repetitive single-leg heel raise endurance exercises, as well as difficulty in walking and ascending stairs, along with ankle swelling; these symptoms were accompanied by positive results in the call squeeze and knee flexion, and their diagnoses were confirmed through MRI or ultrasound examinations (16 studies). Across all the studies, it was evident that preoperative imaging tests were routinely obtained, signifying that surgical judgments should rely on the corresponding imaging outcomes, with ultrasound and MRI being the most frequently employed supplementary examinations. In 3 studies, patients received conservative treatment for a period of 6 months before undergoing surgery, which included physical therapy and the use of anti-inflammatory medications. In the future, controlled studies comparing non-surgical and surgical treatments for CATR will be necessary to more conclusively establish surgical criteria. However, the ethics behind performing such studies involving non-surgical options are challenging, given the present evidence, which suggests that surgery is associated with better outcomes.

Is it possible to primary repair the stump of the CATR?

Recommendation. When the defect of the 2 stumps of the CATR is no more than 2 cm, primary repair after [refreshening] the tendon edges can be attempted (aD).

Statement. Direct repair of the stump of the CATR in end-to-end fashion would be an ideal option. However, owing to the tendon adhesions and atrophy of the gastrocnemius, suture [of] the stumps of the CATR [is quite] challenging. Although according to Myerson's classification and Kuwada's classification, a tendon defect of 2 to 3 cm could be managed with end-to-end repair, the results of these guidelines have not been assessed in a scientific fashion, even by the

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Patients who underwent peroneus brevis tendon transfer had a delayed return to sports but a higher likelihood of resuming high impact sports when compared to those who received the FHL transfer.

authors reporting them. In extreme [plantarflexion], although some defects can be directly sutured, this will increase the tension on the tendons, prolonging the postoperative recovery time and mobilization. When the defect is minimal, primary repair has the advantage of preserving the patient's native tissue and restoring the original anatomy of the Achilles tendon. It can potentially lead to faster healing and recovery, as well as reducing the need for more complex procedures like tendon flap or tendon grafting. The study authors stress, however, that no comparative study has been performed, and that, given the atrophic nature of the tendon stumps in CATR, it does make sense to use grafts to bring new vital tissue to the chronic rupture site.

When should tendon flaps be used?

Recommendation. V-Y advancement tendon flap is a safe and reliable strategy for CATR with the gap less than 5 cm. Local fascial turndown flaps can be used for an anatomic repair of CATR with a large gap more than 5 cm. Large scar, calf atrophy, and reduction of tendon strength are the major drawbacks (aC).

Statement. Lin et al employed V-Y tendon plasty on 20 patients with CATR who had a tendon gap of 5 cm (ranging from 4 to 9 cm). The study reported a significant improvement in American Orthopedic Foot and Ankle Society Score (AOFAS) and Achilles Tendon Total Rupture Score (ATRS) scores ($P < 0.001$) after a follow-up period of 32.8 months. However, isokinetic strength analysis was not performed. Guclu et al performed a study on 17 patients with CATR who underwent V–Y tendon plasty with a fascial turndown flap following a debridement procedure for an average 6 cm Achilles tendon defect (ranging from 4.5 to 8 cm). Patients experienced a significant reduction in plantarflexion peak torque at both 30 and 120 degrees, which was attributed to gastrocnemius recession and correlated with the size of the tendon defect. Additionally, the mean calf atrophy measured 3.4 cm (with a range of 1–6 cm) after an average follow-up period of 195 months. Raju et al presented a study on 12 CATR patients with a tendon gap exceeding 8 cm, where they utilized a gastrosoleus turndown flap along with V-Y plasty. After an average follow-up period of 34 months, the major limitations observed were a preoperative calf diameter loss of 3.4 cm and a noticeable decline in plantarflexion strength on the affected side. Studies involving larger sample sizes and a prospective study design are desirable.

When should tendon transfer be used?

Recommendation. When the defect is between 3 and 6 cm, a local tendon transfer [peroneus brevis tendon transfer or flexor hallucis longus (FHL) transfer] procedure should be taken into consideration (aC).

Statement. Peroneus brevis tendon transfer and FHL tendon transfer can effectively reconstruct the Achilles tendon defect less than 6 cm without considerable tension. They reduce the necessity for extensive soft tissue procedures such as turn down flaps or V-Y plasty. Biomechanically, the peroneus brevis tendon exhibits increased load to failure compared to the tendon of FHL. The current evidence suggests that individuals who undergo peroneus brevis tendon transfer experience a more gradual return to sports in comparison with those who undergo FHL transfer. It should be noted that peroneus brevis tendon transfer results in most patients regaining their ability to engage in preinjury sports and daily activities. The operated ankle may have lower peak torque and eversion strength compared to the unaffected limb, although such differences, though statistically significant, are of dubious clinical significance. Maffulli et al employed peroneus brevis tendon transfer to reconstruct the CATR with the defect of 4.0 to 6.5 cm in 16 patients. At the 15.5-year review, the patients retained good functional outcomes. However, permanently impaired ankle plantarflexion strength and decreased calf circumference are the major complications. Peroneus brevis tendon transfer is viable to enable recreational athletes and non-athletes to resume their sports activities, but it may not be the appropriate solution for young competitive athletes. Patients who underwent FHL transfer experienced significant satisfaction without any impact on the function of their hallux. On the other hand, patients who underwent open FHL transfer retained nearly normal maximum strength but exhibited reduced endurance compared to the unaffected limb. Additional augmentation following FHL transfer did not show statistically significant results. Further augmentation following FHL transfer did not produce any further positive effects and is not warranted.

Peroneus brevis tendon transfer versus FHL transfer—which is better?

Recommendation. Patients undergoing either procedure could receive comparable long-term functional results (aC).

Statement. No study comparing the 2 techniques was found to provide conclusive evidence of one method having a clear advantage over the other. Maffulli et al conducted a comparison between peroneus brevis tendon transfer (n = 20) and FHL transfer (n = 21) in CATR patients with a gap

of less than 6 cm. Patients who underwent peroneus brevis tendon transfer had a delayed return to sports but a higher likelihood of resuming high impact sports when compared to those who received the FHL transfer. According to Maffulli et al and other researchers there was a reported improvement in Achilles tendon total rupture score and AOFAS following peroneus brevis tendon transfer. An additional 20 studies reported comparable outcomes regarding the Achilles tendon total rupture score and AOFAS after performing the open FHL Transfer. Patients undergoing either peroneus brevis tendon transfer or FHL transfer can anticipate experiencing similar functional outcomes.

No significant functional deficit has been documented, and although a statistically significant loss in peroneus brevis strength has been reported, patients do not report any increase in episode of lateral ankle instability. The use of peroneus brevis tendon transfer is therefore to be considered a suitable tendon transfer option in selected patients.

