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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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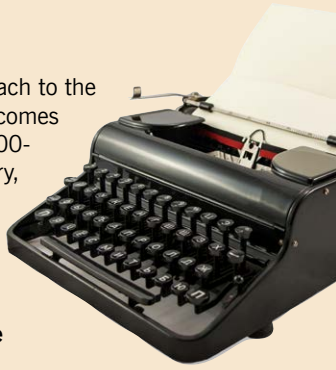

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Guest **Perspective**

Concussions: More Than Meets the Eye

NATA STUDY FINDS INCREASING RISK OF SUICIDE IDEATION WITH SECOND CONCUSSION

By Mark Mendeszoon, DPM

In 2007, one study estimated there were 300,000 sports-related traumatic brain injuries in high school and collegiate athletes. Sports brain injuries and concussions were second only to motor vehicle accidents amongst people aged 15-24.[1] Fast forward to a 2018 study using data from the Youth Risk Behaviors Survey where 15.1% of students (~2.5 million) reported having at least 1 concussion during the prior 12 months, and 6.0% reported 2 or more concussions.[2] Are there really that many more concussions, or is it increased awareness of symptoms, greater fear of now-known consequences, or better reporting mechanisms? It's probably a little bit of each, but it's all important because we're learning that the term "mild" when placed in front of Traumatic Brain Injury may be a misnomer.

While recent studies have shown a direct correlation between concussions and depression and even suicide in teenagers, a new study from the National Athletic Trainers' Association has been able to shine a light on the seriousness of the correlation: the November 2023 study[3] shows students who reported 2 or more concussions in 1 year were at 2-fold greater odds of reporting suicide attempts when compared to students reporting a single concussive event in that timeframe. (See Story on page 15).

As we enter 2024, high school athletes have become bigger, stronger, and faster with better nutrition, strength programs, diet supplements, early sports specialization, and the pressure to succeed. Most high school student-athletes believe that they will compete at the NCAA level, but the reality is that only 7% of high school athletes compete in college, and only 2% receive athletic scholarships.

Unlike sprains, strains, and fractures that are physically obvious, concussions do not present so readily. The field medical personnel and athletic trainers are responsible for initially recognizing the signs and symptoms of a concussion, which can include balance and gait dysfunction. The medical team covering sports is well versed and trained in recognizing, evaluating, testing, and initially treating those athletes who sustain a head injury. As healthcare providers, we must protect the student-athlete from any injury, including concussions, and then get them to the proper sports medicine specialist or a neurologist for evaluation and treatment.

As a team physician for the last 28 years, I have a stringent policy for not returning athletes to competition after a noted head injury. Despite the pleas of the athlete and pressures from the coaching staff and parents to get their child back into the game, it is ultimately the doctor's (my) responsibility to prevent long-term complications, which can lead to mental status changes, depression, and yes, even suicidal tendencies and suicide. There have been several episodes in the heat of the moment where I have been cursed at, pushed, and even spat on for refusing to allow the athlete to return.

Concussion protocol has been rigorous over the last few decades, especially in young athletes. Classes, webinars, and education have increased tremendously for medical professionals and the coaching staff. Early recognition is a key to preventing long-term consequences for an individual with a concussion. As soon as a head injury is visualized, that athlete immediately goes through the initial concussion protocol. Then, depending on the severity of the head injury, the athlete is sent to a sports medicine specialist or neurologist who does further testing and evaluation of the athlete. After passing physical and mental acuity testing the athlete is slowly allowed to get back to activities. Today's concussion protocols have been established to determine the safe return of an athlete back to sports.

It is important to note that concussions also occur in sports that are not considered contact, such as soccer, field hockey, and running. Thus, coaches, athletic trainers, medical personnel, and parents/guardians need to recognize the early warning signs of concussions. The long-term sequella of concussions has been directly linked to chronic traumatic encephalopathy (CTE).

From countless news outlets we've seen the stories of former big name football players who have suffered with CTE. Athletes who have suffered from CTE typically struggle mentally for years, becoming a shell of their former selves and battle depression, irrational thoughts and actions, alcohol and drug abuse, suicidal tendencies, and even death. This latest NATA study shows us how early the damage can begin and why our job is so critical on the field—and anywhere we treat young athletes. Those potential outcomes are not worth getting the game-winning shot, homerun, or touchdown in high school.

Mark Mendeszoon, DPM, is a senior partner at Precision Orthopaedic Specialties Inc. located in Chardon, OH. He is the Fellowship Director at University Hospitals Advanced Foot & Ankle Center as well as Assistant Professor at Iowa State University, Kent State University, Miami University, and Ohio University. He also serves as President of the Great Lakes Region of the American College of Foot & Ankle Surgeons and is the owner of the Achilles Running Shop in Willoughby, Ohio and Erie, Pennsylvania.

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FREQUENCY OF CONCUSSIONS INCREASES US HIGH SCHOOL ATHLETES' REPORTING OF SUICIDAL ATTEMPTS

Utilizing nationally representative data from the Youth Behavior Risk Surveillance System (YBRSS), a new study[1] examined the association between self-reported concussion frequency and non-fatal suicidal behaviors among U.S. high school students. The study appeared in a special mental health issue of the *Journal of Athletic Training*, the scientific journal of the National Athletic Trainers' Association.

"We found that students who reported 2 or more concussions in 1 year were at 2-fold greater odds of reporting suicide attempts when compared to students reporting a single concussive event during that same time," said lead author Jacob Kay, PhD, MSc, rehabilitation scientist, Prisma Health Children's Hospital, Pediatric Concussion Clinic, Columbia, South Carolina in a press release. "We also found that male and female youth may be impacted differently – when biological sex was factored in our analyses, results indicated that this finding may have been driven by males; the strength of association did not increase from single to multiple concussions among females."

"Ensuring a young athlete has appropriate mental health support is vital to their overall sports participation and as critical as physical preparation," said NATA President Kathy Dieringer, EdD, LAT,ATC. "This study sheds significant light on the role that concussion can have on mental health and provides a roadmap to establishing the right school and medical professional protocols. Athletic trainers play an integral role in working with students to ensure their overall health and welfare."

Key Statistics

- It has been estimated that roughly 1.9 million adolescents sustain sport- and recreation-related concussions (SRRCs) annually in the United States.[2]
- In 2020, suicide was the second leading cause of death among individuals between the ages of 10-14 and 25-34 , and the third leading cause of death among individuals between the ages of 15-24.[3]
- In 2020, roughly 100,000 adolescents (aged 10 to 19 years) were hospitalized for intentional self-harm (latest available data).[4]

What The Study Authors Did

- The YBRSS is a school-based survey administered biennially in both private and public high schools across the U.S. The YBRSS provides valid measures of health risk behaviors among this cohort. Data from the 2017 and 2019 YBRSS were combined and cross-sectionally analyzed.
- A total of 28,442 respondent questionnaires were available for analysis. After adjusting for missing data (independent and dependent variables of interest, as well as covariates), researchers were left with a final sample of 17,397 students, or 61.16% of the total sample.
- Statistics were calculated to evaluate the association between concussion history and (1) sadness or hopelessness, (2) suicidal ideation, (3) suicidal planning, (4) suicidal attempts, and (5) injurious suicidal attempts.
- All statistical models were adjusted for the covariates of age, sex, race and ethnicity, bully victimization, sexual orientation, and physical activity.
- For each model, an interaction term between concussion exposure and sex was included to explore possible differences between males and females.

Topline Results

- Students who reported two or more concussions in a year were at significantly greater odds of reporting suicidal attempts than students reporting a single concussion.
- Among respondents, 15.0% noted at least one SRRC during the past 12 months, with 5.6%reporting two or more SRRCs.
- A greater proportion of male students (16.7%) versus female (13.2%) students experienced 1 or more concussions during the past year.
- A greater proportion of female students reported feeling sad or hopeless (44.3% vs 23.6%) ler

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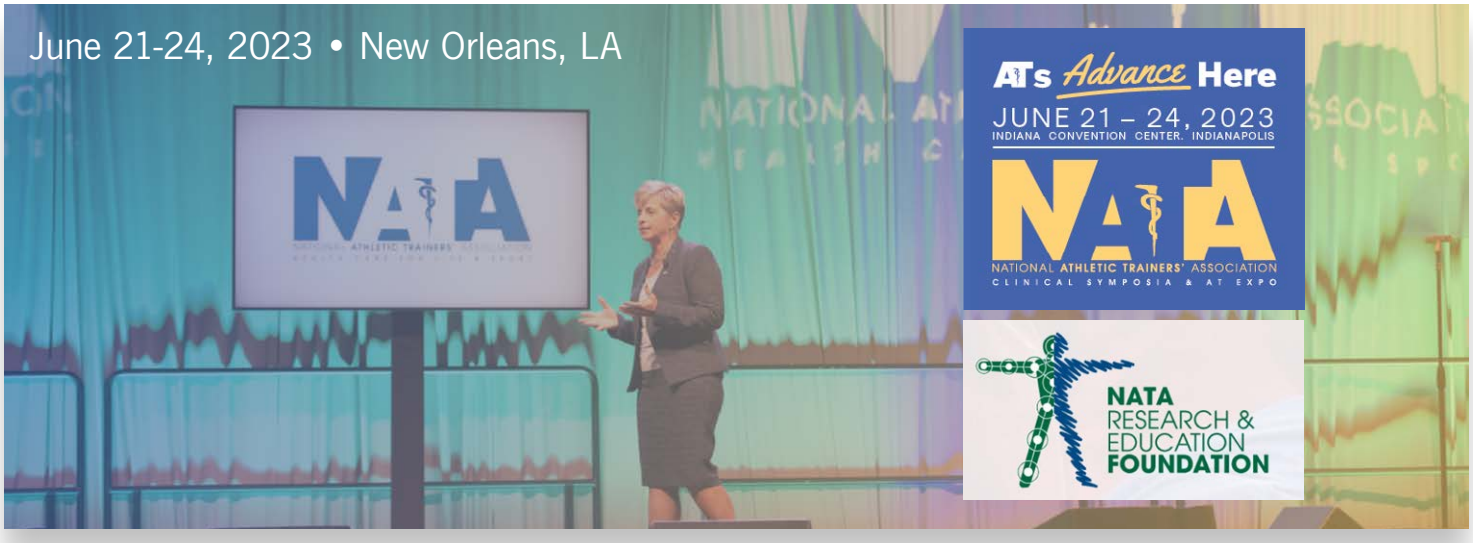

Meeting Highlights III from the National Athletic Trainers' Association

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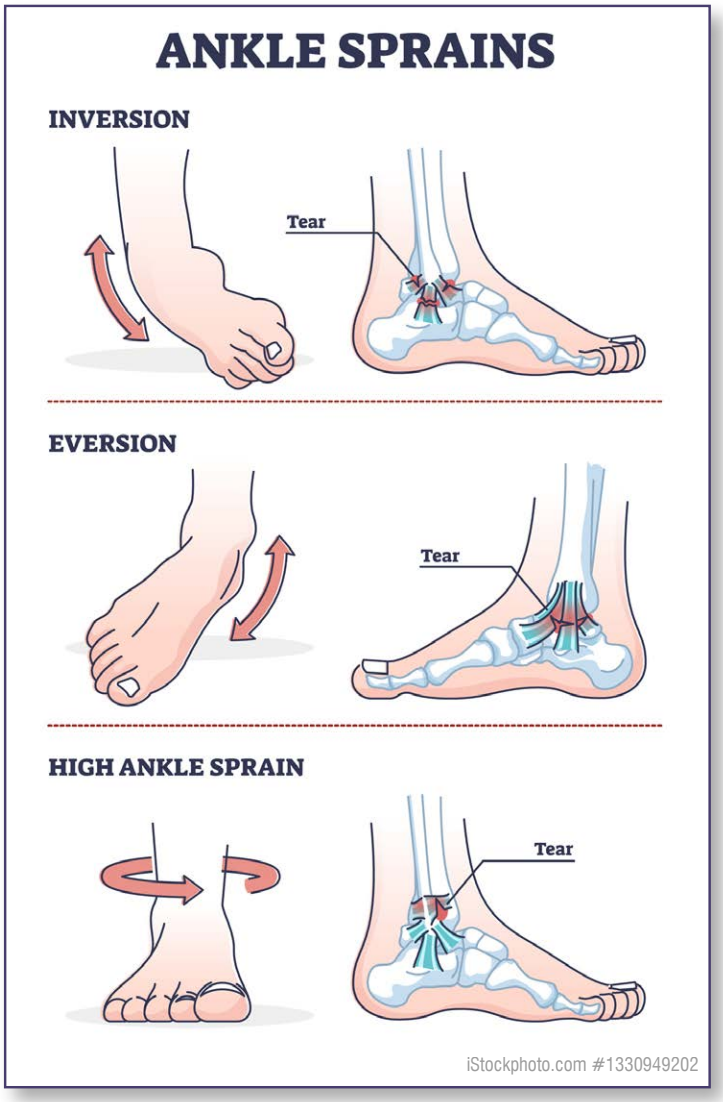
SYNDESMOSIS SPRAIN IN A 19-YEAR-OLD DIVISION 1 COLLEGIATE FOOTBALL PLAYER

Background: Syndesmosis ankle sprains account for 25% of all ankle sprains in National Collegiate Athletic Association (NCAA) football athletes. Typical return-to-play (RTP) time for an ankle syndesmosis sprain is approximately 8 weeks. However, in a small randomized controlled trial, it was found that the platelet rich plasma (PRP) treatment group (one injection) had a mean RTP time of 40.8 ± 8.9 days. Ultrasound guided therapeutic PRP injections are an up-and-coming treatment to decrease RTP time in syndesmosis ankle sprains.

Patient: A 19-year-old male, Division-1 collegiate football player, sophomore, with a diagnosed syndesmosis ankle sprain. The athlete presented with right lower leg pain during an on-field evaluation by the team athletic trainer (AT) during practice. The athlete had no previous right lower leg injuries. During practice, another player fell on the athlete's foot while it was plantar flexed and externally rotated. Following the incident, the athlete was unable to bear weight and was removed from the field for further evaluation. The anterior portion of the athlete's right ankle was swollen and tender to palpate over the anterior distal tibiofibular ligament. The evaluating AT performed a Kleiger's and Squeeze test, both were positive. Imaging revealed no fractures, but an MRI revealed a grade 2 syndesmosis ankle sprain on November 10th, 2021.

Intervention & Treatment: The team physician and AT decided 5 days after the injury, a PRP injection would add to the course of treatment and afford the athlete an opportunity to return at an accelerated rate. Following the PRP injection the athlete was partially weight bearing for one week. The athletes' pain, swelling, and range of motion (ROM)



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were examined each day prior to rehabilitation by the AT. At the start of rehabilitation, the athlete focused on light ROM, open kinetic chain exercises, and swelling control. Each week the athlete was able to progress through the rehabilitation plan, incorporating the Hydroworx and alter-gravity treadmill to further advance the athlete to weight-bearing and closed kinetic chain exercises. Typical interventions in the literature do not include the Hydroworx and alter-gravity treadmill with PRP injection. By the beginning of week 4, the athlete started RTP activity and functional training on the turf. By the end of week 4, the athlete was able to return for non-contact practice with physician clearance due to no swelling, point tenderness, and increasing function. The athlete had physician clearance for full participation in games 34 days post-injury.

Outcomes or Other Comparisons: The athlete in the case presented was able to return for full-contact practice within 29 days of the initial injury with the use of PRP injection, Hydroworx, and alter-gravity treadmill therapy.

