Review Paper

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Foot Orthoses vs. Intrinsic Foot Muscle Strengthening: Why Choose One When You Can Have Both?

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Abstract: This manuscript discusses the proposed effects of foot orthoses on gait kinematics and kinetics, as well as their preventative and treatment benefits for common lower extremity overuse injuries. The efficacy of intrinsic foot muscle strengthening — an approach that may support or replace foot orthoses in a (p)rehabilitation program — will also be examined. Foot orthoses are widely used in clinical practice, but their benefits should not be overstated. Whether foot orthoses induce a meaningful change in foot, ankle, or knee motion is still under debate and requires further review. Foot orthoses are an effective intervention for preventing several common lower extremity overuse injuries including stress fractures, medial tibial stress syndrome, plantar fasciitis, and patellofemoral pain syndrome. Foot orthoses also demonstrate a positive treatment effect in both patellofemoral pain syndrome and plantar fasciitis when combined with appropriate strengthening and stretching. Prefabricated, rather than custom, foot orthoses are favourable for their cost-effectiveness and similar efficacy to its competitor. Intrinsic foot muscle strengthening, while more time-consuming, reduces the risk of lower extremity overuse injuries and improves static alignment and dynamic function of the foot. Higher quality foot orthoses, gait, and lower extremity injury research studies, that minimize confounding variables and use standardized orthotics, are necessary to further the current field of injury (p)rehabilitation and allow for definitive evidence-based clinical applications. Presently, the combination of clinical success and research findings suggest that foot orthoses may play a role in both the prevention and treatment of lower extremity injuries, at least as an adjunct to intrinsic foot muscle strengthening. The careful consideration of materials and construction of the foot orthosis, and the relaying of these options to the patient, seem to be critical to the effectiveness of the foot orthosis and should be a part of any individualized prevention or treatment plan.

Introduction

Lower extremity (LE) overuse injuries have increased as physical activity has gained popularity.[1] These injuries are often caused by the interaction of several extrinsic and intrinsic risk factors.[2,3] Major extrinsic risk factors include errors in training progression, relating to the F.I.T.T. Principle (i.e., frequency, intensity, time, or all three), and/or improper shoe selection (i.e., excessively worn out, incorrect size, or ill-equipped for the playing surface and demands of the intended activity).[2,4,5] Intrinsic risk factors include previous injuries, exercise form, and biomechanical abnormalities of the foot, ankle, and lower leg.[2,6] Currently, there is debate over whether excessive pronation or supination is associated with a greater risk of developing LE overuse injuries. While more pronation or supination was initially believed to be more dangerous,[7–15] some researchers now employ a more system-wide approach when examining the relationship between pronation, gait, and LE overuse injuries, and recognize that viewing

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any one component in isolation may over-simplify the association.[16-19]

An orthotic or foot orthosis (FO) is a device that helps to support, align, and correct deformities or motion within the foot, reducing intrinsic risk factors of injury.[14,20,21] FOs are widely used to prevent and treat common LE overuse injuries[3,4,22-30] such as stress fractures,[3,22,31-33] medial tibial stress syndrome (MTSS),[3,25] plantar fasciitis (PF),[27,34-37] and patellofemoral pain syndrome (PFPS);[38-40] however, there is growing debate over whether FOs are necessary.[1,23,25,41]

The foot is integral to gait, or locomotion, as it attenuates shock and transfers force between the ground and the LE kinetic chain.[6,7,13,30,42,43] Pathomechanics of the foot can occur from congenital defects such as errors in osseous development, ligamentous laxity, tight Achilles tendon(s),[6] or impaired intrinsic foot muscle (IFM) functioning. These structures work collectively to control the deformation of the medial longitudinal arch (MLA) as it responds to loading on ground contact during the gait cycle.[12–14,44] Pronation (or supination) may compensate to varying degrees for soft tissue or osseous abnormalities, allowing gait to occur largely undisturbed.[6] Variations in gait exist between and within people, and therefore the risks associated with compensatory motion of the foot (e.g., excessive pronation/supination) may need to be reconsidered on an individual basis. Research suggests that direct strengthening of the IFM can restore proper function to the MLA and allow for more efficient load-transference and biomechanics of the foot.[7,8,13–15,42] This raises the question: are orthotics the most effective prevention and treatment intervention for LE overuse injuries, or are there other more effective alternatives available, such as IFM strengthening? The purpose of this review paper is to address this question and provide practical recommendations as to how FOs can be better implemented into a (p) rehabilitation program. FOs are proven to prevent and treat LE overuse injuries from physical activity and sport; however, combining IFM strengthening and FOs may be a more effective approach.[9,10,13,14,26]

This manuscript will begin with the analysis of gait variability to contextualize further discussions of FOs. This leads into an examination of the effects of FOs on the kinematics and kinetics of the foot, ankle, and knee. Next is a brief discussion on overuse injuries, contextualizing FOs' role in both prevention and treatment of common LE overuse injuries. The paper then discusses the mechanism and efficacy of IFM strengthening, as both a treatment and prevention strategy for LE overuse injuries. Lastly, the discussion of FOs, IFM strengthening, and overuse injuries is concluded with practical recommendations.