Open versus endoscopic FHL transfer procedure for CATR–which is better?

Recommendation. Patients undergoing either procedure could receive comparable long-term functional results (bC).

Statement. Currently, there is no available comparative study examining the differences between open and arthroscopic FHL transfer for CATR.

The use of flexor hallucis longus (FHL) tendon transfer presents a suitable option to restore continuity in CATR patients with excellent results. Notably, certain researchers have recently presented endoscopic approaches for the transfer of FHL. A total of 22 patients with CATR underwent endoscopic FHL transfer, and the average follow-up period was 30.5 months. The AOFAS score improved from 55 before the operation (with a range of 26–75) to 91 (with a range of 74–100) postoperatively. Additionally, all patients successfully resumed their daily activities without any complications or difficulties. A systematic review found that endoscopic FHL transfer resulted in reduced complications compared to open FHL reconstruction, while still achieving favorable clinical outcomes and allowing patients to return to their preinjury activity levels. Despite the appealing advantages of this technique as a minimally invasive procedure, the surgeon remains vigilant about the potential complications. In the study by Zou et al, 19 patients with CATR underwent endoscopic FHL transfer, and they were followed up for an average of 31 months. The ATRS and AOFAS scores showed significant improvement, increasing from 23.3 ± 10.3 and 52.1 ± 12.4 to 98.3 ± 9.2 and 97.5 ± 18.9, respectively. Notably, 12 relatively young patients were able to achieve a return to their preinjury activity levels. Nevertheless, given the lack of comparability in sample sizes between the groups, further studies are required to reach a definitive conclusion.

When should free tendon graft be used?

Recommendation. Free tendon graft would be recommended if the gap of the CATR is larger than 6 cm (aC).

Statement. While the FHL transfer and gastrosoleus turndown flap techniques have been employed in patients with CATR involving gaps exceeding 6 cm, the utilization of free tendon grafts was more prevalent. In CATR patients in whom the gap between the stumps was greater than 6 cm, Maffulli et al employed free grafts from the gracilis tendon for the reconstruction procedure. In the cohort of 15 patients, an average follow-up of 10.9 years revealed sustained positive functional outcomes, despite enduring limitations in ankle plantar flexion strength and reduced calf circumference. Performing minimally invasive reconstruction of the Achilles tendon in patients with a gap exceeding 6 cm, utilizing a free graft from the ipsilateral semitendinosus tendon, leads to notable improvement of symptoms and enhancement of function. However, patients should be advised that full recovery of calf circumference and ankle plantarflexion strength is unlikely to be achieved. Nilsson et al conducted endoscopic reconstruction using ipsilateral semitendinosus autografts in the management of CATR, with favorable results in a cohort of 22 patients. In a series of 15 CATR patients who underwent endoscopic-assisted reconstruction using autografts from the hamstring muscles, isokinetic testing at a 2-year follow-up revealed a minor and statistically not significant difference in strength between the affected and unaffected sides. While the use of tendon allograft to patients with CATR has yielded favorable clinical outcomes, their effectiveness necessitates further validation and confirmation.

When to start range of motion and weight bearing?

Recommendation. Early range of motion of the knee and toes is advised to avoid the limitations of joint immobility. Patients can be encouraged to bear as much weight as possible on the second day after surgery aided by below-the-knee walking cast and elbow crutches. Two-weeks post-surgery, patients can be granted clearance for full weight bearing while keeping the [walking] boot in place (aC).

Statement. No study specifically addresses the issue of postoperative care after surgical treatment of CATR. In general, early functional treatment yielded superior subjective outcomes while displaying no increased re-rupture rates compared to postoperative immobilization. Immediate loading and ankle motion led to improved overall health and vitality at 6 months postoperatively. Patients were advised to engage in active knee and toe flexion and extension, along with isometric calf muscle exercises and straight-leg raises. Early weight bearing and immediate functional rehabilitation following surgical treatment for CATR appears to improve long-term functional results, including the ability to resume work. A below-knee cast was prescribed for the first 2 weeks following the surgery, and patients were allowed to bear weight on the metatarsal heads during this period if they could tolerate it. The walking boot could be employed to support early full weight bearing for the following 6 weeks. Subsequently, the boot was taken off, and patients were allowed to walk with full weight bearing after 8 weeks.

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When to return to sports?

Recommendation. Resuming regular sports activities should not occur earlier than 12 weeks post-surgery, and engaging in strenuous sports should be postponed for a minimum of 12 months (aC).

Statement. A recent meta-analysis, drawing data from 15 studies, revealed that the rate of return-to-play stood at 76% among professional athletes, with an average time to return to sports of 11 months. These findings align with the return-to-sports rate of 80% reported in Zellers and colleagues' comprehensive systematic review and meta-analysis, which encompassed 85 studies. Usuelli et al studied 8 patients with CATR who underwent a semitendinosus tendon graft transfer. Six of these 8 patients successfully resumed their preinjury sports activities, achieving this milestone at an average of 7.0 months. The rate of athletes returning to sport after experiencing a CATR still stands at 80%. However, it remains challenging for them to reach their baseline performance levels until 2 to 3 years following surgery, which can have a significant impact on an athlete's overall career.

Conclusion

This guideline outlines the prevailing surgical approaches for CATR presently. It aims to offer surgeons valuable insights to inform their surgical decisions for CATR patients based on the available evidence. Additionally, the study authors expect that this guideline will offer valuable insights for orthopedic researchers as they formulate future study methodologies, taking into account the current understanding of surgical treatment for CATR.

The main *recommendations* are outlined as follows:

1. Surgery is recommended for patients who still experience CATR symptoms despite unsuccessful conservative treatment and show signs of CATR on both physical and imaging evaluations.
2. Primary repair procedures are recommended in CATR patients when the defect is no more than 2 cm.

> Early weight bearing and immediate functional rehabilitation following surgical treatment for CATR appears to improve long-term functional results, including the ability to resume work.

3. V-Y advancement tendon flap is recommended for CATR patients with the gap less than 5 cm; Fascial turndown flap is available for the patients with CATR when the gap is more than 5 cm. However, these techniques produce large wounds and have a respective impact on the biomechanics of the gastrocnemius-Achilles tendon complex.
4. Tendon transfer procedures, such as the peroneus brevis tendon transfer and FHL Transfer, are advisable to address gaps ranging from 3 to 6 cm in patients with CATR.
5. Both open and endoscopic FHL transfer techniques are suitable for CATR patients undergoing tendon transfer procedures.
6. Free tendon graft procedures are recommended for CATR patients with the gap more than 6 cm.
7. Early range of motion of the knee and toes, along with weight-bearing support from a below-the-knee cast and elbow crutches starting on the second day after CATR surgery are recommended; full-weight bearing in suitable orthosis is recommended 2 weeks postoperatively.
8. For CATR patients, return to regular sports would be recommended 12 weeks post-surgery, and return to strenuous sports is recommended 12 months after the surgery. ler

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Effectiveness of Offloading Interventions for People With Diabetes-related Foot Ulcers

By P.A. Lazzarini, D.G. Armstrong, R.T. Crews, C. Gooday, G. Jarl, K. Kirketerp-Moller, V. Viswanathan, and S.A. Bus

Offloading treatment is crucial to heal diabetes-related foot ulcers (DFU). This systematic review aimed to assess the effectiveness of offloading interventions for people with DFU.