Conclusions: Syndesmotic ankle sprains can take a great deal of time to heal; however, the use of ultrasound guided PRP therapeutic injection, Hydroworx, and alter-gravity treadmill allowed the athlete in this case to RTP at an accelerated rate. It is important to consider other factors that were involved such as early diagnosis of the injury, decision of the medical staff to use PRP, and the rehabilitation regimen. The athlete was able to return within 29 days of injury compared to the average 40 days but was consistently participating in rehabilitation twice a day, five days a week. Adherence to the rehabilitation program was essential for progression each week.

Clinical Bottom Line: The addition of PRP into a treatment plan, including Hydroworks and alter-gravity treadmill, for syndesmosis ankle sprains could be considered an alternative approach for an accelerated RTP although more research needs to be conducted to confirm the full benefits of PRP.

Source: *Malven K, Pollard-McGrandy AM, Rice L, Roskelly J, Nogle S, Covassin T. Syndesmosis Sprain in a 19-Year-Old Division 1 Collegiate Football Player: Type 2 Clinical CASE Study Abstract. J Athl Train. 2023;58(6S):264.*

SYNDESMOSIS ANKLE SPRAIN IN A 21-YEAR-OLD DIVISION 1 COLLEGIATE FOOTBALL PLAYER

Background: Syndesmotic injuries make up 12% of all ankle sprains, but 25% of ankle sprains in football. Historically, screw fixation has been the predominant type of surgery, which provides stabilization to the syndesmosis joint. However, the strong fixation procedure can cause a loss of movement in the early recovery phase, an inability to bear

weight, and typically needs the screw to be removed. The tightrope procedure provides athletes with a faster recovery, as there is no need for removal and allows for early weight bearing. Typical recovery timeline for a screw fixation is 4-6 months, compared to the tightrope procedure taking 2-3 months. The use of blood flow restriction (BFR) could be an effective addition to rehabilitation intervention to decrease the time to return to sport (RTS).

Patient: A 21-year-old, Caucasian, male, Division I collegiate football athlete, defensive end, junior presented with left (L.) lower leg pain the day after a game. During the game, the athlete was rushing when he was forced into plantar flexion and inversion as another player fell on top of him. He continued to play the entirety of the game without reporting the injury. The evaluating athletic trainer (AT) performed the squeeze test and Kleiger, which was positive. Imaging revealed no fractures, but an MRI revealed a L. syndesmosis ankle sprain and a fracture of the fibula.

Intervention & Treatment: The team physician and the AT decided that a surgical treatment with the addition of BFR as part of the rehabilitation would afford the athlete an opportunity to return at an accelerated rate. Rehabilitation started by targeting edema with soft tissue mobilization, ankle exercises, as well as BFR to assist with the acute phase of healing. The athlete started his progression to weight bearing beginning with seated exercises, then assisted exercises, working his way to full weight bearing by the 12th day. BFR continued to be performed 4 days a week to strengthen the surrounding musculature. To further assist in the athlete's recovery, a run progression was introduced by using the alter-G to increase strength and range of motion. During week 4, the athlete was introduced to tempo running, which is a gradual building of speed for a certain length of yards, as well as performing sport-specific functioning drills with the AT, and training fully with strength and conditioning staff. A week after physician clearance 9/17 injury 10-11-physician practice, the athlete was able to begin progression back to practice, and the subsequent week (10-18), was able to play as tolerated in the following game, while being braced and taped.

Outcomes or Other Comparisons: The athlete made excellent progress with tightrope surgery and BFR. The athlete recovered in 33 days compared to the average 64 days after a tightrope procedure, with the use of BFR during rehabilitation.

Conclusions: The main priority after an injury is to RTS in the shortest and safest amount of time as possible. Tightrope procedure facilitates recovery exponentially, when compared to screw fixation surgery. Incorporating the use of BFR during the recovery phase could potentially accelerate this process even further, as shown in this case. The recovery time was reduced by almost half when compared to the average of 64 days. In athletic populations, the tightrope procedure is

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the most favorable intervention for a syndesmotic ankle sprain.

Clinical Bottom Line: Tightrope procedure for a syndesmotic ankle injury can significantly reduce the return to play time in the athletic population, along with the assistance of BFR during rehabilitation. The use of BFR to aid in the healing process of a syndesmotic ankle injury is a practical application that can be used in a variety of patient populations because it can be personalized to the patient.

Source: *Worley J, Pollard-McGrandy AM, Dufon S, Smith L, Homer M, Zita A, Molliter E, Belhomme T, Roskelly J, Rice L, Scott R, Nogle S, Covassin T. Syndesmosis Ankle Sprain in a 21-Year-Old Division 1 Collegiate Football Player. J Athl Train. 2023;58(6S):266.*

RETURN-TO-SPORT FOLLOWING DELTOID LIGAMENT AND SYNDESMOSIS REPAIR IN A DIVISION 1 FOOTBALL DEFENSIVE BACK

Background: A 22-year-old, Division I male football defensive back, with no previous history of ankle injury, sustained a left ankle injury during competition. The mechanism of injury was direct contact to the lateral lower leg from an opponent forcing the ankle toward eversion. Initial on-field evaluation revealed palpable pain over the medial ankle with no sign of fracture or obvious deformity; and the athlete was assisted off the field NWB. Sideline evaluation revealed pain and point tenderness over the medial and anterior ankle, decrease dorsiflexion flexion and eversion active range of motion, and pain with eversion ligamentous stress testing with increased laxity. The athlete was able to fully weight-bear but was not able to perform functional movements, removing him for continuing with the competition. On-site radiographs were negative for fracture or dislocation. The athlete was fitted with a walking boot, instructed to weight-bear as tolerated, and follow-up the following day with the sports medicine team.

Differential Diagnosis: Based on the initial signs, symptoms, and radiographs, differential diagnoses included: deltoid ligament sprain, anterior inferior tibiofibular ligament sprain, syndesmosis sprain.

Intervention & Treatment: Follow-up evaluation revealed gross swelling around the ankle and discoloration over the medial ankle. Standard-of-care treatment was initiated which included cryotherapy, pain-free PROM exercises, isometric strengthening, and NSAIDs. The athlete was referred to the team physician for repeat radiographs and MRI. Diagnostic testing noted a complete rupture of the deltoid ligament, grade II anterior inferior tibiofibular ligament sprain and bone contusions of the medial malleolus and talus. The athlete was referred to a physician with specialization in foot and ankle injuries for further evaluation. The evaluation concluded that the athlete suffered a complete rupture of the deltoid ligament and syndesmosis. There was also gross instability in the ankle and surgical intervention was indicated. The athlete underwent surgery that included a primary repair of the deltoid ligament combined with a syndesmotic Tight Rope fixation. Following post-surgical recovery, the athlete completed an aggressive intervention and return to sport program that included: progressive strengthening and proprioceptive ankle exercises with blood flow restriction, early initiation of a weight-supported gait/running program, progressive functional and sport specific agility drills, and gradual return to sport activities. The athlete was able to return to sport in 5 weeks with no restrictions and returned to the starting line-up at week 6 from the date of surgery. The athlete continued full participation with the use of an external ankle brace, modified spartan taping, and custom fitted orthotics.

Uniqueness: Ankle injuries that include a deltoid ligament rupture, combined with syndesmotic disruption are not commonly reported in the athletic population. This traumatic injury requires surgical fixation to stabilize the ankle and the typical time to return to sport varies, on average, from 4-6 months. We present a unique case where early access and frequency of an aggressive rehabilitative program, integrating a multi-disciplinary healthcare team, resulted in positive outcomes where the athlete was able to safely and successfully return to high level sport in 5 weeks.

Conclusions: Ankle injuries that result in rupture of the deltoid ligament and syndesmosis result in gross ankle instability. This injury is rare in sports and requires an extensive surgery that combines multiple surgical procedures. A 22-year-old football player sustained this traumatic ankle injury that commonly requires 4-6 months of recovery. Through an integrated healthcare team approach, an aggressive intervention program was successful in positive outcomes with the athlete returning to sport in 5 weeks. This unique case challenged the conventional recovery times as a result of early access and frequency of an aggressive rehabilitative program, while taking into account the physiological and patient response to the injury and rehabilitation.

Source: *Blankenship VT, Foster SZ, Kessler KG, McDonough EB, Waldrop NE, Nguyen A. Return-to-Sport Following Deltoid Ligament and Syndesmosis Repair in a Division 1 Football Defensive Back: Type 4 CASE Study. J Athl Train. 2023;58(6S):267.*

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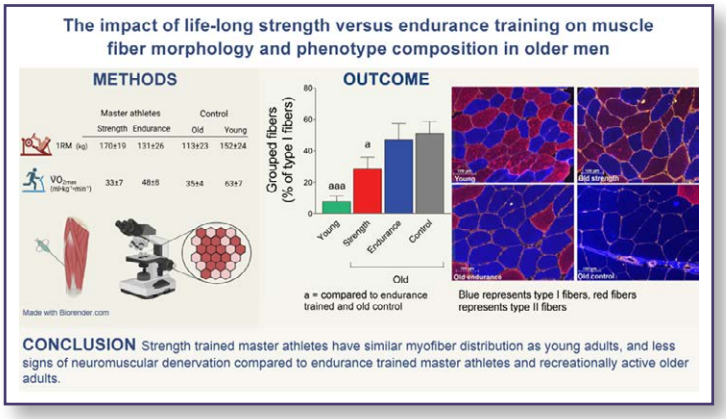
STRENGTH TRAINING PRESERVES AGING FAST-TWITCH MUSCULATURE



Aging is typically associated with decreased muscle strength and rate of force development (RFD), partly explained by motor unit remodeling due to denervation, and subsequent loss of fast-twitch type II myofibers. Exercise is commonly advocated to counteract this detrimental loss. However, it is unclear how lifelong strength versus endurance training may differentially affect markers of denervation and reinnervation of skeletal myofibers and, in turn, affect the proportion and morphology of fast-twitch type II musculature. Thus, the study authors compared fiber type distribution, fiber type grouping, and the prevalence of atrophic myofibers (≤1,494 µm2) in strength-trained (OS) versus endurance-trained (OE) master athletes and compared the results to recreationally active older adults (all >70 yr, OC) and young habitually active references (<30 yr, YC). Immunofluorescent stainings were performed on biopsy samples from vastus lateralis, along with leg press maximal strength and RFD measurements. OS demonstrated similar type II fiber distribution (OS: 52.0 ± 16.4%; YC: 51.1 ± 14.4%), fiber type grouping, maximal strength (OS: 170.0 ± 18.9 kg, YC: 151.0 ± 24.4 kg), and RFD (OS: 3,993 ± 894 N·s−1, YC: 3,470 ± 1,394 N·s−1) as young, and absence of atrophic myofibers (OS: 0.2 ± 0.7%; YC: 0.1 ± 0.4%). In contrast, OE and OC exhibited more atrophic fibers (OE: 1.2 ± 1.0%; OC: 1.1 ± 1.4%), more grouped fibers, and smaller proportion of type II fibers (OE: 39.3 ± 11.9%; OC: 35.0 ± 12.4%) than OS and YC (all $P < 0.05$). In conclusion, strength-trained master athletes were characterized by similar muscle morphology as young, which was not the case for recreationally active or endurance-trained old. These results indicate that strength training may preserve type II fibers with advancing age in older men, likely as a result of chronic use of high contractile force generation. ler

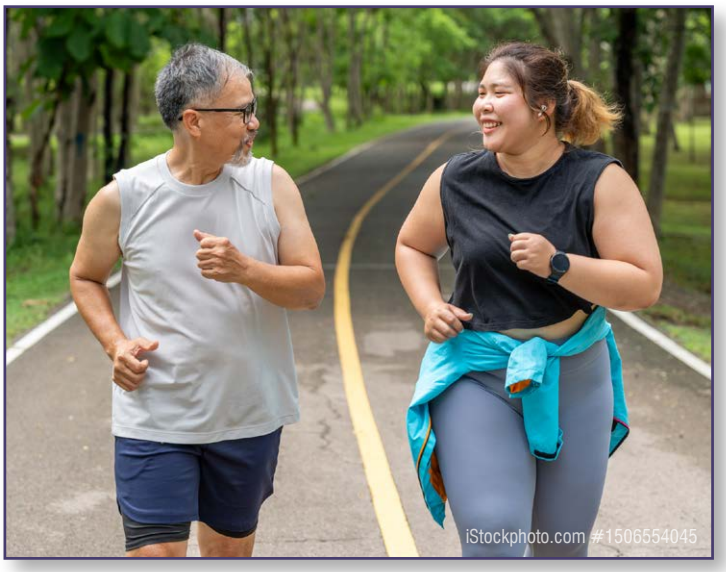
Source: *Tøien T, Nielsen JL, Berg OK, et al. The impact of life-long strength versus endurance training on muscle fiber morphology and phenotype composition in older men. J Appl Physiol (1985). 2023 Dec 1;135(6):1360-1371. doi: 10.1152/japplphysiol.00208.2023.*

THE DELTOID LIGAMENT & ANKLE STABILITY

When a complete deltoid tear caused severe instability of the ankle joint, augmented anterior repair was sufficient to stabilize the complete tear, and no additional benefit was provided by posterior repair. For isolated anterior tear, repair with tibiocalcaneal augmentation was the optimal treatment. Deltoid repair with augmentation may reduce or avoid the need for prolonged postoperative immobilization and encourage accelerated rehabilitation, preventing stiffness and promoting earlier return to preinjury activity. ler

Source: *Brady AW, Bryniarski A, Brown JR, et al. The biomechanical role of the deltoid ligament on ankle stability: Injury, repair, and augmentation. Am J Sports Med. 2023;51(10):2617-2624. doi: 10.1177/03635465231181082.*

DOESN'T MATTER HOW YOU REACH 150-MIN PHYSICAL ACTIVITY TARGET



Are so-called "Weekend Warriors"—those folks who cram all their physical activity into 1–2 days—better than those who distribute their activity more evenly over the week? In a study from Massachusetts General Hospital, researchers looked at 90,000 people who wore accelerometers for a week. They compared 3 groups: those who got less than the guideline-recommended 150 mins/wk of physical activity, those who hit the guideline by working even throughout the week, and those who concentrated their 150+ minutes in just 1 or 2 days. The 2 groups who hit the 150-min/wk target were associated with lower risk of heart attack, stroke,

Continued on page 20

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heart failure, and irregular heartbeat compared to the inactive group. The authors concluded that even when concentrated within 1–2 days each week, in-range targeted physical activity may be effective for improving overall cardiovascular risk.

Source: *Khurshid S, Al-Alusi MA, Churchill TW, Guseh JS, Ellinor PT. Accelerometer-derived "Weekend Warrior" physical activity and incident cardiovascular disease. JAMA. 2023;330(3):247–252. doi:10.1001/jama.2023.10875*

TEXTURED INSOLES DO NOT AFFECT GAIT, SENSATION, PROS IN MS

Innovative shoe insoles, designed to enhance sensory information on the plantar surface of the feet, could help to improve walking in people with Multiple Sclerosis (MS). This study sought to compare the effects of wearing textured versus smooth insoles, on measures of gait, foot sensation, and patient-reported outcomes (PROs), in people with MS.

Figure. Smooth (A) and textured (B) shoe insoles.

The authors report on a prospective, randomized controlled trial with concealed allocation, assessor blinding, and intention-to-treat analysis. Thirty ambulant men and women with MS (Disease Steps rating 1–4) were randomly allocated to wear textured or smooth insoles for 12 weeks. Self-reported insole wear and falls diaries were completed over the intervention period. Laboratory assessments of spatiotemporal gait patterns, foot sensation and proprioception, and PROs, were performed at Weeks 0 (Baseline 1), 4 (Baseline 2), and 16 (Post-Intervention). The primary outcome was the size of the mediolateral base of support (stride/step width) when walking over even and uneven surfaces. Independent t-tests were performed on change from baseline (average of baseline measures) to post-intervention.