Gait and Foot Orthoses

Gait Variability (No Normal is the New Normal)

The discussion surrounding gait is slowly evolving as researchers shift from a purely reductionist perspective towards an appreciation of the whole system of the movement. A phenomenon as complex as gait, involving numerous structures working in a concerted fashion, cannot be reduced to its individual parts if it is to be dissected accurately. Additionally, it is more widely understood that variability in gait mechanics exists within and between individuals[17,18,43] due to: different conditions of locomotion (e.g., speed and surface),[45,46] neuromuscular factors (e.g., MLA control, IFM and extrinsic foot muscle strength and endurance, mobility, or balance),[19] and pathologies (e.g., patho-mechanics of the foot, pain, or neuro-degenerative conditions such as Parkinson's).[43,45] While optimal gait is specific to each individual,[17,18,43] and variations exist in the surface features of gait, core recognizable elements exist between people.[43]

The foot plays a crucial role in locomotion because it is the portion of the LE that contacts the ground.[43] The appropriate functioning of the foot is achieved through the coordinated actions of pronation and supination, which occur at the subtalar and midtarsal joints at specific times during the stance phase of gait.[6,8] Pronation (subtalar/rearfoot eversion, forefoot/midtarsal abduction, and ankle/talocrural dorsiflexion) occurs with complete foot flatness (until approximately 25% of stance), and allows the foot to adapt to irregularities in the ground surface and mitigates peak vertical ground reaction forces on each ground contact.[6,26,30,42] Supination (subtalar/rearfoot inversion, forefoot/midtarsal adduction, and ankle/talocrural plantarflexion) begins at midstance and stiffens the foot to create a rigid lever for propulsion, complimenting pronation.[6,26,30,42]

Previous research[6,30,39,44,47] often dichotomized pronation as either normal or abnormal, based on its magnitude, duration, or timing.[17,18] Overpronation has been assumed to either limit or prevent supination, or impair the foot's ability to attenuate the various compressive, tensile, shearing, and rotational forces experienced during weight-bearing in stance.[6,30,39,44,47] Novel research, however, suggests that substantial pronation (or supination), beyond necessity, is likely not of concern for increased injury risk, provided it does not provoke pathology; however, this may not represent the most energy-efficient biomechanics for an individual.[17,18] Pronation is a component of an integrated and complex system,[19] and should not be examined in isolation as a mechanism for injury.[17] Within a systematic clinical approach, individual consideration is required to determine the optimal magnitude of pronation and supination, as well as an acceptable level of step-dependent variability, that compliments an individual's specific anthropometry and promotes the safest and most efficient transference of forces from distal to proximal joints.[17,18,43,44] Improved control through a greater range of motion may also assist in tolerating novel situations, and thus allow for the most adaptable movement solutions.[18]

The inherent variability of gait and the lack of clear and consistent definitions within the literature of what may constitute "normal" pronation[18] presents challenges when trying to quantify biomechanical deviations.[17,18] It is time to put this dichotomy to rest as we revisit this idea through the perspective of gait variability.

Evidence on Orthotics Influencing Gait Kinematics and Kinetics

FOs are designed using a clinician's measurement of a foot's static, unloaded alignment;[6] however, it is not clear how dynamic foot function relates to static foot posture or alignment.[16] Therefore, FO prescription may benefit from a clinician's assessment of dynamic foot function as well.[16] Biomechanical FOs are intended to maintain a neutral subtalar and midtarsal joint alignment (a position of neither pronation nor supination) during dynamic activities such as walking and running.[2,4,6,30,48-50] Despite the theoretical basis for the prescription and widespread practical use of FOs, a review of primary research,[30,48,49,51-53] previous review articles,[2,24,50,54,55] and a 2010 meta-analysis[21] reveals the equivocal nature of FOs' effects on one's LE kinematics and kinetics of movement. The meta-analysis[21] and several of the reviews[2,50,54,55] report that while FOs result in statistically significant changes in kinematics and kinetics of the foot and leg, these changes are typically not seen consistently across subjects or conditions, and are too small to be of any clinical relevance. However, one systematic review[55] revealed a consistent reduction in rearfoot inversion moments with the use of orthotics, highlighting the findings of other studies[52,53] in this conclusion.