Methods: These authors searched PubMed, EMBASE, Cochrane databases, and trials registries for all studies relating to offloading interventions in people with DFU to address 14 clinical question comparisons. Outcomes included ulcers healed, plantar pressure, weight-bearing activity, adherence, new lesions, falls, infections, amputations, quality of life, costs, cost-effectiveness, balance, and sustained healing. Included controlled studies were independently assessed for risk of bias and had key data extracted. Meta-analyses were performed when outcome data from studies could be pooled. Evidence statements were developed using the GRADE approach when outcome data existed.

Results: From 19,923 studies screened, 194 eligible studies were identified (47 controlled, 147 non-controlled), 35 meta-analyses performed, and 128 evidence statements developed. We found:

- Non-removable offloading devices likely increase ulcers healed compared to removable offloading devices (risk ratio [RR] 1.24, 95% CI 1.09–1.41; N = 14, n = 1083), and may increase adherence, cost-effectiveness, and decrease infections, but may increase new lesions.
- Removable knee-high offloading devices may make little difference to ulcers healed compared to removable ankle-high offloading devices (RR 1.00, 0.86–1.16; N = 6, n = 439), but may decrease plantar pressure and adherence.
- Any offloading device may increase ulcers healed (RR 1.39, 0.89–2.18; N = 5, n = 235) and cost-effectiveness compared to therapeutic footwear, and may decrease plantar pressure and infections.
- Digital flexor tenotomies with offloading devices likely increase ulcers healed (RR 2.43, decrease plantar pressure and infections, but may increase new transfer lesions.
- Achilles tendon lengthening with offloading devices likely increase ulcers healed (RR 1.10, 0.97–1.27; N = 1, n = 64) and sustained healing compared to devices alone, but likely increase new heel ulcers.

Discussion

Summary of main findings: We systematically reviewed all studies investigating offloading interventions for people with DFU and identified 194 eligible studies (including 47 controlled studies), performed 35 meta-analyses and developed 128 evidence statements. For the critical outcome of ulcers healed, we found with moderate certainty that non-removable knee-high offloading devices are likely to be superior to all other offloading interventions to heal plantar forefoot or midfoot DFU, with low certainty that any offloading devices may be superior to therapeutic footwear, and with no certainty that any other nonsurgical offloading interventions are superior to offloading devices. Whereas in combination with offloading devices, we found

This article has been excerpted from Lazzarini PA, Armstrong DG, Crews RT, et al. Effectiveness of offloading interventions for people with diabetes-related foot ulcers: a systematic review and meta-analysis. Diabetes Metab Res Rev. 2024;e3650. https://doi.org/10.1002/dmrr.3650. Editing has occurred, including the renumbering or removal of tables, and references have been removed for brevity.

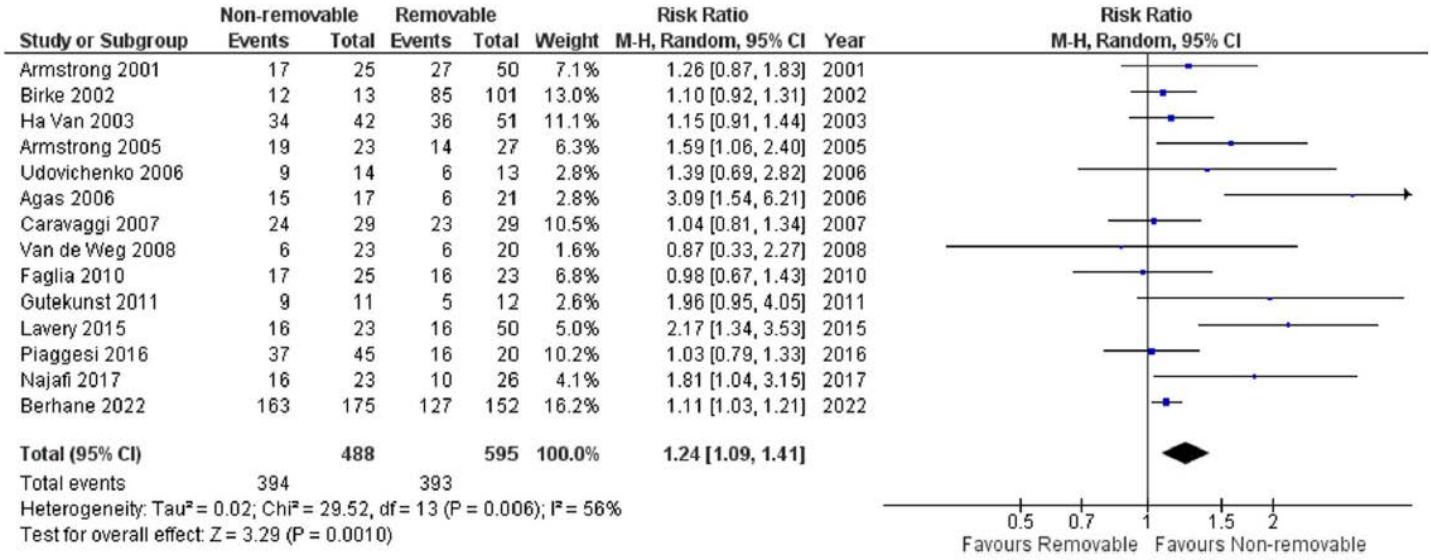

FIGURE 2 Forest plot for non-removable versus removable offloading devices on proportions of ulcers healed.

with moderate certainty that digital flexor tenotomies and Achilles tendon lengthening are likely to be superior to offloading devices alone to heal plantar lesser digit and metatarsal head ulcers, respectively, and with low certainty that metatarsal head resections and joint arthroplasties may be superior to heal other plantar metatarsal head ulcers and hallux ulcers.

Comparison with other reviews: Over the last decade there have been over 20 systematic reviews on different offloading interventions in people with DFU. Therefore, we limit our comparisons of findings in our new review to those of our previous review of all offloading interventions, and all other reviews performing meta-analyses on different offloading interventions.