The results showed there were no differences in stride width between groups, when walking over the even or uneven surfaces ($P \geq 0.20$) at post-intervention. There were no between-group differences for any secondary outcomes including gait (all P values > 0.23), foot sensory function (all P values ≥ 0.08) and PROs (all P values ≥ 0.23).

In their conclusion, the authors wrote that in their small trial, prolonged wear of textured insoles did not appear to alter walking or foot sensation in people with MS who have limited foot sensory loss. They also called for further investigation to explore optimal insole design.

Source: *Hatton AL, Williams K, Chatfield MD, et al. Effects of wearing textured versus smooth shoe insoles for 12 weeks on gait, foot sensation and patient-reported outcomes, in people with multiple sclerosis: a randomised controlled trial. Brain Impair. 2023;24(2):148-167. doi: 10.1017/BrImp.2022.33.*

EVEN HOUSEHOLD CHORES HELP ACHIEVE PHYSICAL ACTIVITY TARGETS

Studies show that fewer than 1 in 5 middle-age adults engage in regular exercise. But nearly everyone engages in micropatterns of physical activity, aka short bouts of daily living activities—in other words, chores or errands. Now, a study from Australia has looked at the associations of bouts of moderate-to-vigorous intermittent lifestyle physical activity and the proportion of vigorous activity contributing within these bouts with mortality and major adverse cardiovascular events (MACE). Using Biobank data from 25,241 adults (mean age 61.8 yrs) who used wrist-worn accelerometers, the researchers reported that people who did 1–3 minutes of such activities over the course of the day had a 34% lower risk of early death or MACE over the 7.9-year study period. The study participants averaged 27 mins/day of moderate-to-vigorous activity with no formal workouts. Movement matters!

Source: *Ahmadi MN, Hamer M, Gill JMR, et al. Brief bouts of device-measured intermittent lifestyle physical activity and its association with major adverse cardiovascular events and mortality in people who do not exercise: a prospective cohort study. Lancet Public Health. 2023;8(10):e800-e810. doi: 10.1016/S2468-2667(23)00183-4.*

EFFECT OF EARLY PARTIAL WEIGHT BEARING ON SANDERS IV CALCANEAL FRACTURES

This research explored and analyzed the effects of early partial weight-bearing rehabilitative exercise on postoperative recovery after Sanders IV calcaneal fractures.

Researchers from The Department of Rehabilitation Medicine at the Yantai Yuhuangding Hospital in China worked with 86 patients hospitalized with Sanders IV calcaneal fracture from April 2018 to January 2020. The patients were randomly divided into the observation group (n=44) and the control group (n=42). The control group carried out the conventional rehabilitative exercise (partial weight bearing began at 13 weeks post-surgery), and the observation group underwent early partial weight-bearing rehabilitative exercise at 4 weeks. The foot function between the 2 groups was compared after 24 weeks of treatment.

The foot function of the observation group after 24 weeks of treatment was notably superior to that of the control group ($P < 0.05$).

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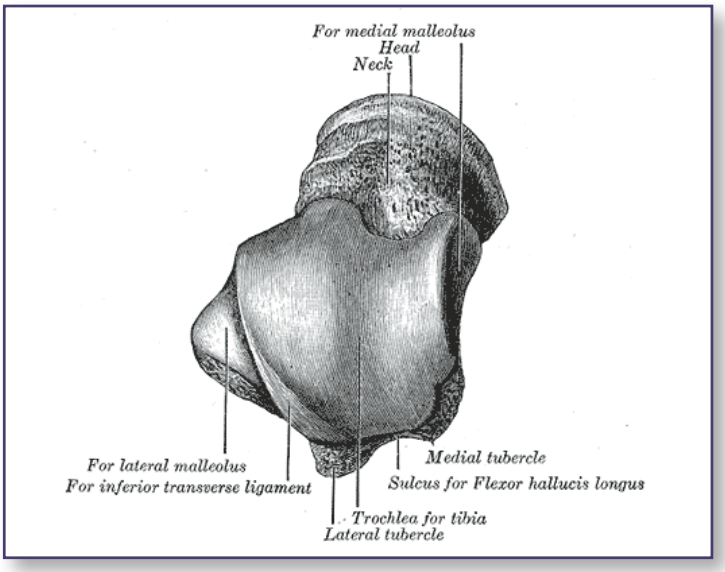
The Maryland foot function scores of the 2 groups at 6 weeks, 12 weeks, and 24 weeks post-operation were critically higher than those before treatment (P <0.05), and the score of the observation group was substantially higher than that of the control group (P <0.05). The American Orthopaedic Foot & Ankle Society scores of patients in the 2 groups at 6 weeks, 12 weeks, and 24 weeks post-operation increased over that before treatment (P <0.05), and the scores of the observation group were evidently higher than that of the control group (P <0.05). In addition, the comparison of Angle B'hler and Angle Gissane between the 2 groups of patients 24 weeks post-operation showed statistically insignificant difference (P >0.05).

The authors concluded that early partial weight-bearing rehabilitative exercise can effectively promote the postoperative functional recovery of patients with Sanders IV calcaneal fractures, and at the same time it has no impact on internal fixation or calcaneus shape.

Source: *Li Y, Xie L, Li W. Effect of early partial weight-bearing rehabilitative exercise on postoperative functional recovery of Sanders IV calcaneal fractures. Am J Transl Res. 2021 Jul 15;13(7):8316-8322.*

RETROSPECTIVE REVIEW SHOWS EARLY FIXATION OF TALUS FRACTURES IS SAFE



Talus fractures are often the result of high-energy mechanisms and can lead to devastating complications. Treatment is often operative; however, the appropriate timing of this has been debated. The purpose of this study was to determine the efficacy and safety of the early treatment of talus fractures.

The authors retrospectively reviewed patients age 18 years or older who underwent definitive operative stabilization of their talus fracture at a single urban level 1 trauma center. Patients were split into 2 groups based on time to definitive fixation: ≤ or >24 hours. Pertinent demographic, surgical, and follow-up data were collected and analyzed.

Their results examined a total of 108 fractures: 65 in the ≤24 hours fixation group and 43 in the >24 hours fixation group. Fractures involving the talar neck were the most commonly treated fracture pattern followed by the body and the head. There was no difference between the 2 groups in length to full weight bearing, union, or time to union. Open fracture was found to be the only significant risk factor for nonunion in both groups. There was no significant difference in infection or arthrodesis rates between the 2 groups.

The authors concluded that definitive treatment of talus fractures within 24 hours from presentation is both safe and effective with equal outcomes and without increased complications when compared with those injuries that undergo delayed or staged definitive fixation.

Source: *DeGenova DT, Miller KB, Paulini AS, et al. Early Definitive Fixation of Talus Fractures Is Safe: A Retrospective Review. Foot Ankle Spec. 2023:19386400231218333. doi: 10.1177/19386400231218333.*

HIP THERAPY TEMPERS LOW BACK PAIN, AIDS GAIT SPEED

Hip-focused physical therapy for older adults with chronic low back pain, hip pain, and hip muscle weakness may offer promise to address pain-related disability and functional limitations. NIA-funded scientists recently conducted a clinical trial comparing hip- versus back-focused therapies. Their findings, published in *The Lancet Rheumatology*, indicate that both therapies improved mobility with the hip therapy resulting in greater reduction in low back pain-related disability.

Low back pain is very common among older adults and is the leading cause of musculoskeletal disability worldwide. Additionally, older adults with chronic low back pain are at greater risk for losing functional abilities (such as activities of daily living), being institutionalized, and

Continued on page 25

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dying. Previous research that focused on improving low back pain only included participants age 37 to 56 years on average, and risk factors such as hip pain and muscle weakness were not assessed.

For this new trial, University of Delaware, Duke School of Medicine, and University of Pittsburgh researchers sought to determine whether a hip-focused intervention tailored to the characteristics of older adults age 60 to 85 with chronic low back pain, plus hip pain and weakness, would reduce pain and functional limitations when compared to a non-tailored, spine-focused intervention. They recruited 184 participants and randomly assigned them to hip- or spine-focused physical therapy.

The results showed a modest difference favoring the hip-focused treatment for low back pain–related disability immediately following the 8-week intervention, but no difference at 6 months. There was no difference of gait speed between the groups. However, further analyses found that 46% of participants in the hip-focused group and 33% in the spine-focused group had a substantial improvement in disability scores (50% or greater reduction in disability scores); while 53% of the hip-focused participants and 60% in the spine-focused participants had substantial improvement in gait speed. In addition, hip-focused treatment was associated with improvements in chair-rise performance at 6 months and 6-minute walk test performance at 8 weeks and 6 months.

According to the researchers, this is the first clinical trial to assess the efficacy of a tailored intervention matched to an at-risk subgroup of older adults with chronic low back pain and coexisting hip pain and muscle weakness. These findings also provide a potentially important precision medicine example of how task-specific exercise interventions based on particular risk factors may be applied to improve physical function for older adults with chronic pain. ler

Source: *Hicks GE, George SZ, Pugliese JM, et al. Hip-focused physical therapy versus spine-focused physical therapy for older adults with chronic low back pain at risk for mobility decline (MASH): A multicentre, single-masked, randomized controlled trial. Lancet Rheumatology. 2024;6(1):E-10-E20. doi: 10.1016/S2665-9913(23)00267-9.*

YET ANOTHER REASON NOT TO BE SEDENTARY

Based on data from nearly 50,000 adults in the United Kingdom, researchers from the U.S. National Institutes of Health have shown an association between dementia risk and daily sedentary behavior. Though the study cannot establish a causal link, it does support the idea that more time spent not moving–such as sitting while watching TV, working on a computer, or driving–may be a risk factor for dementia. The findings were published in the *Journal of the American Medical Association*.

A research team led by scientists at the University of Southern California and the University of Arizona looked at data from the UK Biobank. Focusing on adults 60 years and older who wore accelerometers, the researchers used machine learning to predict what patterns of

accelerometry data truly predicted sedentary behavior. They then used hospital and death registry data to determine which of these participants developed dementia in the following years.

Median duration of sedentary behavior was just over 9 hours per day, similar to results of studies on US adults. The analysis also indicated association between sedentary time and dementia risk. Most notably, the risk for dementia increased greatly for adults who were sedentary more than 10 hours a day.

Though this study did not test the role of physical activity and dementia risk, UK Biobank data has also been used to show a healthy lifestyle that includes daily activity is associated with lower risk of dementia. These recent results support the need to study whether there is a causal link between sedentary time and dementia risk and what aspect of sedentary behavior increases that risk. ler

Source: *Raichlen DA, Aslan DH, Sayre MK, et al. Sedentary behavior and incident dementia among older adults. JAMA. 2023330(10):934-940. doi: 10.1001/jama.2023.15231.*

STUDY TO REDUCE INCIDENCE OF KNEE OA RECRUITMENT TO START 2/2024

Osteoarthritis (OA), the leading cause of disability among adults, has no cure and is associated with significant comorbidities. The premise of this randomized clinical trial is that, in a population at risk, a 48-month program of dietary weight loss and exercise will result in less incident structural knee OA compared to control.

The Osteoarthritis Prevention Study (TOPS) is a Phase III, assessor-blinded, 48-month, parallel 2 arm, multicenter randomized clinical trial designed to reduce the incidence of structural knee OA. The study objective is to assess the effects of a dietary weight loss, exercise, and weight-loss maintenance program in preventing the development of structural knee OA in females at risk for the disease. TOPS will recruit

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1,230 ambulatory, community dwelling females with obesity (Body Mass Index (BMI) ≥30 kg/m^2) and aged ≥50 years with no radiographic (Kellgren-Lawrence grade ≤1) and no magnetic resonance imaging (MRI) evidence of OA in the eligible knee, with no or infrequent knee pain. Incident structural knee OA (defined as tibiofemoral and/or patellofemoral OA on MRI) assessed at 48 months from intervention initiation using the MRI Osteoarthritis Knee Score (MOAKS) is the primary outcome. Secondary outcomes include knee pain, 6-min walk distance, health-related quality of life, knee joint loading during gait, inflammatory biomarkers, and self-efficacy. Cost effectiveness and budgetary impact analyses will determine the value and affordability of this intervention.

Principal investigators are located at Brigham and Women's Hospital in Boston, University of North Carolina at Chapel Hill, Wake Forest University in Winston-Salem, North Carolina, and the University of Sydney in Australia. To learn more, visit ClinicalTrials.gov Identifier: NCT05946044.

Source: *Messier SP, Callahan LF, Losina E, et al. The osteoarthritis prevention study (TOPS) – A randomized controlled trial of diet and exercise to prevent Knee Osteoarthritis: design and rationale. Osteoarthr Cartil Open. 2023;6(1):100418. doi: 10.1016/j.ocarto.2023.100418.*

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Surgical Treatment of Ingrown Toenails Part II: Post-operative Data

By Victoria Exley, BSc (Hons) Pod, MSc; Katherine Jones, PhD; Grace O'Carroll, PhD; Judith Watson, PhD; and Michael Backhouse, PhD

Ingrown toenails (onychocryptoses) are one of the most common nail pathologies, yet there is a lack of data to assess the evidence surrounding the nail surgery procedures from which clinicians must choose.

When performing nail surgery, clinicians must choose from a multitude of procedures and variations within each procedure. While much has been published to guide this decision making, there is a lack of up-to-date, robust systematic reviews to assess the totality of this evidence. This second paper by the same authors reports outcomes on healing time, post-operative complications, pain, and participant satisfaction.

Methods

Five databases (MEDLINE, Embase, CINAHL, Web of Science and CENTRAL) and 2 registers (Clinicaltrials.gov and ISRCTN) were searched to January 2022 for randomized trials evaluating the effects of a surgical intervention(s) for ingrown toenails. Data on co-primary outcomes of symptom relief and symptomatic regrowth were presented in the study authors' first paper. This paper presents data for the secondary outcomes and further discussion.

Results

Of 3,928 records identified, 36 randomized trials were included in the systematic review. Healing time appears to be reduced with shorter application of phenol. A reduced healing time was also apparent with the addition of curettage, although this may also increase the risk of postoperative bleeding and pain. Postoperative bleeding was also reportedly lower in people who received local anesthetic with epinephrine but no tourniquet. Use of phenol with nail bed excision may decrease the risk of infection. Lower pain scores were reported when using partial matrixectomy and surgical interventions with phenol. Shorter duration of pain was reported with phenolization and wedge resection. Participant satisfaction was high overall.

Risk of bias was assessed for 6 domains in each study (Figure 1).

Discussion

This is the second paper from the same authors of this systematic review and meta-analysis of randomized controlled trials of surgical treatments for ingrown toenails. The first reported the methods used in the review and reported results from the primary outcomes of recurrence and relief of symptoms. This second paper focuses on the secondary outcomes of healing time, postoperative complications (eg, infection and hemorrhage), postoperative pain (duration and intensity), and participant satisfaction. Although a large number of trials were identified for inclusion in the review, the poor reporting, heterogeneity of the studies and differences in outcome measures/timepoints, meant a meta-analysis was not possible on these secondary outcomes.

Perhaps the most obvious clinical finding from this is the lack of robust clinical conclusions that can be drawn from all these studies. Possibly the clearest pattern to emerge was around the use of phenol. Shorter application of phenol during the chemical matrixectomy was linked to shorter

This article has been excerpted from "A systematic review and meta-analysis of randomised controlled trials of surgical treatments for ingrown toenails part II: healing time, post-operative complications, pain, and participant satisfaction." J Foot Ankle Res. 2023 Sep 6;16(1):55. doi: 10.1186/s13047-023-00655-7. PMID: 37674170; PMCID: PMC10481456. Editing has occurred, including the renumbering or removal of tables, and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

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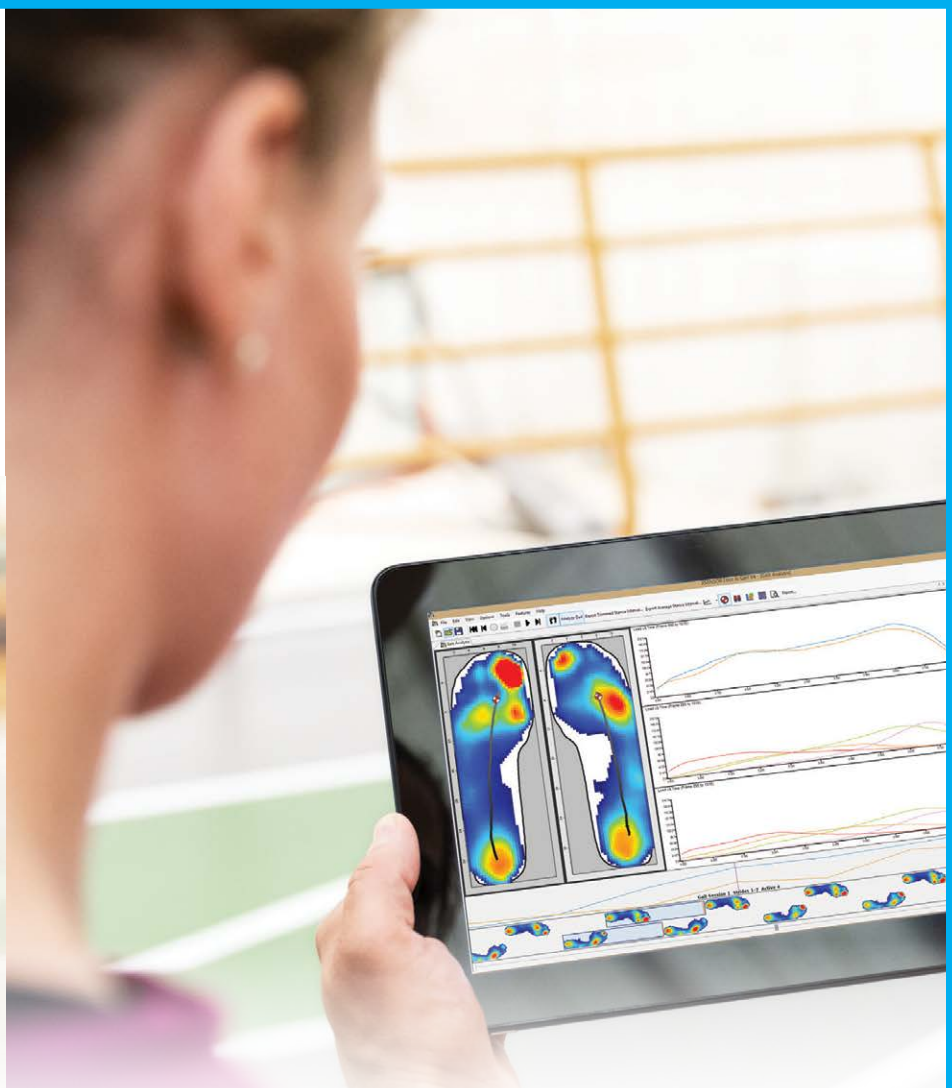

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time to healing in 2 studies, but application duration appeared to have little effect on postoperative complications. Although this may suggest that clinicians should use a shorter duration of phenol, this must be balanced against the meta-analysis in the first paper which indicate higher rates of regrowth are associated with shorter application times. The optimal balance of effectiveness and sequalae is yet to be determined and clinicians may opt to vary application times to meet the needs of individual patients.

Curettage has been explored in several studies. Alvarez-Jimenez et al. reported that using a Martini bone curette following partial nail avulsion and destruction of the nail matrix with phenol reduced healing time by a third (7.5 ± 1.8 days compared to 12.4 ± 3 days, p = 0.001). They also found that it reduced rates of postoperative infection, but increased postoperative bleeding and as reported previously had no effect on recurrence. However, with only 51 patients, and that this has not been tested in multiple trials, care must be taken not to over-interpret these findings. It is notable that while interventions such as curettage may benefit some outcomes such as healing, it may increase others such as postoperative bleeding. A similar pattern was found with phenol where longer durations of application were linked to reduced likelihood of regrowth but increased healing times. Clinicians and future studies should prioritize these competing risks and benefits in a way that prioritizes what is important to patients.

Many studies report infection rates following nail surgery but combining these isn't yet possible as case definitions are unclear and inconsistent. Standardized definitions of surgical site infections and severity classifications exist and have been used in other fields of surgical research, but they have not yet been validated and applied to nail surgery. Despite the clear interest in postoperative infection as an outcome, only 1 trial explored the use of oral antibiotics and found no evidence that they reduced the rate of postoperative infection. However, with only 50 to 53 participants per group, it would only have been powered to identify a large effect.

Other postoperative sequalae, such as hemorrhage, also had unclear case definitions and were poorly reported. With some studies only capturing data for some outcomes up to 48 hours post procedure, there is not enough time to meaningfully assess the effect of an intervention on complication rates. Perhaps more worryingly, there was a lack of information on the reporting of adverse events in general despite clear legal and governance frameworks being in place for many years.

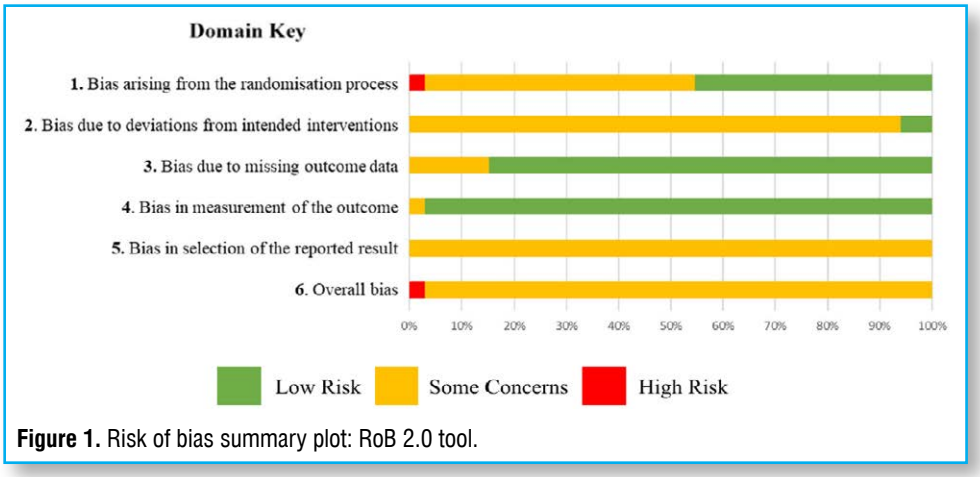

Figure 1. Risk of bias summary plot: RoB 2.0 tool.

Another frequently captured outcome was patient satisfaction. This is a widely used, but poorly defined concept in healthcare and although definitions vary, they generally center on satisfaction being the extent to which an individual's experience meets their expectations. However, patient expectations are not a stable trait and change over time as has been recognized elsewhere. Evidence from randomized trials have shown that patient expectations can be deliberately modified, and that patient expectations can be guided toward what clinicians consider achievable. Modification of patient's expectations would in turn influence their final level of satisfaction, which brings into question its value as a measure of treatment effectiveness.

Given the limitations of the studies identified in this review, it's clear that many fundamental questions remain unanswered around the surgical treatment of ingrown toenails: Is destruction of the nail matrix always necessary? What is the optimal technique to prevent symptomatic regrowth? How should patients be reviewed and monitored postoperatively? Are different procedures more appropriate for subgroups of patients? Further high-quality collaborative trials are needed to answer these questions.

Conclusion

This second paper reports secondary outcomes from a robust systematic review of randomized trials on surgical treatment of ingrown toenails. Despite the large volume of clinical trials conducted on the topic, few clinical conclusions can be drawn due to the poor quality of these studies. Further high-quality clinical trials are needed to answer fundamental questions in the surgical treatment of ingrown toenails. ler

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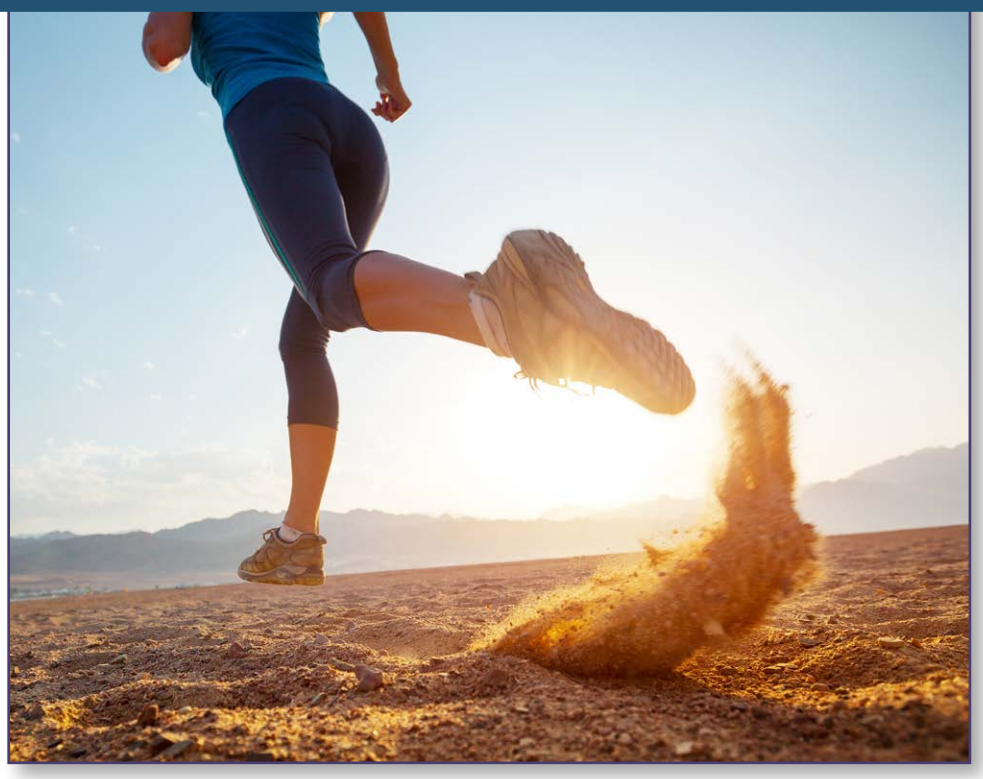
Force & Foot Function

By Paul Graham, B App Sc (Pod), FAAPSM



Natural forces affect every step we take. When the forces are too great for plantar tissues to handle, overloading occurs. Tissue overload can occur throughout the kinetic chain, wreaking havoc from end to end.

Over the past 15 to 20 years, research has focused on tissue overloading as the most common cause of overuse injury. Overload is caused by the forces of everyday life – push, pull, friction, gravity, and acceleration. These all generate forces on our bodies that can increase the risk of dysfunction and potential injury if the forces are higher than the tissues can withstand. These forces can be independent; but more commonly, they interact as we go through the movements of daily living.

Forces that affect us the moment we bear weight are the properties of gravity and the resultant ground reaction force (GRF) based on Newton's third law: for every action, there's an equal and opposite reaction.

It is important to understand how our body weight is transmitted onto the ground and how the GRF acts on our feet. Measures of plantar pressures allow us to see how those forces act on the foot. If the foot's active and passive supportive mechanisms are overwhelmed or not stable enough to resist the GRF, we see compensation and dysfunction. These mechanisms are described in Kirby's longitudinal arch load-sharing system[1], combined with the recent studies of the role of the intrinsic muscle control by the central nervous system.[2,3]

Our body weight is primarily transmitted through our skeleton, which in turn is supported by connective tissues, allowing the forces to be dynamically shared during movement, particularly side-to-side movements.

Most humans have some asymmetry, which affects how the body functions and how body weight is transferred. Obvious asymmetries that affect function and plantar pressures include scoliosis, genu valgum or genu varum, internally or externally rotated lower legs, leg length differences, and high arch vs. low arch feet. As we age, asymmetry arises less from injuries, and more from adaptations and imbalances from everyday life.

Misalignments don't necessarily mean that we'll be injured, but they may contribute to injury by changing the pathways of force generation throughout the body. The red and yellow lines in Figure 1 represent the force placement. They are exactly equal in magnitude even though in the pictures it doesn't show that.

While the foot's default compensatory mechanism is pronation, depending on individual structure, compensation for a given condition may cause one person's foot to roll

This is an excerpted transcript from a 4-part webinar series titled "Clinical Gait Assessment Using Plantar Pressure Analysis," sponsored by XSENSOR Technology Corporation. A second excerpted transcript from the same series focused on Developing Treatment Strategies & Predicting Outcomes Using Plantar Pressure Analysis will appear in a future issue. To hear the entire webinar, visit https://learn.xsensor.com/clinical-gait-assessment-using-plantar-pressure-analysis-part-2.

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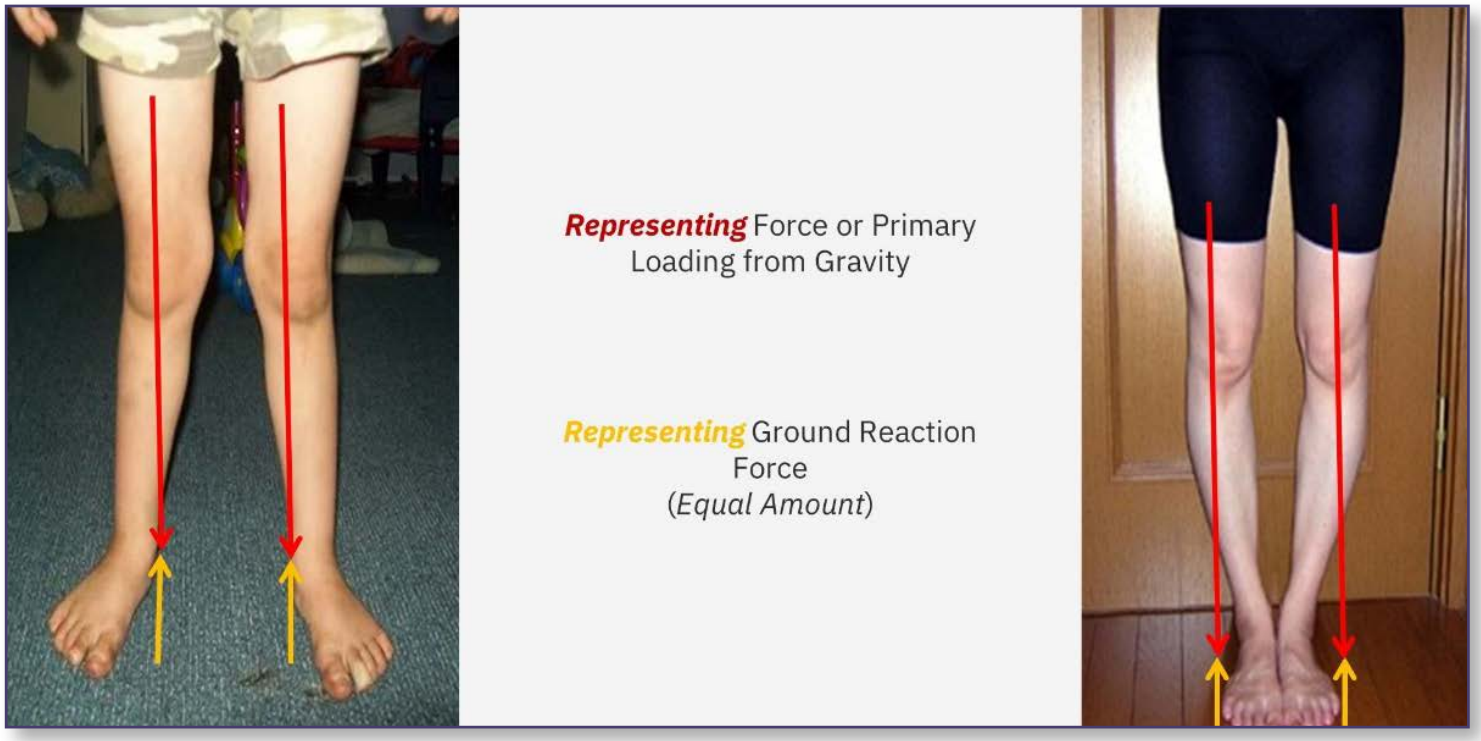

Figure 1. Force Pathways & Asymmetry. In the patient with the knock knees (left), the weight bearing is more to the inside of the foot, making the foot roll in or pronate more. On the right, the patient's weight will be placed depending on the level of compensation the body can offer.

outward, but it may cause another's foot to roll inward.