Compared to our previous review, our new review has made many methodological improvements. These include investigating additional comparisons and outcomes, identifying additional included studies, performing meta-analyses, more rigorously assessing effect sizes and certainty of evidence, and using Summary of Findings (SoF) tables in line with the GRADE approach. These improvements resulted in our new review including multiple meta-analyses (35 vs. 0), SoF tables (20 vs. 0), and many more evidence statements (128 vs. 47) in line with GRADE and Cochrane standards, than our previous review. Thus, the findings in this new review should supersede those of our previous review.

Four other reviews have performed meta-analyses on nonremovable offloading devices. Those authors also found that non-removable offloading devices likely heal more ulcers than removable offloading devices (Others: RR 1.15–1.43 vs. Our review: RR 1.24). Further, like us, the only review to also conduct Certainty of Evidence (CoE) assessments also assessed the supporting evidence to be of moderate certainty for this critical ulcers healed outcome, and only downgraded for serious inconsistency based on moderate heterogeneity.

Otherwise, only one review pooled any other of our important outcomes for offloading devices, and also found non-removable devices may develop more new lesions (they only investigated skin maceration) than removable devices (Other: RR 1.38 vs. Our: RR 1.77). Thus, all reviews to date support the superiority of non-removable knee-high offloading devices over removable offloading devices to heal plantar forefoot or midfoot DFU but suggest non-removable devices may also result in the development of more new lesions than removable devices.

Similarly, two other reviews also found total contact casts (TCCs) likely make little-to-no difference to ulcers healed compared to non-removable walkers (Others: RR 1.02–1.06 vs. Our: RR 1.05). However, the only review to also assess CoE, assessed the supporting evidence to be of low certainty due to very serious imprecision, whereas we assessed it to be moderate certainty due to serious imprecision. The difference in assessments was likely due to our review including additional participants from new trials in our meta-analysis, hence improving the precision of the effect. Thus, all reviews suggest non-removable walkers are equally as effective as TCCs to heal plantar forefoot or midfoot DFU.

Only one other review performed a meta-analysis comparing different removable offloading devices. Unlike us, they found removable knee-high offloading devices may heal less ulcers compared to removable ankle-high devices (they called these devices therapeutic footwear), whereas we found little-to-no difference (Other: RR 0.75 vs. Our: RR 1.00). Further, they assessed the CoE as very low certainty due to serious indirectness based on studies using different devices and very serious imprecision. However, we assessed as low certainty also due to serious indirectness, but only serious imprecision. Again, the difference in assessments for effects and certainty are likely due to our review

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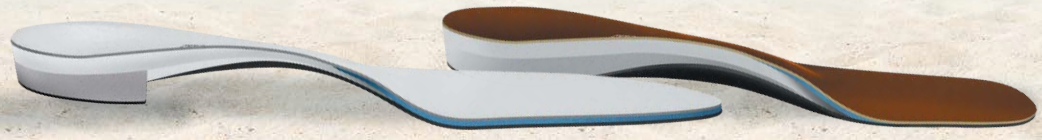

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including many more additional participants from new trials and hence improving the precision of the effect. Thus, these latest findings suggest different removable offloading device heights may have a similar effect on healing plantar forefoot or midfoot DFUs.

Two other reviews also found offloading devices likely heal more ulcers than therapeutic footwear (Others: RR 1.62–1.68 vs. Our: RR 1.39). However, the only review to also assess the CoE, assessed the certainty as moderate due to serious indirectness, whereas we assessed the certainty as low due to very serious inconsistency based on high statistical heterogeneity. However, we noted in our sensitivity analysis a much greater effect in favor of non-removable offloading devices over therapeutic footwear (RR 1.98). Thus, all reviews suggest any offloading devices are more effective than any therapeutic footwear to heal plantar forefoot or midfoot DFU.

For other non-surgical offloading interventions, only one review pooled findings, and also found felted foam with removable devices may decrease plantar pressure more than a device alone (Other: MD 107 kPa lower vs. Our: MD 98 kPa lower). Further, they assessed the CoE as moderate certainty due to serious imprecision, whereas we assessed CoE as very low certainty as these findings were based on non-controlled studies only and had serious indirectness. We also noted in sensitivity analyses that these effects reduced after 3–7 days of application (MD 70 kPa lower). Thus, these reviews suggest felted foam with devices may reduce plantar pressure more than devices alone.

For surgical offloading interventions, one review also found Achilles tendon lengthening with non-removable devices likely healed slightly more ulcers than devices alone (Other: RR 1.06 vs. Our: RR 1.10), and increased sustained healing (note they analyzed ulcer recurrence, the reverse outcome to sustained healing) (Other: RR 0.45 vs. Our: RR 3.41), but they did not assess CoE. Otherwise, two other reviews that reported they performed meta-analyses, actually reported pooled non-weighted findings, which are challenging to compare. However, they also found Achilles tendon lengthening with devices likely heal slightly more ulcers than devices alone, metatarsal head resections with devices may heal more ulcers than devices alone, and joint arthroplasties with devices may also heal slightly more ulcers than devices alone. Thus, all reviews suggest that some surgical offloading interventions in combination with offloading devices may heal more ulcers and keep them healed compared to offloading devices alone for some specific plantar DFU locations.

> Thus, all reviews to date support the superiority of non-removable knee-high offloading devices over removable offloading devices to heal plantar forefoot or midfoot DFU

Limitations and strengths: First, our comprehensive systematic search strategy should mean we identified the vast majority of eligible studies by using clearly defined clinical (PIC) question comparisons, broad search terms, validated search strategies, and independent experts to screen and assess all studies. Yet, there is still a possibility we may have missed some eligible studies, as we did not hand search references, did not update our search since April 2022, and our previous reviews did not include some additional outcomes included in this review. To minimize missing eligible studies, we hand searched references of prior reviews, searched clinical trials registries, included all eligible trials nearing completion, and extracted data on all additional outcomes from included papers in our previous reviews.

Second, our systematic approach to our qualitative assessments should mean we minimized missing any important evidence, by prioritizing the most important clinical question comparisons and outcomes with external experts and persons with lived experience of DFU, defining all populations, interventions, comparators and outcomes using international standards, systematically assessing study designs, risk of bias, levels of evidence and extracting data from all included trials. We note though we did not use latest Cochrane risk of bias tools, but instead used previous Cochrane tools and a specific IWGDF tool for DFU studies to be consistent with our previous reviews.

Third, this review is one of the first in the DFU field to robustly adhere to best practice GRADE methodological approaches, by also using recommended (meta-)analyses, consistent reporting of effect sizes (RR or MD), GRADE evidence tables to assess CoE, and GRADEPro online applications to develop controlled language evidence statements, and to summarize all findings into SoF tables for each comparison. However, we note we used total risk of bias scores from previous Cochrane tools rather than risk of bias items from latest Cochrane tools to inform our CoE ratings and started our CoE assessments for level 2 studies at high instead of low as used in other reviews. We also occasionally pooled data from different controlled study designs, plus reported high I2-statistic values. To address all this though, we performed multiple sensitivity analyses and erred on the side of downgrading our CoE assessments for risk of bias and inconsistency and we note all evidence statements supported only by level 2 studies have been downgraded to (very) low CoE. Thus, we are confident this is the most comprehensive, robust, and clinically valuable offloading systematic review published to date.