Less obvious asymmetries that affect function are neuromuscular control and tone, neurological functions such as proprioception and information from other receptors, the origin and insertion of muscles creating joint movements, and the axis of joints, which also will influence joint movements.

Thanks to Kevin Kirby's work describing it,[4] a well-known axis of the foot is the subtalar joint (STJ) axis (Figure 2). If the axis is medially deviated, then GRF pressing under the foot will cause excessive pronation. If the axis is laterally deviated, then the same GRF pressing under the foot will cause excessive supination. And this is just one axis. When we talk about the midfoot joint axes, it gets more complicated with multiple axes, where each influences function.

Why the Body Compensates

Day-to-day activity creates forces that require compensation. Repeated dysfunctional patterns of movement create habits, which if continued, will create tissue adaptations that may positively or negatively affect function.

The busy-ness of life's day-to-day activities often causes poor posture and function, and the repetitive nature leads to the risk of imbalance. While this commonly affects the trunk and head posture through changes in muscle balance and center of gravity (COG), it also can potentially alter gait and require compensation in the feet and legs. Based on all the gait styles you've seen in people walking by at the shopping center, it is clear the human body can compensate in several different ways.

Exercise, for example, is good for us, and to get stronger, we do need to push boundaries. Overtraining, however, is pushing the body beyond its limits. If we ignore the signs the body gives to not continue, this often results in injury or worse, a cycle of injury where the patient does what's required to recover, then pushes themselves to get stronger as quickly as possible, resulting in reinjury. That cycle is real and pernicious, and all too common. Footwear heel height can also cause changes in the COG requiring postural shifts in the hips, knees, and extended torso to facilitate walking. Shoes should be worn as appropriate for the occasion and to provide appropriate support, as you wouldn't wear high heels to run a marathon.

Being overweight increases the loading on all tissues and can exponentially increase loading on already overloaded tissues. Excessive weight can also cause an abducted gait, often with a transverse plane sway or waddling type of gait. If the compensation in the frontal and sagittal planes is insufficient for full compensation, other structural misalignments may occur.

Surgery to address major injury, such as through sports, a car crash, workplace injury, or an arthritic joint, can make a world of difference to a patient's quality of life. But we need to ensure that the outcome is the best possible and does not alter force transmission negatively.

How the Body Compensates

To reduce the risk of injury, our body compensates by redistributing forces across several tissues by using the input from the neural sensors and then distributing the forces generated through muscle strength, connective tissue elasticity, and joint mobility.

The postural inputs include visual acuity

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from the eyes, balance from the vestibular canal system in the inner ear, tempo-mandibular-joint proprioception for head position, proprioception from the foot to provide a plane of reference for the rest of the body, and joint and soft tissue function feedback from mechanoreceptors and Golgi tendon organelles. With all this input, the brain uses muscles as a key part of the compensatory mechanism.

Muscles initiate movement and power and provide a significant stabilization force. As we age and our muscles atrophy, prolonged normal movements and activities can become painful as muscles fatigue. We need to consider low tone or high tone muscle issues, trigger points, neuromuscular disorders, et cetera, in how patients' muscles will react with all this compensation.

While transmission of forces is primarily through the skeletal structure, the web of connective tissues such as fascia, ligaments, periosteum, and tendons provide stability and energy return making repetitive movement very energy efficient. This helps the passive supportive mechanisms of the body, such as in the foot.

Joint mobility, usually classified as joint stiffness in biomechanical terms, should be seen as describing not only the joint range of motion (ROM), but the characteristics of the capsular apparatus and associated soft tissues. People with stiff joints are less able to compensate, so the joint above and below are loaded more.

People with a greater ROM usually have greater capacity to compensate and redirect forces and often are not as symptomatic, even though their feet may look worse.

Clinical Signs of Lack of Compensation

If there is not enough compensation to allow fluid gait due to significant structural asymmetry, functional imbalance or lack of muscle function or joint ROM, we will see various changes. For example, if a person complains of being clumsy, check their tibial torsion: Commonly, it will be internally rotated. Or maybe the foot and ankle joints are too stiff to allow compensation to occur. Or they may have a neuromuscular disorder that makes them less aware of spatial arrangements. If the body can't compensate enough, the patient will indeed trip more easily than other people.

The abductory twist as the heel lifts off the ground when a person is walking is another example where the joints in the midfoot and the STJ don't have enough ROM to compensate, and the dysfunction of the soft tissues restrict movement. So as the heel lifts, the torque that is being developed by the structure is shown by the twisting of the heel.

A side-to-side gait can occur if there are joint blockages or other features that reduce compensation in the frontal plane, which is the

first plane to compensate, and in the sagittal plane, which is the second. So the body is only able to compensate through the transverse plane. That's just one of many reasons why someone would have a side-to-side gait. But if you rule out all the other reasons, then you should consider the body's ability or inability to compensate properly.

Similarly, if a person has muscle weakness or ankle, subtalar or midfoot joint restrictions, we'll see some odd types of gait, particularly in running, as the body is forced to use every compensatory trick it can to help allow normal movement to occur. But if it is commonly occurring at the end of or toward the end of a sporting activity, it's usually because the muscles are fatigued; they've shortened, and therefore are not providing their stabilization role and the level of compensation is not enough.

Pronation Is Not All Bad

In the past, pronation of the foot was seen as a bad thing. If you look at your bare foot while seated and it is non-weight bearing, most will see an arch. This describes the structure of your foot, which may have a higher arch profile or a lower arch profile. We need to be careful when describing any low arch profile as excessively pronated and thus pathological.

Now, if you stand up and look at the same foot, the chances are that it will be pronated or rolled in. The medial column of the forefoot will dorsiflex, the arch will elongate, and the whole arch will flatten. This describes the

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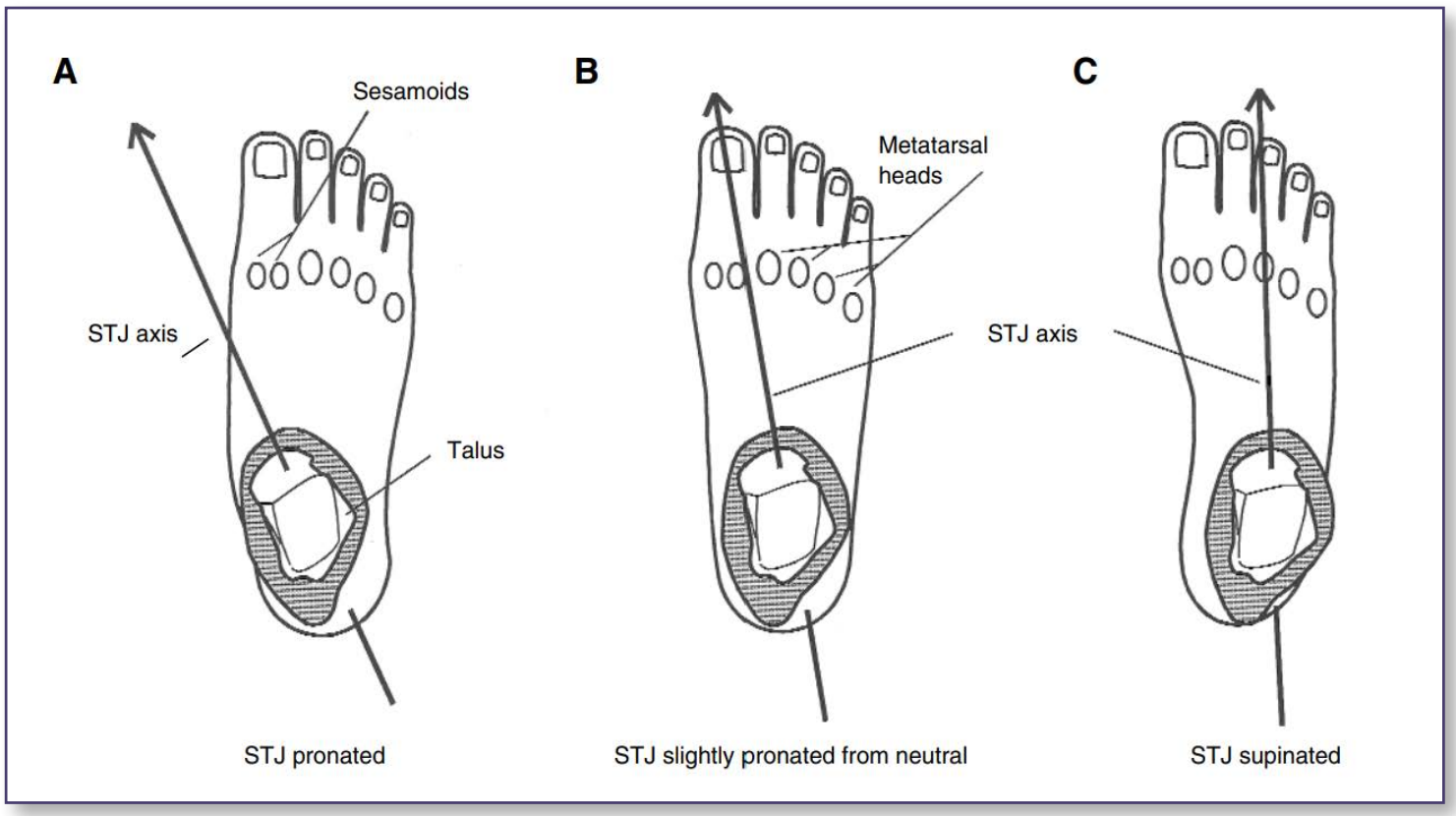

Figure 2. Significant Subtalar Joint Axis Displacement. When a foot that functions normally is in relaxed bipedal stance, resting slightly pronated from neutral position, the STJ axis passes through the posterior-lateral calcaneus posteriorly and above the first intermetatarsal space anteriorly (center, B). As the STJ undergoes pronation motion, the talus internally rotates and medially translates in relation to the plantar foot, causing the STJ axis to internally rotate and medially translate (left, A). As the STJ undergoes supination motion, the talus and STJ axis externally rotate and laterally translate in relation to the plantar foot (right, C). Reprinted from reference 1 with permission from the American Podiatric Medicine Association; all rights reserved.

function of your foot as it compensates for what could be several reasons. It could be a structural factor – genu valgum, excessive external tibial torsion, ligament laxity. It could be from muscle contracture, posterior leg musculature, weak intrinsic or extrinsic musculature, or muscle dysfunction due to growth. It could be pain avoidance, leg length difference, painful corn, et cetera. All this is to say, a pronated foot simply tells us that the foot is compensating for something. Our challenge as clinicians is to discover what the body is compensating for.

Figure 3 shows how the foot manages the forces applied to it in normal activity. In cases where the auto-supportive mechanisms are substantial enough to resist the deforming forces, the foot will function normally. In cases where the active and passive-supportive mechanisms are just enough to resist the deforming forces, the person is at risk of injury. If they apply a greater level of force through the foot, they will overwhelm these mechanisms and can develop injury. This can occur with a major event such as a sporting injury, or more commonly over time, with aging and lifestyle choices (weight gain, loss of strength and mobility), so even a small increase in force may cause an injury.

The active and passive supportive mechanisms work through:

- stabilizing the calcaneocuboid joint, which facilitates peroneus longus weight transfer to the medial column from low gear to high gear,
- the windlass functions stabilizing the medial column on the midfoot,
- proper function of the first metatarsophalangeal joint into pre-swing phase, and
- contracture of the plantar connective tissues, pushing our toes into the ground and catapulting us over the planted foot.

McPoil and Hunt, in their 1995 research paper, *"Evaluation and management of foot and ankle disorders, present problems and future directions"*, proposed the use of a new model: the tissue stress model.[6] They presented this as an effective alternative to the traditional Root et al[7] biomechanics paradigm for evaluating and treating foot disorders. Since then, this theory has been validated by several other research studies as we have moved from a kinematic explanation of foot function to a more kinetic focus on the forces and the ability of the tissues to manage the load placed on them. When everyday forces are applied to tissues at high risk, such as in the patient with neuropathy, bony prominences, or poor circulation, they can also affect the ability of tissues to withstand high tissue loading and direct injury can occur. The breakdown of tissue, delayed healing rates, and possible requirement of amputation can be the dramatic result.

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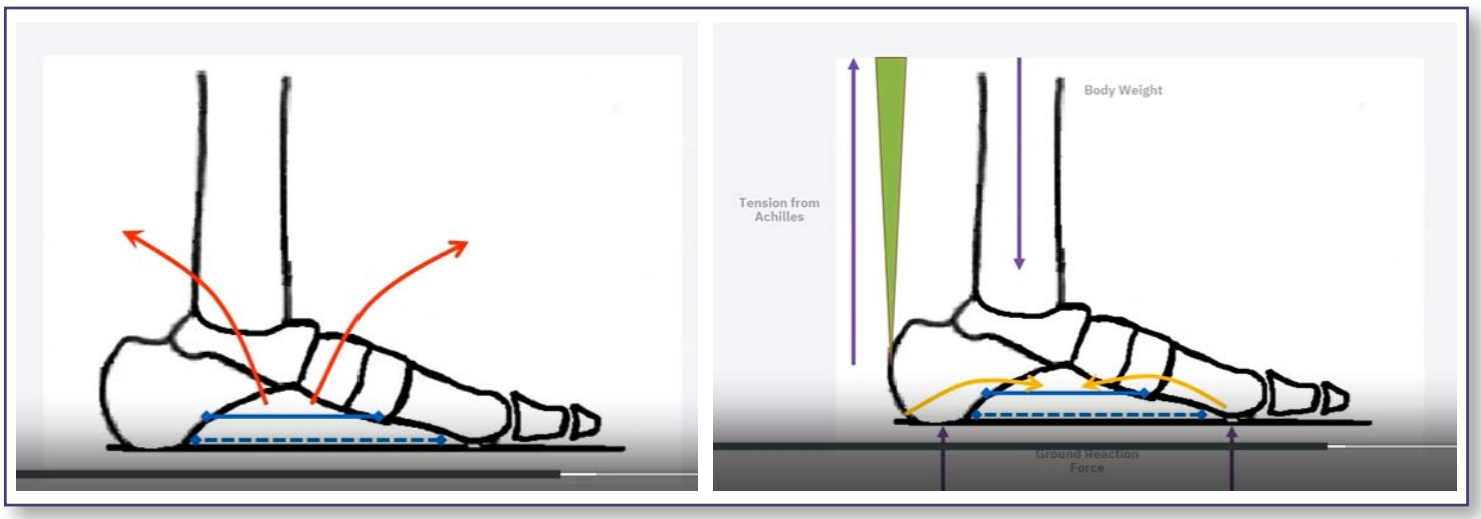

Figure 3. How the Foot Manages Force. A) The blue lines show how the foot and the medial and lateral longitudinal arch are stabilized by the intrinsic musculature and soft tissues. This dorsiflexes the rear foot and plantarflexes the forefoot, leading to the development and the maintenance of the arch structure shown by the red arrows. B) The gray line depicts the forces of body weight, the maroon line shows the tension from the Achilles, and the purple lines show the GRF applied underneath the foot. These tend to create the opposite rotation, lowering the arch of the foot and elongating the arch, as shown by the yellow arrows. Author's drawing based on works by Kevin Kirby.[5]

Directly Redistributing Forces

In our aim to prevent such tissue damage and ulceration or to heal those present, we need to address any circulatory issues as well as manage neuropathy, but we should never lose sight of the importance of assisting the body to manage the direct loading of those tissues.

In 2014, Waaijman et al showed that in-shoe peak pressure of less than 200 kPa and high adherence (> 80%) of wearing custom offloading insoles and footwear can reduce the risk of foot re-ulceration by over 50%, and that is significant.[8]

Foot dysfunction does not necessarily mean injury, but it may mean an increased risk of injury. For example, running places higher stress on tissues and when combined with uneven surfaces, injuries can occur.

How can we know the outcome of these forces?

Just as research has changed the way we understand how forces impact the foot and the outcomes, it also has questioned much of current practice. There are many studies that question the validity of non-weight bearing tests and weight bearing tests as well as recent studies that question the long-held foundations of our understanding of function and dysfunction. The most recent that comes to mind is Anja-Verena Behling et al 2023 paper, "Chasing footprints in time - reframing our understanding of human foot function in the context of current evidence and emerging insights".[9]

The constantly changing landscape of theories regarding foot function, can make it difficult to be completely confident in exactly how to measure dysfunction and to know if what we are measuring is the root cause of the symptoms and concern the patient presents with.

"To measure is to know" -Lord Kelvin

We can measure the outcome of loading objectively, quickly, and easily by using plantar pressure mapping. Using this data, we can understand the loading characteristics of the tissues and whether the tissue loading occurs too fast. We can understand if it is poorly distributed or if the intensity is too much. We can analyze if the foot is pronating or supinating with validated techniques and the function of the rearfoot, midfoot, and forefoot joint complexes, all in dynamic weight bearing gait. With some equipment we can analyze this in running and with others, analyze these factors in the patient's day-to-day life, removing any artificial barriers seen in clinical examination. We can also test balance and so much more.

If we use an in-shoe sensor, such as the XSENSOR Technology's Intelligent Insole Clinical system, we can not only see this with our patient walking barefoot, but also in their shoes, replicating activities in their activities of daily living (ADL), sport, or work duties. This data presents a picture of the actual forces being placed on the foot during these activities and gives us the best window into why the patient is experiencing the concerns that they've come to see us with.

The XSENSOR Clinical Foot & Gait software provides further information such as where the loading is and the symmetry during the swing phase as well as the relationship between footsteps, distances, and timings. Everything you need to know to start understanding the complexities and components of the presenting condition so you can start to address them.

The information we gain from this equipment tells us what is happening, but it doesn't tell us why. But by understanding what is happening, we can develop a hypothesis and then test it using dynamic plantar pressure to see in real time whether our hypothesis is supported by the relevant changes. While the examina-

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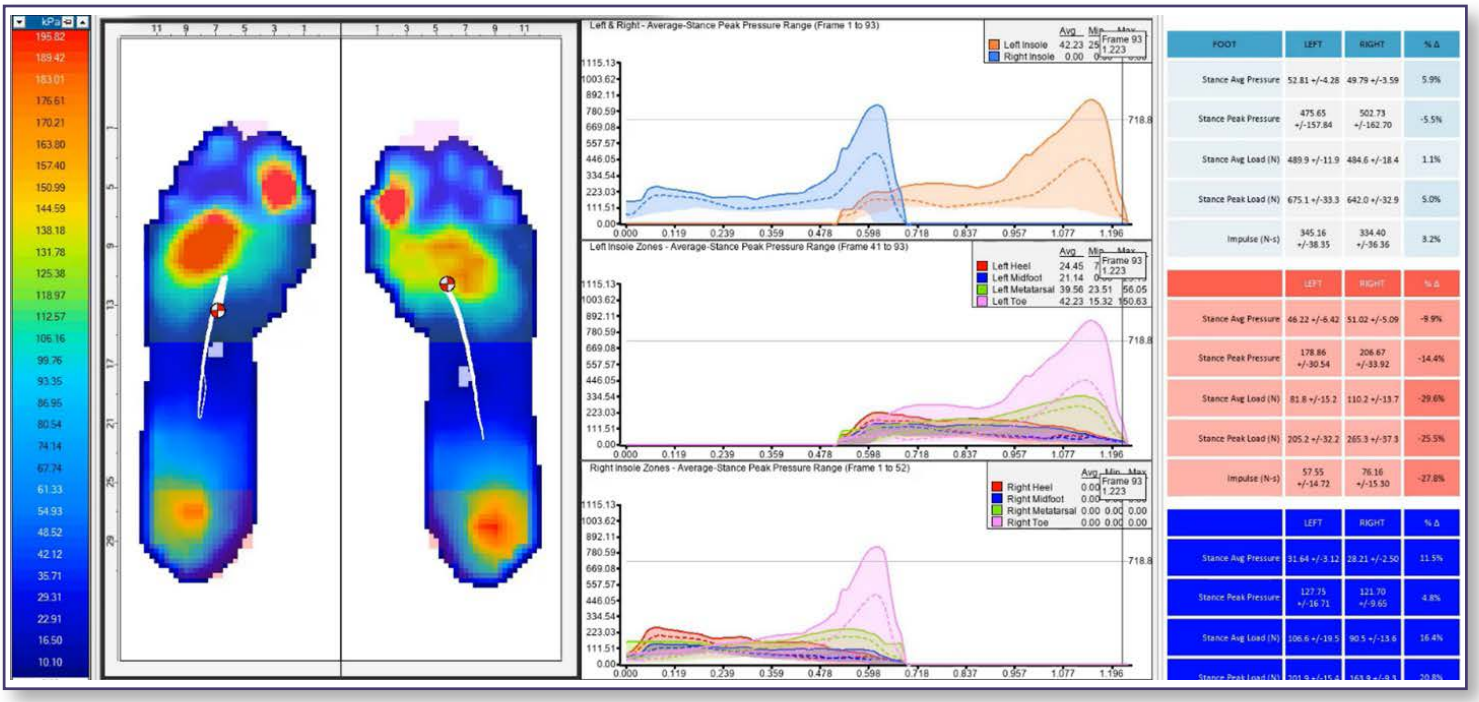

Figure 4. Presentation of a Patient with a Firm Forefoot Supinatus Condition Resulting in Bursitis. Above is a pressure map of a patient, captured using XSENSOR's Intelligent Insoles | Clinical, with a firm forefoot supinatus, L/foot > R/foot. The XSENSOR Foot & Gait Clinical software provides data on the placement and intensity of loading and other vital statistics. It can also provide insight into the dysfunction through the midfoot joint complex based on the abnormal trajectory of loading. From this information we can institute a treatment strategy and then at an appropriate future progress review, assess if this strategy has made the desired changes in function as well as improvement of symptoms.

tions, our understanding of the complexities of foot function and the interaction of the rest of the body in all the various activities we do each day and their related forces loading the foot may not be perfect, plantar pressure analysis provides a reliable, objective, and repeatable window that we can depend on to gain the diagnostic insight and develop the most efficacious treatment strategy possible.

Paul Graham is an Australian podiatrist with a special interest in musculoskeletal conditions. He was awarded a Fellow of the Australasian Academy of Podiatric Sports Medicine in 1999. He offers training in plantar pressure analysis through his company Step Force. He has provided plantar pressure training in universities in Australia and is a Faculty of Manipal University in India. He has used plantar pressure analysis in his clinical practice for over 25 years for the diagnosis and treatment of gait and foot dysfunctions.

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Falls and Related Injuries Due to Chronic Ankle Symptoms

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

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

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

Methods

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

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

Results

There were 186 falls reported among the chronic ankle symptoms group and 34 falls reported by controls. In the chronic ankle symptoms group, there were significantly more fallers (64%; n = 86) (individuals with 1 or

This article has been excerpted from "Falls and falls-related injuries in individuals with chronic ankle symptoms: a cross-sectional study" J Foot Ankle Res. 2023 Aug 16;16(1):49. doi: 10.1186/s13047-023-00649-5. Editing has occurred, including the renumbering or removal of tables, and references have been removed for brevity. Use is per CC Attribution 4.0 International License.

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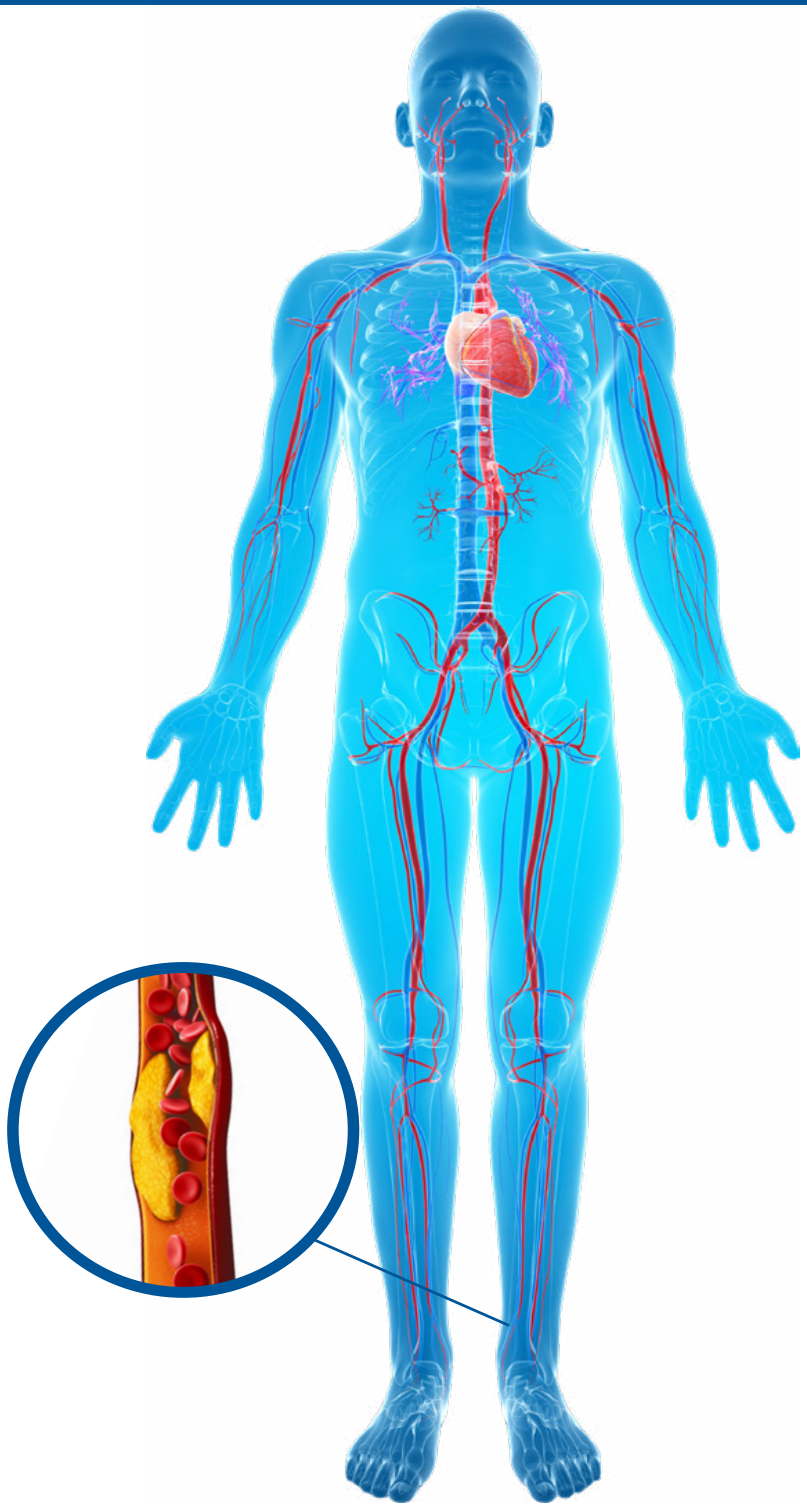

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Continued from page 45

Table 1

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

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

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

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

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

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

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

Discussion

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

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

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

Conclusion

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

The authors are from the Division of Physiotherapy, School of Health and Rehabilitation Sciences at the University of Queensland in St. Lucia, Australia.