Implications for Practice

First, the largest implication for practice from this systematic review is that some offloading interventions are likely much more effective in practice than others to heal DFU. For instance, non-removable offloading devices will likely heal more plantar DFU than nearly all other offloading interventions. Digital flexor tenotomies and Achilles tendon lengthening in combination with offloading devices will also likely heal more plantar lessor digit DFU and some plantar metatarsal head DFU respectively, than offloading devices alone. Any offloading device will probably heal more plantar DFU than therapeutic

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If adherence to knee-high devices could be improved to similar levels found for ankle-high devices, then knee-high devices would probably be superior for healing due to the additional benefits on plantar pressure and activity, but this hypothesis needs further testing.

footwear or any other non-surgical offloading intervention. Finally, metatarsal head resections and joint arthroplasties with offloading devices will also probably heal more plantar metatarsal head DFU and plantar hallux DFU respectively, than devices alone.

Second, different types of the same offloading device category may make little difference to healing but may result in differences to other important outcomes. For instance, it seems different types of non-removable devices probably make little difference to healing plantar DFU, but non-removable walkers will probably decrease plantar pressure, new lesions and falls, and improve patient satisfaction and cost-effectiveness more than TCCs. Similarly, different types of removable devices probably make little difference to healing ulcers, but knee-high devices will probably yield a greater decrease in plantar pressure, activity, and new lesions and be more cost-effective, while ankle-high devices may decrease falls and initial costs, and increase balance, adherence and satisfaction.

Third, the effect an offloading intervention has on important surrogate outcomes, such as plantar pressure, weight-bearing activity, and adherence, seem to combine to produce their effect on healing. For example, removable knee-high devices seem to have the benefit of reducing more plantar pressure and activity than removable ankle-high devices, but at the expense of increasing non-adherence, and in turn, these outcomes seem to counterbalance to produce similar effects on healing. This also suggests that if adherence to knee-high devices could be improved to similar levels found for ankle-high devices, then knee-high devices would probably be superior for healing due to the additional benefits on plantar pressure and activity, but this hypothesis needs further testing.

Fourth, it seems the greater the benefit an offloading intervention has on healing, the greater the benefit it will also have on other important outcomes, such as decreasing the likelihood of infections and amputations, and potentially increasing sustained healing. However, these greater benefits also seem to come with greater risks of some harm for other important outcomes, such as increasing the likelihood of new lesions and falls and decreasing patient satisfaction. Thus, it is important that a clinician and person with a DFU understand and carefully balance the potential benefits on healing, infections and amputations, with the potential harms on new lesions, falls, and satisfaction outcomes, when selecting the best offloading intervention(s) for the person's situation.

Lastly, all these interventions still only have low-to-moderate certainty of supporting evidence for their beneficial effects on healing ulcers, and typically (very) low certainty for their beneficial or harmful effects on other outcomes. Therefore, we recommend it is important that clinicians help people with DFU in their care to consider the beneficial and harmful effects of different offloading interventions, and the certainty of evidence for these effects, when selecting offloading interventions that are best for each person and their values. For example, the evidence suggests the benefits of choosing a non-removable device over a removable device are that they will likely heal the person's DFU faster, may reduce their chance of developing infections and having amputations, and be more cost-effective over their treatment duration. However, the evidence also suggests the harms of choosing a non-removable over a removable device are that they may also increase the chance of developing a new lesion (abrasion, blister, callus, ulcer, etc.), may cost more initially, and they may be a little less satisfied when using the device.

Therefore, one person with a DFU who values better healing, infection, or amputation outcomes more greatly, may select a non-removable device. Whereas another who values avoidance of new lesions, intervention satisfaction, or initial cost outcomes more greatly, may select a removable device. Thus, we suggest clinicians use the summarized findings in [the original article] along with the updated IWGDF guideline on offloading interventions for people with DFU, to help people with DFU in their care to select the best offloading intervention for the person.

Implications for research: With no high CoE, and very few outcomes with moderate certainty, further trials are needed in most areas of the field, however we specifically recommend several key areas.

First, whilst non-removable devices are most effective on healing as they maximize adherence, they also seem to increase some harms. We also found (with low certainty) that non-removable walkers compared with TCCs may limit these harms, by yielding greater reductions in plantar pressure and new lesions, paired with increased user satisfaction. Thus, more high-quality trials are needed to determine if non-removable walkers may be a superior nonremovable option to traditional TCCs.

Second, while all removable devices are likely inferior to nonremovable devices due to lower adherence, and different removable devices may make little difference to healing compared with each other, they also seem to have different benefits on other outcomes that if harnessed collectively may improve healing. Thus, we recommend more high-quality trials are needed to determine which removable devices are most effective at maximizing the

collective benefits on plantar pressure, adherence, and satisfaction, such as existing removable devices, new smart devices, or combination interventions of different devices with psychological interventions.

Third, while a new high-quality surgical trial showed digital flexor tenotomies likely improve healing of lessor digit ulcers, more high-quality trials in other surgical offloading procedures are still needed to improve certainty, such as for Achilles tendon lengthening, metatarsal head resections, metatarsal osteotomies, and joint arthroplasties. Further trials are also required to determine which offloading devices are best combined with these surgical interventions or even if offloading devices are needed.

Fourth, although some new controlled studies suggest the offloading interventions most effective for less complex plantar forefoot DFU may also be those most effective for more complex DFU, more high-quality trials are needed to better inform clinicians about effective offloading treatments for infected, ischaemic, rearfoot, and particularly non-plantar ulcers. Further, this review found some evidence that different devices may have different effects on different forefoot locations, and thus, future trials should report outcomes on specific forefoot DFU locations, such as the hallux.

Fifth, whilst some new controlled studies came from low-to-middle income countries or those with hotter climates, there is still a need for more trials in those settings, including developing and trialing lighter, cooler, and less expensive devices, without losing the key mechanical offloading features of existing devices.

Sixth, although for the first time we were able to pool various important outcomes, the certainty of evidence for these outcomes was nearly always (very) low. Thus, we continue to recommend that future trials report these other important outcomes, consistent with international standards, so as to continue to be able to pool the effects for these important outcomes in future.

Seventh, unlike peak plantar pressures thresholds for DFU prevention, we note there are still no objective thresholds for other outcomes that indicate DFU healing. Thus, we recommend studies explore if such thresholds for plantar pressure, activity, adherence, or a combination plantar tissue stress measure may inform how much offloading is most effective for healing and in turn guide the development of future offloading interventions tested against such thresholds.