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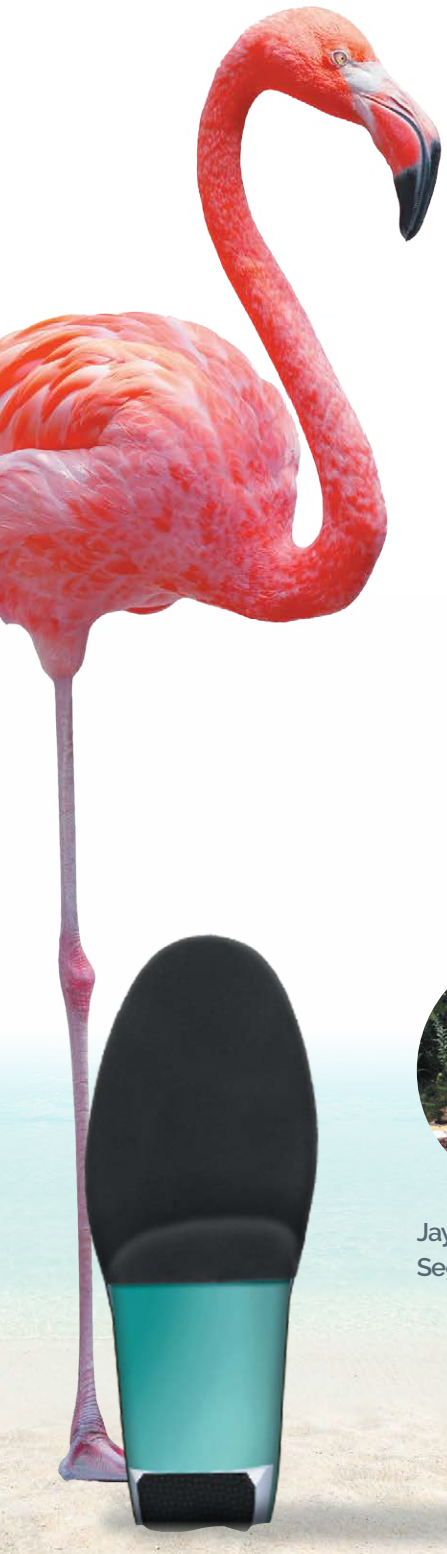

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Do the Fasciae of the Soleus Have a Role in Plantar Fasciitis? Part II

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

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

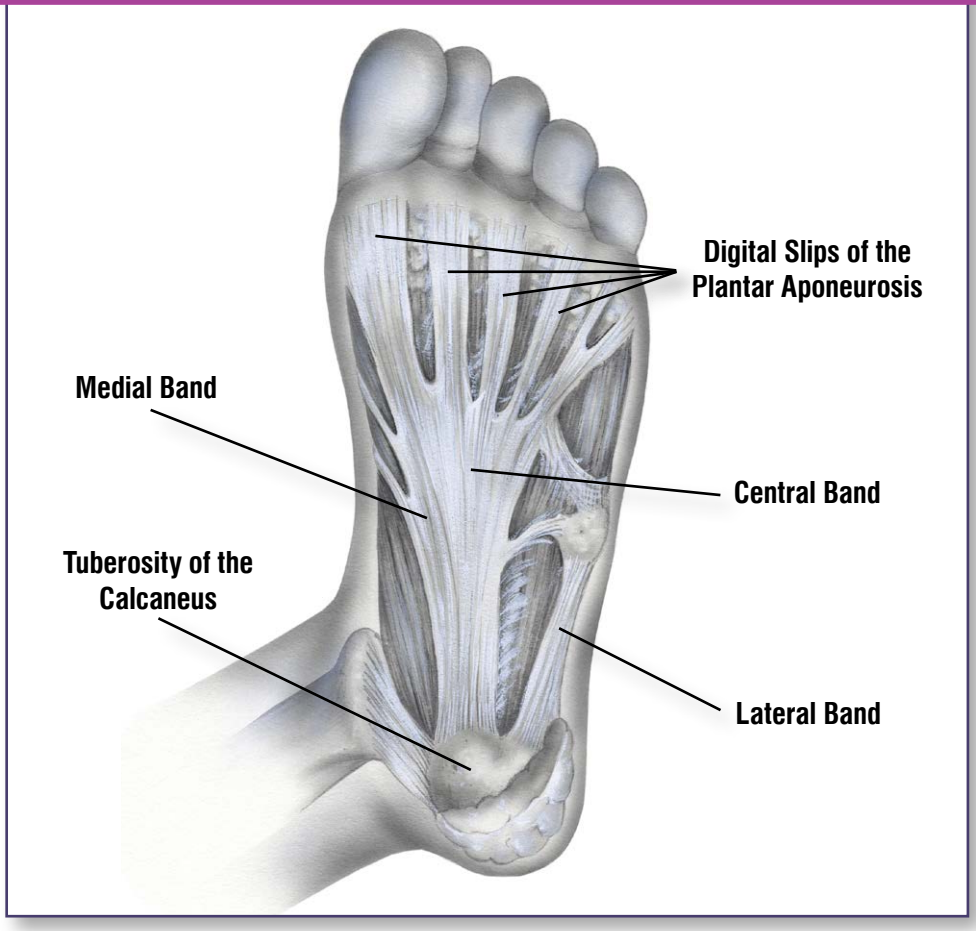

Figure 1. Schematic representation of the anatomy of the plantar aponeurosis.

The Critical Coordination between the Triceps Surae Muscle, Achilles Tendon (AT), and Plantar Aponeurosis (PA): the Emerging Role of the Fascia

The potential role of the suro-Achilleocalcaneal-plantar complex in PA pathology

The triceps surae complex represents the main extensor and propulsion system of the foot, and is equipped with a very sophisticated driving belt, namely the AT-posterior part of the calcaneus-PA in continuity with the fibrous skeleton of the triceps surae. This suro-Achilleo-calcaneal-plantar system was first described by Arandes and Viladot in 1954. They showed how the triceps surae complex is placed in series with the PA to ensure force transmission from the triceps surae toward the toes during walking, running, and jumping. Also referred to as the Achilleo-calcaneal-plantar complex (ACP), it was intensively investigated by French and Spanish research groups during the 1990s from both anatomical and biomechanical viewpoints.

The triceps surae muscle contributes differentially to lower limb movements. In detail, the medial and lateral heads of the gastrocnemius cross both the knee and ankle joints, proximally forming the lower boundary of the popliteal fossa. These muscles then connect to each other in the midline of the superficial posterior compartment of the leg, accounting for the characteristic bulge of the calf. In contrast, the soleus is a one-joint muscle. Its fibers originate below the knee, extending more distally along the tibia than those of the gastrocnemius. Thus,

This article has been excerpted from "Do the fasciae of the soleus have a role in plantar fasciitis?" from Clin Anat. 2023 Aug 4. doi: 10.1002/ca.24102, by the same authors. Editing has occurred, including the renumbering or removal of tables, and references have been removed for brevity. Use is per CC Attribution 4.0 International License. Part I, which focused on the current understanding of plantar fasciitis, a brief on the anatomy of the Achilles tendon and its pathophysiology, and the anatomical and structural continuity between the plantar aponeurosis and Achilles paratenon, appeared in our Oct/Nov 2023 issue.

Continued on page 51

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Continued from page 49

the soleus only crosses the ankle joint, having no action on the knee joint. As a result, the gastrocnemius is mostly involved in forward propulsion during walking, running, and jumping, whereas the soleus primarily acts as a foot stabilizer, giving the body vertical support while standing. This is reflected in their muscle fiber type compositions: the gastrocnemius predominantly consists of Type II (or fast twitch) fibers while the soleus contains a high percentage of Type I (or slow twitch) fibers. Consequently, skeletal muscle mass is lost more rapidly in the soleus than in the gastrocnemius, making the soleus a more sensitive indicator of skeletal muscle atrophy in response to muscle "disuse." This is well documented both in rodents and humans, with considerable similarities.

The soleus is generally considered at lower risk for strains than the gastrocnemius. However, soleus muscle injury could have been underestimated, owing to misdiagnosis as thrombophlebitis or gastrocnemius strain. Furthermore, soleus muscle strains could be underappreciated owing to the traditional use of sonography (ultrasound) for assessing calf muscle injuries. Gastrocnemius strains are easier to detect because the muscle has a superficial anatomical location, while the soleus is located much deeper in the calf region. This could explain why sonography reveals fewer soleus injuries than gastrocnemius injuries.

However, structural alterations in muscle strain injuries or abnormal patterns of skeletal muscle activity are not necessarily restricted to the muscle, but can affect the fascia. Very recently, Otsuka et al. reported changes in the elastic properties and mechanical behavior of the fascia lata associated with underlying quadriceps femoris muscle contractions, measured in vivo by shear wave elastography. The surrounding fasciae of adjacent muscles are intimately connected, creating continuity rather than separation. This challenges the classic concept of muscles as independent actuators of movement, the fasciae being merely passive packing of the underlying skeletal muscles. Contrary to this common assumption, increasing evidence demonstrates that the fascia performs several important functions in the body beyond architectural/structural ones. It is an active player in biomechanical force transmission and tensile load bearing. At the same time, it can change its biomechanical properties in response to musculoskeletal dynamics. This intimate relationship between skeletal muscles and fascia supports the concept of "myofascial continuity," which emphasizes that an endless and extensive tensegrity network runs throughout the human body. This has enormous potential implications for both training and therapy. An example of this emerging concept is the superficial back line, a myofascial chain/meridian consisting of the PA, the AT, and the gastrocnemius, which then runs toward the hamstrings, the lumbar fascia, the erector spine, and up to the epicranial fascia. These latter findings could provide a plausible explanation for the onset of plantar fasciitis symptoms as a consequence of muscle overuse, where tension is transferred from a stiff gastrocnemius to the

Continued on page 53

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Continued from page 51

HA content of the fascia lata was significantly reduced in patients with hip osteoarthritis (OA), where altered joint mechanics, distorted hip posture, and altered gait consequent on the disease resulted in altered fascial structure and behavior, further worsening the OA symptoms.

sole through the AT-calcaneal-plantar complex. As a proof of concept, gastrocnemius tightness has long been considered a risk factor for plantar fasciitis. For instance, in 2011 Patel and DiGiovanni found that 83% of a sample of 254 subjects with plantar fasciitis had an isolated contracture of the gastrocnemius and/or gastrocnemius-soleus tightness. At the same time, there is evidence that these muscles do not move totally independently of each other. Percutaneous electrical stimulation of the gastrocnemius can induce simultaneous displacement of the soleus, which suggests force transmission between these muscles. Other recent in vivo studies provide evidence for inter- and intramuscular interactions within human calf muscles. Therefore, it seems plausible that even soleus muscle dysfunctions can impair force transmission between the calf muscles and the myofascial system, becoming an etiological factor in plantar fasciitis.

Structural and Functional Coupling between Muscles and Fascia

The potential role of the fascial tissue in PA pathology

Over the years, inexact, ambiguous, or confounding definitions have portrayed the human fascial system as something "mostly left to the imagination of the students". The differences in characteristics of the fascia depending on the anatomical region (neck, trunk, or limbs) provide an additional challenge to the definition of this organ. Although the fascia remains largely neglected, new methodological findings and assessment methods, along with changes in anatomical dissection, have greatly clarified the anatomical and biomechanical recognition and definition of this fundamental system of the human body.

In recent years, the fascia has received increasing attention as a major contributor to movement perception, coordination, and the pathogenesis of musculoskeletal pain and dysfunction. Contrary to earlier assumptions, it is potentially a force transmitter intimately connected to the underlying skeletal muscle. A 2019 study by Schleip et al. demonstrated that the fascia has inherent contractility, thereby actively influencing musculoskeletal and biomechanical behavior. A potential role of fascia stiffness in limiting the maximal range of motion (ROM) of a joint has been also hypothesized. However, further efforts are needed to optimize the proposed novel methods for estimating the motion pattern of the fascia in vivo and its adaptability during muscle contraction.

At the microscopic level, fascial tissue comprises 2 or 3 layers of collagen fiber bundles, the fibers being differently oriented in each layer. This contributes to the strong resistance to traction of the fascia itself. Remarkably, the fascial system is viscoelastic because it contains high levels of hyaluronic acid (HA) in the interfaces between the collagen layers and between the deep fascia and the underlying muscle epimysium. This allows gliding to occur between the structures during movement and force transmission. The high concentration of HA also enables the facial tissue to undergo greater viscoelastic deformation than muscles and tendons. HA is a linear glycosaminoglycan consisting of regular repeating disaccharide units of N-acetyl-glucosamine and D-glucuronic acid, linked by β1-3 and β1-4 glycosidic bonds, respectively. Proper functioning of a healthy fascia requires specific levels of this essential component of the extracellular matrix. These can differ depending on the anatomical site, so the sliding properties of specific fascia also differ. For instance, Fede et al. reported a significant difference between the amount of HA in the aponeurotic fasciae (fascia lata of the thigh and rectus sheath of the abdomen, about 43 μg/g) and that in the epimysial fascia (or epimysium) of the trapezius and deltoid (about 6 μg/g). This is not surprising since these structures have totally different functions and mechanical properties. The aponeurotic fascia envelops various muscles and has a high potential for gliding, whereas the epimysium adheres more tightly to the underlying muscles. Alterations in the physiological levels or physicochemical properties of HA have been associated with several myofascial diseases.

It is well established that the main phenotypic and biochemical adaptations induced by exercise training involve the skeletal muscles. However, evidence that has emerged in recent decades suggests that the fascial tissue can also undergo molecular adaptations and/or alterations in response to muscle exercise. In particular, muscle overuse, disuse, or misuse can increase HA fascial densification, which results in greater resistance to fascial layer sliding and increased fascial stiffness. Muscle contraction-driven changes in loose fascial connective tissue can include increased HA production, aggregation of HA into supramolecular structures, changes in HA viscoelasticity and viscosity, and reduced HA lubrication. The HA content of the fascia lata was significantly reduced in patients with hip osteoarthritis (OA), where altered joint mechanics, distorted hip posture, and altered gait consequent on the disease resulted in altered fascial structure and behavior, further worsening the OA symptoms. Besides overuse syndromes, connective tissue can become tighter

Continued on page 55

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Continued from page 53

after direct traumatic injuries not involving muscle lesions. For instance, residual alterations in fascial sensitivity and movability (fascial densifications) were more prevalent in the lower limbs of individuals with a history of ankle sprain than in healthy controls.

Therefore, in recent years, different fascia-directed treatment modalities such as fascial manipulation, increased local temperature, and alkalinization have been proposed to reverse these alterations in HA and thus relieve the pain associated with fascial densification. Any impairment of proper fascial gliding results in anomalous tension and altered input transmission from the mechanoreceptors and nociceptors embedded within the fascial layers, which can influence musculoskeletal dynamics negatively and create conditions for the onset of myofascial pain. Indeed, if we inject hypertonic saline into the erector spine muscle, the thoracolumbar fascia, and the overlying subcutis, the patient will complain of more intense and unpleasant pain sensations if the fascia rather than muscular or subcutaneous tissue is injected. This means that the fascia can be considered a fully-fledged major pain generator in the musculoskeletal system. As a proof of concept, compelling evidence demonstrates that the fascia is more strongly innervated with multiple myelinated and non-myelinated sensory nerve fibers, including nociceptive ones, than the adjacent muscle tissue.

Consistent with this hypothesis, repetitive microtraumas to the gluteus maximus muscle from overuse and misuse led to myofascial pain syndrome. Likewise, a recent report showed that the onset of acute Achilles paratendinopathy could be related to histological and biomechanical changes in the crural fascia resulting from calf muscles injury. Another recent study described a case series of 9 athletes with pain in the Achilles region who had tears in the fascia cruris from the attachment to the paratenon and AT. The deep crural fascia also has been implicated in overuse injuries such as medial tibial stress syndrome (MTSS), also known as "shin splints". Bouché and Johnson hypothesized that the tenting effect of the tendons of the deep leg flexors, caused by eccentric muscle contraction, exerts a tensile strain load on the deep fascia directed toward its tibial crest insertion. It is therefore not surprising that manual treatment of the crural fascia is emerging as an effective option for relieving pain and restoring exercise tolerance in MTSS patients. Concerning the calf muscles, fascial lesions are more prevalent following muscle strain injuries within the soleus than the gastrocnemius or the hamstrings. Besides muscle contraction-driven changes in the mechanical properties of the fascia, mechanical adaptations at the fascial level after chronic stretching interventions have also been hypothesized. However, how and to what extent fascial tissue properties are affected by muscle overuse, misuse, or trauma still merits further investigation.

Future Directions and Perspectives

From the present narrative review, it transpires that clinicians and therapists who are going to treat plantar fasciitis should be more aware of the complex anatomical and biomechanical substrates that can underly the onset and development of PA pathology. In particular, their attention should not be restricted to the plantar aspect of the foot, but rather focused upstream on the myofascial chain consisting of the PA, the AT, and the triceps surae muscle and their fasciae. Evidence reported in the present paper has highlighted that biomechanical abnormalities within the myofascial unit can be crucial since they can place excessive stress on the PA and ultimately contribute to heel pain and plantar fascitiis. At the same time, the fascial tissue should not be neglected since it is potentially a prime contributor to the pathophysiology of several chronic musculoskeletal painful conditions. Clearly, the structure, function, and biomechanics of the fascial system still deserve more attention. Notwithstanding the decisive involvement of the fascia in the onset of overuse muscle injuries and painful syndromes, fascial injuries and alterations continue to be generally overlooked and are seldom considered. Future research efforts should be focused on the optimization of novel approaches to studying fascial mobility in vivo in both physiological and pathological conditions. This will allow clinicians to optimize treatment strategies and rehabilitation protocols to obtain better outcomes for patients affected by lower-limb musculoskeletal conditions such as plantar fasciitis.