Last, in addition to the above recommended quantitative studies, we recommend more qualitative research should explore patients' perceptions as to the importance of outcomes, benefits and harms of different offloading interventions to truly understand the perspectives of people with DFU.

Conclusions

This new systematic review shows there is a moderate certainty of supporting evidence for some offloading interventions to heal DFU, but most offloading interventions used in practice have low or very low CoE, and some others have no supporting evidence at all. The offloading interventions with moderate certainty to be most effective to heal plantar forefoot or midfoot DFU are non-removable knee-high offloading devices (either non-removable walkers or TCCs) and digital flexor tenotomies and Achilles tendon lengthening in combination with offloading devices for specific plantar forefoot DFU locations. Otherwise, all removable offloading devices have low certainty that they are more effective to heal plantar forefoot or midfoot DFU than any other non-surgical offloading intervention, such as therapeutic footwear, felted foam, or wheelchairs. Although the evidence for offloading interventions to heal non-plantar, rearfoot, ischemic, or infected DFU is very limited, the evidence suggests the most effective interventions for plantar forefoot or midfoot DFU are also probably those most effective for these more complex DFU. However, high-quality trials of nearly all interventions are still required before any offloading interventions have a high certainty of supporting evidence for their effects on the critical outcome of healing DFU, and the other important outcomes for people with DFU, such as new lesions, falls, infections, amputations, quality of life, and costs.

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OTC BIOELECTRIC BANDAGE BY VOMARIS

Vomaris has launched its US Food & Drug Administration–cleared PowerHeal™ bioelectric bandage for over-the-counter (OTC) use. Foundationally inspired by the body, the technology mimics the electrical energy that skin naturally creates and uses to heal itself. This revolutionary approach not only creates an optimal healing environment by maintaining moisture, it provides crucial antibacterial protection and introduces a new dimension of care, by generating electricity through moisture-activated microcell batteries that are embedded within PowerHeal bandages. This innovation is a game-changer for individuals facing a spectrum of acute and chronic wounds, including cuts, scrapes, large abrasions like road rash and turf burn, burn wounds, surgical incisions, and challenging wounds such as those from diabetes or ulcers resulting from venous disease. With a variety of sizes, and no-adhesive and adhesive options available, individuals can find the right fit for their needs, whether addressing acute injuries or managing chronic conditions.

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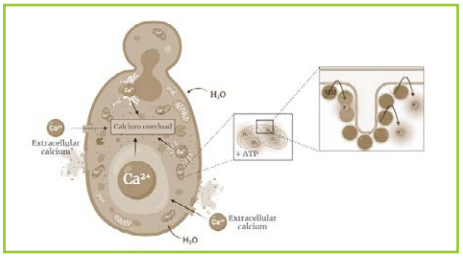
MOLECULAR MACHINES COULD TREAT FOOT FUNGUS

That stubborn athlete's foot infection an estimated 70% of people get at some point in their life could become much easier to get rid of thanks to nanoscale drills activated by visible light.

Proven effective against antibiotic-resistant infectious bacteria and cancer cells, the molecular machines developed by Rice University chemist James Tour, PhD, and collaborators are just as good at combating infectious fungi. Based on the work of Nobel laureate Bernard Feringa, PhD, the molecular machines are nanoscale compounds whose paddlelike chain of atoms moves in a single direction when exposed to visible light. This causes a drilling motion that allows the machines to bore into the surface of cells, killing them.



Schematic representation of the mechanisms by which light-activated molecular machines kill fungi. Molecular machines bind to fungal mitochondria, decreasing adenosine triphosphate production and impairing the function of energy-dependent transporters that control the movement of ions, such as calcium. This leads to the influx of water, which causes the organelles to swell and eventually the cells to burst. Image courtesy of Tour Group/Rice University.

Fungal infections pose a particular threat to patients with a weakened immune system, such as cancer patients and transplant recipients. COVID-19 has made matters worse. Immunosuppressants were widely used early in the pandemic to reduce the risk of long-term organ damage caused by an overactive immune system in response to the virus, a tactic that allowed fungal infections to proliferate. Additionally, overuse of antifungals in agriculture is also contributing to resistance in humans.

In contrast to most antifungals, development of resistance to the visible-light activated nanoscale drills was not detected. Spinning at 2–3 million times per second, their rotors cause fungal cells to disintegrate by disrupting their metabolism. By targeting the mitochondria, the researchers' molecules disrupt the cell's metabolism, resulting in an overall energy imbalance that leads to an uncontrolled flow of water and ions such as calcium into the cell, eventually causing the cell to explode.

REVITALIGN'S NEW ATHLETIC WALKING SHOE

Waco Shoe Company has released a new addition to its women's line: the Revitalign® Gaia athletic walking shoe. The new offering embodies a shift in orthotic design, merging unparalleled comfort with a chic aesthetic. Designed for the dynamic woman on the move, the shoe addresses the need for a stylish yet therapeutic footwear option. It features an Ortho-Stretch 3D knitted upper, promising a forgiving fit for individuals with common foot complaints, such as bunions. Available in 5 colors—black, white, sand shell, blue fog, and red plum—the athletic shoe suits a variety of tastes and styles. Equipped with state-of-the-art pure walking technology, the Gaia features an engineered outsole for robust ground traction, advanced cushioning that provides a cloudlike walking experience, and articulated flex zones for superior foot mobility. At its core, the shoe offers 360-degree orthotic support, catering to the orthopedic health of its wearers.

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RESEARCHERS EXPLORE USE OF VIBRATION TO TREAT PF

Image courtesy of Sahmyook University.

Treatment for plantar fasciitis (PF) includes pain management through anti-inflammatory drugs, stretching exercises, night-splint therapy, steroidal medications, and extracorporeal shock wave therapy (ESWT). While ESWT has proven to be beneficial and effective in reducing heel pain, it is expensive and has adverse effects such as increased pain sensitivity, especially in chronic cases. To this end, a team of researchers led by Dr. JongEun Yim, associate professor of physical therapy and director of the Active Aging Research Center at Sahmyook University in Seoul, South Korea, explored the use of local vibration (LV) in combination with ESWT to treat PF.

Interestingly, the study revealed the combination of LV and ESWT as an effective approach for treating chronic PF. The team conducted a randomized controlled trial involving 34 participants that were divided into 2 treatment groups. One group received a combination of LV and ESWT, while the other group underwent ESWT alone. Parameters were assessed at the beginning and end of a 5-week treatment period, including ultrasonography to track plantar fascia thickness, and a questionnaire to evaluate plantar-heel pain and foot function. The results indicated that using the LV and ESWT combination was more effective and significant in reducing the thickness of the plantar fascia and heel pain.

"LV devices are portable, inexpensive, and reduce pain after PF treatment," said Yim. "This study highlighting the novel combination approach may help to establish a treatment protocol for the PF condition."