Increasing evidence demonstrates that the fascia performs several important functions in the body beyond architectural/structural ones.

Finally, because of the intimate anatomical and biomechanical relationship between the PA and the triceps surae complex, calf-stretching exercises are commonly used in therapeutic and rehabilitation protocols for plantar fasciitis. However, despite their widespread clinical application, their effectiveness in managing this condition has sometimes been questioned and conflicting data are reported in the current literature. This indicates the need for more carefully designed studies within this field. Other conservative treatments should be considered. This is the case, for instance, with eccentric calf-muscle exercises, which are increasingly being used to reduce pain and improve function in patients with Achilles tendinopathy. Thus, future research efforts should focus on evaluating the effectiveness of eccentric loading exercises for calf muscles and also for plantar fasciitis. Additional knowledge of the mechanisms that could underpin their clinical benefit would affect both the management and treatment of plantar fasciitis.

The authors serve s teaching or research faculty in the Department of Translational Research and New Technologies in Medicine and Surgery, and the Center for Rehabilitative Medicine "Sport and Anatomy" at the University of Pisa in Italy.

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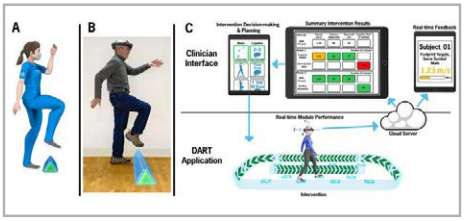
AR MAKES PARKINSON'S DISEASE PT MORE ACCESSIBLE

An augmented-reality (AR) headset is an effective digital tool for improving posture, gait, and "freezing" in people with Parkinson's disease, according to a recent Cleveland Clinic trial. The "Dual-task Augmented Reality Treatment" (DART) uses the Microsoft HoloLens2 to run patients through dual-task training (DTT), a series of tasks designed to engage the brain and body simultaneously.

Activities are designed to counter Parkinson's disease's effect on the parts of the brain that control mental and physical tasks. Think about walking while listening to an audiobook or talking while shopping at the grocery store. DTT helps address the lack of balance and stability that can lead to falls or difficulty moving, said Jay Alberts, PhD, Center for Neurological Restoration. This therapy, although effective, isn't widely used because of the time and resources it takes to measure patient progress and personalize a program, among other limitations.



A) An avatar demonstrates physical therapy exercises on the DART platform. B) A user wearing an augmented reality headset follows along with the program. C) The headset records and analyzes user progress for clinician review. Image courtesy of Cleveland Clinic.

Instead of a human therapist, the DART program uses a digital avatar named Donna, named after Alberts' mother. The user wears the AR headset and sees Donna in their line of sight. The user then hears instructions through the headset, which tracks their movements and responses. Donna guides the exercises and demonstrates movements. The headset collects data for clinicians to review and use to design future sessions.

DART can create over 230 combinations of DTT activities. The clinical trial of just under 50 people compared results from participants in sessions led by an in-person therapist and those using the DART platform. Both groups showed comparable, clinically significant improvement after the therapy. Retention was also high for both groups.

DART is not meant to take the place of a physical therapist, but to serve as technology to enable more widespread use of DTT, said Alberts

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ENGINEERS USE WEARABLE SENSORS, TRAINING TO REDUCE TRIP-INDUCED FALLS

Professor Michael Madigan, PhD, and doctoral candidate Youngjae Lee with the Madigan Bio-

A study participant trips of a section of the walkway that raised shortly before his approach. Lee and other researchers work to make sure participants aren't expecting the obstacle.

mechanics Group in the Grado Department of Industrial and Systems Engineering at Virginia Polytechnic Institute and State University are working toward a solution to a common problem: trips and falls. They have developed an innovative balance training regimen that could potentially reduce injuries sustained from trip-induced falls in adults over 65.

Lee has also been testing wearable sensors outside the lab to determine if they can accurately track movements and record data for researchers. The goal is for the sensors to measure the effectiveness of balance training in the real world. Lee's research focuses on reactive balance. His balance training helps participants regain their centers of gravity and strengthen their bodies so recovery after a fall is easier.

The balance training allows participants to safely and repeatedly practice these movements in a controlled manner. Over the course of 3 weeks, Lee and other graduate students meet with participants twice per week to go through progressive stepping exercises that mimic the movements necessary to regain footing during a fall. Once participants are comfortable stepping, the training extends to balancing the upper body and learning to balance the torso. At the end of their training program, participants harness up and test their balance recovery skills in the lab.

In addition to the balance training, participants wear the sensors that record body movements on their shoes and underneath their clothing outside the lab for 3 weeks after training. Lee checks the wearable sensors weekly to ensure they're working properly and collecting data. Participants also use voice recorders to describe any incidents of trips and falls and subsequent response.

The wearable sensors are being used as an alternative to balance training on a treadmill, which makes the training much more cost effective and accessible. Training could then take place at senior community centers, rehabilitation offices, retirement communities, and other locations.

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Life Wear Technologies recently unveiled the first-ever sustainable joint support for sport-related injuries, CleanPrene. Formulated from bio-based materials like oyster shells and plant oils and also post-consumer recycled materials like polyester, nylon, and post-use plastics, the splints are ultra-soft and flexible while still offering the same support and compression expected from leading brands. Developed using Bio II™ Foam, certified BioPreferred by the US Department of Agriculture, and focused on providing compression and support without the negative impacts of traditional Neoprene, CleanePrene's bio-based and post-consumer recycled components allow for maximum comfort and mobility throughout use. CleanPrene's 4 over-the-counter splints products are available in knee, wrist, elbow, and ankle varieties; each option is lighter, great for sensitive skin, and is machine washable for long-lasting use.

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BIONIC PROSTHETIC LEG

BionicM, a Japanese medical device startup, has introduced its US Food & Drug Administration 510(k)–registered Bio Leg™. This robotic prosthetic knee joint assists a wide range of movements with power, such as ascending and descending stairs. The knee bends with power and actualizes graceful walking without stumbling, even when walking slowly or in small steps, by using power to bend the knee and lift the toes from the ground during swing phase. Bio Leg prevents knee buckling by assisting knee extension during stance phase. Users can safely bear weight on the prosthetic leg. The easier sit-to-stand feature gives the user a quicker and smoother transition when standing up from a chair; this feature will also assist those who have had a stroke, weakness, or arthritis in the hip or knee joint on the contralateral side. Bio Leg will be available in the US market in 2024.

BionicM
bionicm.com

TOOL STREAMLINES THE CUSTOM FIT OF BIONIC PROSTHETIC LEGS

Researchers with the Griffith Centre of Biomedical and Rehabilitation Engineering

(GCORE) and Menzies Health Institute Queensland, Australia, have developed a groundbreaking diagnostic tool to streamline the fitting of bionic prosthetic legs.

The team generated a digital twin (virtual replica) of the patient's residual limb to create a custom 3D-printed bionic limb. A direct skeletal attachment was surgically implanted into the patient's living bone, which would enable the external attachment to the patient's bionic prosthesis. The new artificial limb was then successfully fitted, and the specially designed diagnostic software was used to test and assess the fitting, measuring the movement of the patient's bones, muscles, tendons, fat, and skin. The system aims to improve function and mobility, and thereby, the quality of life of prosthetic users while potentially reducing healthcare expenses associated with limb loss.

Griffith bionic limbs scientist Professor Laurent Frossard, PhD, is passionate about developing prosthetic solutions and said the new device was a cost-effective solution because it efficiently streamlines the patient's care and fitting procedures. Traditionally, medical professionals have relied on a process of physical examinations, medical tests, and medical imaging to assess health issues affecting a patient's residual limb.

Griffith researchers have developed a diagnostic tool to streamline the custom fitting of bionic prosthetic legs, which usually involve an arduous process of trial and error.

"With the new technology, clinicians can help the patient understand how the load and pressure from the prosthesis stimulates the residuum during fitting of prosthesis and guide them to pain-free use during movements," he said. The device provides a means to increase the ability of walking effortlessly and quality of life for individuals suffering from typical and regular issues that compromise the health of their residuum."

FOOT MASSAGER FOR NEUROPATHY AND NERVE PAIN SUFFERERS

From the ergonomic design to precision point rollers and gentle massage air techniques, the Zarifa Foot Massager packs a punch in the medical massage category. The Zarifa Z-Smart Shiatsu Foot Massager + incorporates the best reflexology foot theory with deep kneading foot massage technology. The flexible spending account–eligible shiatsu foot massager is designed to perform various reflexology massage elements, including tapping, kneading, acupoint, and shiatsu via airbags, massage rollers, and massage nodes. Moreover, Zarifa announced new findings that show how neuropathy sufferers can find relief with massage, significantly reducing medical costs and risks of addiction issues.

Zarifa USA
385/645-0255
zarifausa.com

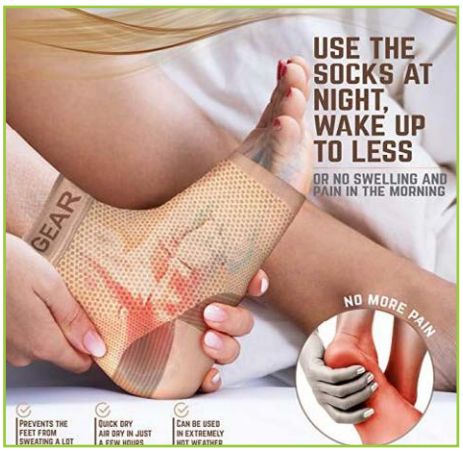
HJF FACILITATES STUDY ON ARTICULATE LABS' NOVEL DEVICE

The Orthopaedic Research and Education Foundation (OREF), in collaboration with the Medical Technology Enterprise Consortium (MTEC) and the US Department of Defense's (DoD) US Army Medical Research and Development Command's (USAMRDC) Military Operational Medicine Research Program (MOMRP), has awarded $1.3 million to the consortium of Articulate Labs, the Henry M. Jackson Foundation for the Advancement of Military Medicine (HJF), and the Keller Army Community Hospital (KACH).

The award will provide funding for a study evaluating the use of Articulate Labs' novel KneeStim™ devices at KACH to speed return to duty for cadets recovering from anterior cruciate ligament reconstruction (ACLR) surgery, all of which will be facilitated by HJF. Developing a wearable device to accelerate physical rehabilitation with less cost and clinician oversight addresses an unmet need and aligns with MTEC's mission to facilitate prototype advancement of technologies that protect, treat, and optimize the health and performance of U.S. military service personnel.

Led by Shawn Gee, MD, an active-duty orthopedic surgeon, the study at KACH will recruit 60 post-ACLR patients to wear KneeStim devices during rehabilitation and daily activities and will c ommence in February 2024.

PLANTAR FASCIITIS SOCKS



People who are committed to their fitness and health and are looking for the best plantar fasciitis socks with arch support can now take advantage of Physix Gear Sport's Plantar

Fasciitis Socks with arch support. The socks are designed to deliver instant arch support, stopping heel pain and throbbing and helping the user to stand and walk freely again. The ankle support features graduated compression to support the ankle. The compression in the ankle to heel support also improves Achilles tendinitis and circulation, reducing inflammation and expediting the plantar fasciitis healing process. The socks work with any footwear, and can also be worn at night to prevent swelling and pain in the morning.

Physix Gear
776/916-7700
physixgear.com

WATERPROOF, TEMPERATURE-CONTROL BOOT INSOLES

Zentek Clothing has updated its temperature control boot insole products to make them accessible for all shoe sizes. The boot insoles provide customers with a trim-to-fit version that should be accessible to all shoe sizes up to men's size 12. These insoles use Zentek's Comfortemp fabric to keep the wearer's feet at a constant and comfortable temperature regardless of atmospheric conditions, ensuring comfort during long hikes or other activities. The insoles use phase-change materials (PCMs) to absorb heat in warm conditions and act as an insulator in colder weather. These materials were developed for use in the aerospace industry, but have recently been made available to the general public and may be helpful in combating extreme temperatures year-round. Their boot insoles can be ideal for winter and summer hiking, as the PCMs can prevent foot discomfort during these long treks.

Zentek Clothing
206/784-5038
zentekclothing.com

SLIM, LIGHTWEIGHT MICROPROCESSOR ORTHOSIS

Blatchford's Tectus® orthosis features a small, lightweight, modular design and enables people with partial lower limb paralysis to walk more naturally, comfortably, safely, faster, and with increased confidence and less pain. Using Blatchford's proprietary Performance Response Technology™ and microprocessor-controlled technology, the orthosis mimics the natural function of the knee joint. Tectus attaches to a custom-made knee ankle foot orthosis and features a complex system of spring, hydraulic, and sensor technology, allowing wearers to replicate a more natural gait cycle. Tectus's spring assist feature uses an adjustable control so the leg fully extends in a timely manner during swing phase. The modular design allows for comfortable and flexible positioning of the device and can fit any thigh circumference. A training mode helps practitioners set up and configure the brace, and users can switch between mobility modes via a digital display or using a handheld remote control.

Blatchford
800/548.3534
blatchfordmobility.com

CHILDREN'S MEDICAL BOOK SERIES

The Strength of My Scars is an innovative children's book series created to instill comfort and hope in pediatric patients and their families. Written by surgeon Maria Baimas-George, MD, MPH, these stories serve as a valuable supplement to conversations with medical professionals with the goal of improving comprehension and satisfaction and reducing anxiety. They are meant to empower children and help them feel safe, teaching them that their scars tell a story of resilience, of which they can be proud. Each book addresses the anatomy, pathophysiology, hospital course, surgical details, and post-operative care pertaining to a specific condition using easy to understand language and colorful visual aids.

Among the titles are: *Broken Bones: Mei and the Monkey Bars, Concussions: Seeing Stars on Sunny Days*, and *Henry Tours the Hospital*. For more information, visit strengthofmyscars.com.

DO YOU HAVE A NEW PRODUCT OR NEWS?

We want to hear about your new product, news, or innovation! We want to hear from you! Please send information to Laura@LERmagazine.com

MICRO-DOSED ECCENTRIC TRAINING

Reference : Yoshida et al. SJMSS 2022

Designed by @YLMSportScience

36 participants were divided into three eccentric training groups during 4 weeks

1x6 group: 1x6 contractions once a week

5x6 group: 1x6 contractions a day for 5 days a week

1x30 group: 5x6 contractions a day in a week

NB: contractions were eccentric & maximal

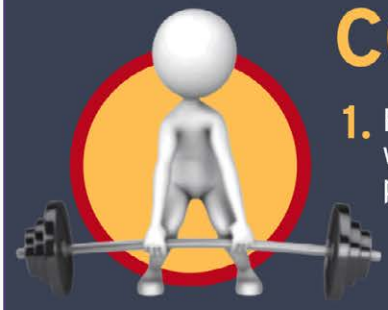
Images provided by PresenterMedia

WHAT THEY FOUND

Changes	1x6	5x6	1x30
Eccentric MVC*	Trivial	**Small increase**	Trivial
Isometric MVC	Trivial	**Small increase**	Trivial
Concentric MVC	Trivial	**Small increase**	Trivial
Muscle thickness	Trivial	**Small increase**	

**MVC: maximal voluntary contraction*

CONCLUSIONS



1. Performing a small number of eccentric contractions five days a week is more effective for increasing muscle strength than performing a larger volume of eccentric contractions once a week
2. Training volume is a factor for muscle hypertrophy in a short-term training

Source: Yoshida R, Sato S, Kasahara K, et al. Greater effects by performing a small number of eccentric contractions daily than a larger number of them once a week. Scand J Med Sci Sports. 2022; 32: 1602-1614. doi: 10.1111/sms.14220

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always a step ahead

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