SYNSYS MICROPROCESSOR FULL-LEG SYSTEM

The SYNSYS microprocessor full-leg system is designed for low to moderate K3 activity levels. Only SYNSYS' hydraulic kinetic coupling and hip-knee-ankle triple flexion with 125° degrees knee flexion and 42° ankle range of motion (ROM) allow users to intuitively descend stairs with the full foot flat on the step, easily squat and bend down, and have greater toe clearance. The prosthesis demonstrated greater stability with 92% longer flat foot time while walking and 2 times more toe clearance. Additionally, it looks and feels more natural than any prosthesis; the ankle ROM allows the foot to easily be placed under the seat in front of the user on public transportation for a more comfortable sitting position and decreases stresses on the socket. It also provides greater confidence with more shoe options than any other prosthesis available, a longer battery life (up to 10 days), and ease while walking.

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SPINAL IMPLANT ALLOWS PD PATIENT TO WALK AGAIN

A long-term Parkinson's disease (PD) patient who had severe mobility problems can now walk fluidly without falling thanks to a new experimental spinal implant that stimulates the user's leg muscles. Marc, 63, has been living with advanced PD since 1996. Dopamine and then deep brain stimulation, which he underwent in 2004, helped treat his tremors and stiffness. But he also developed severe walking difficulties, including balance impairments and freezing of gait.

He received the neuroprosthesis, which comprises an electrode field placed against his spinal cord, at Lausanne University Hospital. Combined with an electrical impulse generator under the skin of his abdomen, the device delivers electric pulses to his spinal cord to activate his leg muscles. The patient wears a movement sensor on each leg and when walking is initiated the implant automatically switches on and begins delivering pulses of stimulation to the spinal neurons. The aim is to correct abnormal signals that are sent from the brain, down the spine, to the legs to restore normal movement.

Image courtesy of Onward.

The implant is yet to be tested in a full clinical trial. But the Franco-Swiss team, who have a longstanding program to develop brain-machine interfaces to overcome paralysis, hope that their technology could offer an entirely new approach to treating movement deficits in those with PD. The team plans to carry out clinical tests on 6 new patients next year. The "proof of concept" would require at least 5 years of development and testing to perfect the technology.

FIBER OPTIC SMART PANTS CAN MONITOR MOVEMENTS

New smart pants, which feature transparent optical fibers directly integrated into the textile,

could help offer a nonintrusive way to track a person's movements and issue alerts if there are signs of distress.

The technology incorporates intensity variation polymer optical fiber sensors directly into fabric that was then used to create pants. The sensors were based on polymethyl methacrylate optical fibers that are 1mm in diameter. The researchers created sensitive areas in the fibers by removing small sections of the outer cladding fiber core. When the fiber bends due to movement, this will cause a change in optical power traveling through the fiber and can be used to identify what type of physical modification was applied to the sensitive area of the fiber. By creating these sensitive fiber areas in various locations, the researchers created a multiplexed sensor system with 30 measurement points on each leg. They also developed a portable signal acquisition unit that can be placed inside the pants pocket and a new machine learning algorithm to classify different types of activities and gait parameters based on the sensor data.

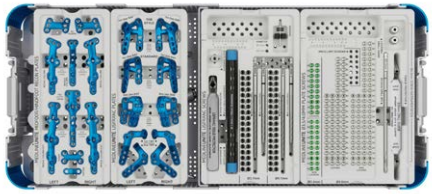
Researchers have developed smart pants that use fiber optic sensors to non-invasively track a person's movements and activities. They detect 30 measurement points on each leg. Image courtesy of Arnaldo Leal-Junior, Federal University of Espirito Santo.

To test their prototype, volunteers wore the smart pants and performed specific activities: slow walking, fast walking, squatting, sitting on a chair, sitting on the floor, front kicking and back kicking. The sensing approach achieved 100% accuracy in classifying these activities.

"This research shows that it is possible to develop low-cost wearable sensing systems using optical devices," said research team leader Arnaldo Leal-Junior from the Federal University of Espirito Santo in Brazil. "We also demonstrate that new machine learning algorithms can be used to extend the sensing capabilities of smart textiles and possibly enable the measurement of new parameters."

The researchers are now working to connect the signal acquisition unit to the cloud, which would enable the data to be accessed remotely. They also plan to test the smart textile in home settings.

LISFRANC PLATING AND SCREW SYSTEM



Medline UNITE's portfolio of midfoot trauma and reconstruction implants has expanded with the addition of a new Lisfranc plating and screw system, the Ancillary Foot Recon Plating System. This plating and screw system offers 18 dual-ray Lisfranc plates that feature bendable and removable tabs to accommodate variations in patient anatomy. The plates also feature more screw holes along with a reinforcement strut design for greater stabilization of the injury. The specially designed Lisfranc screws are available in 3.7mm and 4.1mm diameter options and feature a unique cortico-cancellous thread pitch and an optimized head profile tailored for the anatomy and indication. The biggest innovation in this new system is the Lisfranc targeting guide reduction clamp. This ergonomically designed instrument allows the surgeon to restore the patient's anatomy and perform every step of implanting a "home run screw" through a small medial incision.

Medline UNITE
844/626-8624
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NEW LOW PROFILE AND ARCH SUPPORT INSOLES

Blumaka, a global innovator in performance insoles, expanded its product line to add Low Profile and Arch Support models of its popular Konnect and Comfort insoles. The expansion comes after months of extensive athlete testing. The Comfort line is designed with active, hardworking people in mind. Comfort insoles provide long-lasting cushioning and protection from shock and pounding, feature an antimicrobial top cover for added protection, and are favorites among professionals in the healthcare and service industries. The Konnect line is geared toward professional athletes. The superior performance unlocked by the Konnect line is centered on the insoles' ability to provide traction inside the shoe itself. A textured, anti-slip surface grips the foot, reduces slipping, and allows for superior energy transfer between the athlete and the playing surface. Blumaka insoles are made from 85% scrap foam discarded by global footwear manufacturers.

Blumaka
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HANGER LAUNCHES SUBSIDIARY TO SUPPORT O&P ENTREPRENEURS, SMALL BUSINESSES

Hanger, Inc., Austin, TX, has launched Hanger Ventures, a subsidiary that will invest in entrepreneurs and small businesses, helping to

bring innovative orthotic and prosthetic (O&P) healthcare solutions to the market. Hanger Ventures is designed to focus on accelerating innovation, developing technology, and improving patient outcomes worldwide.

Hanger's Chief Clinical Officer James Campbell, PhD, who leads the Hanger Institute and Clinical and Scientific Affairs division, will now also serve as president of Hanger Ventures. He has 40 years of experience in the O&P profession with distinction in leadership and research, and is a named inventor on 5 issued U.S. Patents.

For more information, visit www.hanger.com/ventures.

SELF-MASSAGE ROLLER STICK

Physix Sports Gear's line of self-massaging roller sticks is designed to help athletes work out tightness, relieve soreness, and release and ease difficult knots, tight muscles, shin splints, and even plantar fasciitis. They target trigger points that include leg cramps, quads, calf, and hamstring tightness, and may prevent many injuries normally experienced by athletes. By using them regularly athletes can minimize pain from sore muscles, increase balance, improve flexibility and range of motion, and help in strength training and rehabilitation. These massage items promote blood flow that aids in quick recovery. They are portable and sturdy, and can conveniently fit into a gym bag. The unique features of these deep tissue massage sticks include a nearly unbreakable stainless-steel core, molded snub handles, and no squeak thermoplastic rollers. The sticks come with 7 individual spindles, which roll independently.

Physix Gear Sport
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MAXIMUM-CUSHION, WICKING SOCKS

OS1st Wicked Comfort® performance socks provide maximum cushion while setting a new benchmark in moisture-wicking and durability. This line of socks debuts the brand's Dry1st® technology, a groundbreaking moisture management treatment designed to swiftly wick away sweat, ensuring dry and comfortable feet. Engineered with Comformance™ yarn, these socks not only deliver unparalleled comfort but also boast exceptional durability, built to withstand intense physical activity. Independent testing by the Manufacturing Solutions Center, commissioned by the brand, demonstrated that these socks wick away moisture 5 times faster and are 2 times more durable than other leading brands, ensuring enduring performance in every step.

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KT ICE PERFORMANCE AND RECOVERY PRODUCTS

The KT Ice series features a range of products to support individuals during their fitness journey. KT TAPE PRO ICE kinesiology tape is engineered to provide flexible and lightweight support during exercise, and it delivers dual-action pain relief by combining the pain relief and support of KT TAPE PRO with the fast-acting pain relief of cooling menthol. KT HEALTH ACTIVATE, formulated with arnica for anti-inflammatory properties and pain relief, primes muscles for activity by warming muscles and reducing stiffness to promote flexibility. KT HEALTH RECOVER offers a soothing solution to alleviate muscle soreness and joint pain. Infused with cooling menthol for targeted pain relief, it facilitates a smooth and efficient recovery process. The KT HEALTH ICE SLEEVE is designed to provide comfortable and flexible cold-compression therapy; it reduces pain and swelling with 360-degree cooling for knees, elbows, ankles, wrists and more.

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UNDERSTANDING EXERCISE-ASSOCIATED MUSCLE CRAMPS

Reference : Miller et al. JAT 2022

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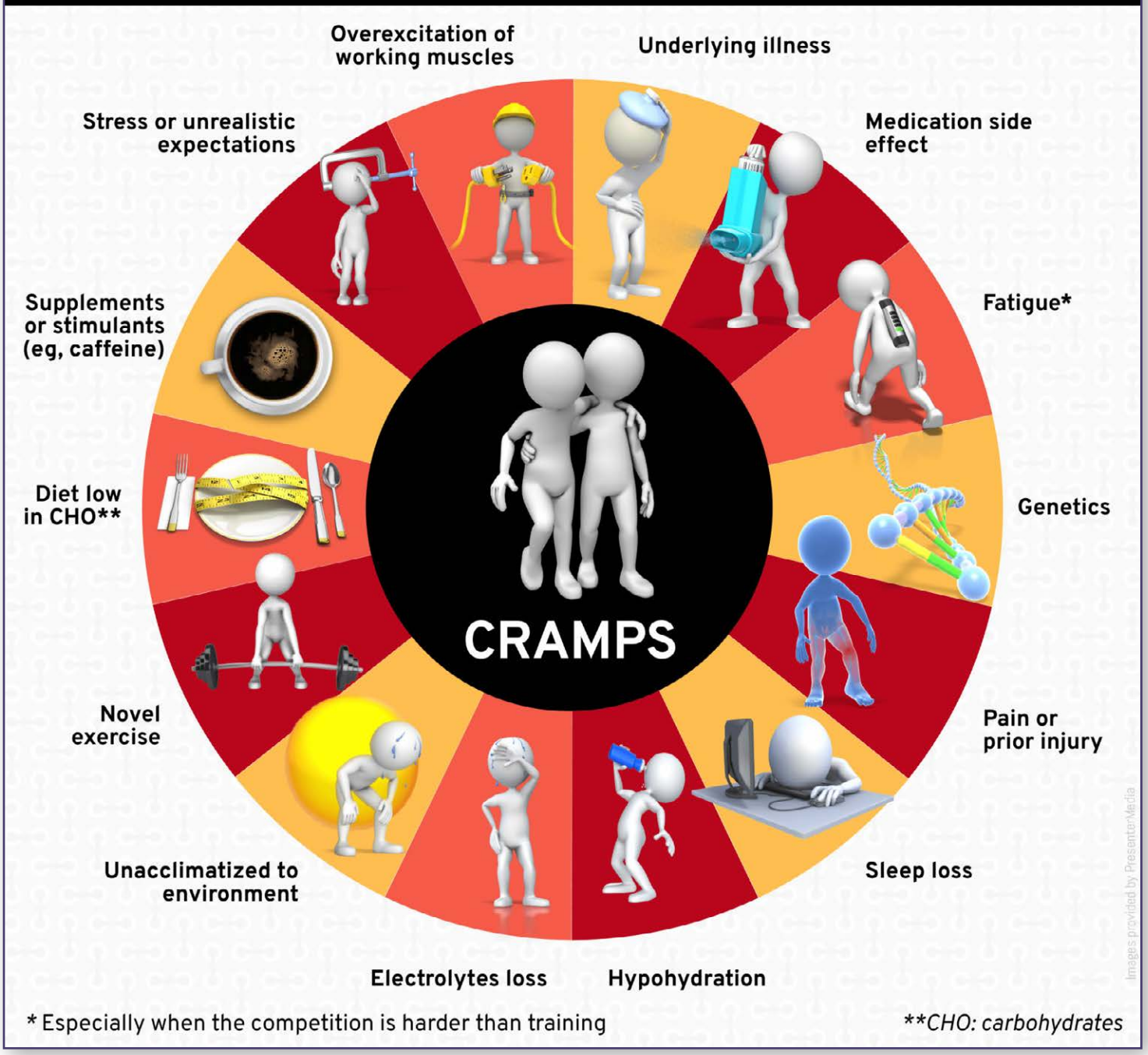

Source: Miller KC, McDermott BP, Yeargin SW, Fiol A, Schwellnus MP. An Evidence-Based Review of the Pathophysiology, Treatment, and Prevention of Exercise-Associated Muscle Cramps. J Athl Train. 2022;57(1):5-15. doi: 10.4085/1062-6050-0696.20

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