Biomechanical FOs have been shown to influence motion occurring at joints within the foot (subtalar and mid-tarsal/transverse tarsal joints), ankle (talocrural joint), and the knee (tibiofemoral joint).[30,48,49,51-53] At the joints of the foot, the use of either semi-rigid[48,51-53] or rigid[30] medially-posted custom biomechanical FOs resulted in significant reductions in overall pronation, rearfoot eversion angle[48,51-53] and velocity,[53] and calcaneal eversion angle[30,53] in participants exhibiting pes planus ("flat feet") in stance.[30,48] Depending on the individual, however, this may or may not contribute to improved gait mechanics. One study[51] also found a decrease in plantarflexion angle at the talocrural joint with the use of FOs; however, the authors attributed this finding to the slight heel lift of the FO reducing the need for the same degree of plantarflexion (as with a normal insole). These researchers[51] may have observed more changes induced by FOs had they used 3D analysis like other studies.[30,48,49,52,53] Relying solely on 2D analysis may have neglected the effect of axial rotation of the leg that accompanies subtalar pronation and supination.[48,49]

FOs can also influence more proximal joints as motion at the foot has implications up the kinetic chain.[4] While one study found an increase in knee flexion because of FOs,[51] another study found a decrease in knee flexion.[53] Eng and Pierrynowski[49] explained this contrast stating that when the FO resulted in small changes in subtalar motion (<2.0°), resultant knee motion was slightly reduced or unaffected. However, when larger reductions in subtalar motion occurred, a compensatory increase in knee motion occurred — likely to maintain shock attenuation capabilities upon foot-strike. While Eng and Pierrynowski[49] found small to moderate effects on frontal and transverse plane motion at the subtalar and midtarsal joints and sagittal plane motion at the knee during walking and running, they noted that soft biomechanical FOs resulted in smaller changes than rigid or semi-rigid FOs.

While many authors posit that these small changes are not clinically relevant, Nawoczenski et al.[48] argue that while minimal, these changes in kinematics likely accumulate to exert a clinically significant effect over many repetitions performed during walking or running. Only one study by Tomaro and Burdett[56] looked at the difference in muscle activity with custom orthotics during gait. They found FOs did not result in a difference in muscle activity based on EMG analysis, except for an increase in the duration of tibialis anterior activity, which has been found to assist with controlling pronation.[53,56] However, this study only assessed the gastrocnemius, soleus, and tibialis anterior, rather than muscles that help mitigate deformation of the MLA and may thus play a greater role in reducing injury risk, such as the peroneals and tibialis posterior.[7–9,12–15,42,53]

Caution must be taken when interpreting these results as all studies used skin and shoe markers for their kinematic measurements during either walking[30] or running.[48,49,51-53] A study by Reinschmidt et al.[57] highlights the presence of skin movement artefact with using skin and shoe markers during highly dynamic movements such as running. Skin movement artefact details how skin and shoe material may move more than the bones being approximated, suggesting that results from the previous studies are likely overestimated.[57] In-shoe goniometers or windows in the shoes should be used to avoid skin movement artefact.[57] To conclude, further investigation on FOs and gait, and improved orthotics, kinematics, and kinetics studies of motion are needed.

Overuse Injuries and Foot Orthoses

An overuse injury results from repetitive microtrauma to a tissue that occurs at a rate that exceeds the body's natural healing process.[2] Overuse injuries of the LE are commonly associated with overpronation during loading conditions,[8–14] as it is thought to impair shock-absorption and transfer force from the ground into passive tissues (e.g., bone, ligaments, tendons) not meant to sustain such high and repetitive loads;[26,33,47] however, this remains equivocal.[16-19] While it is still uncertain whether FOs have a profound effect on controlling abnormal movement kinematics and kinetics, FOs have been successful in the treatment and prevention of several LE overuse injuries.[4,6,33,35] A significant portion of current literature on orthotics and overuse injuries focuses on military populations, as their training is consistent and regimented. However, extrapolations to the general population should be scrutinized as civilians have starkly different activity levels. Nevertheless, many studies provide evidence of FOs as a prophylactic[3,23,25,27,28,32,33,58] or first-line treatment strategy for pain and dysfunction from LE overuse injuries.[24-26]

Prevention

The prophylactic use of FOs may help to prevent the occurrence of an overuse injury, and therefore any physical, psychological, and financial cost associated with treatment or obstructions to training and daily life.[22,23,58] FOs are often seen in the prevention of many common LE overuse injuries, such as stress fractures, MTSS, PF, and PFPS.[3,25] A 2017 systematic review and meta-analysis[30] concluded that FOs are an effective preventative intervention, reducing the risk of overall injuries by 28% (RR = 0.72; CI: 0.55-0.94) and LE stress fractures by 41% (RR = 0.59; CI: 0.45-0.76). However, incidences of soft-tissue injuries were not found to be significantly reduced ($p > 0.05$). In addition, the meta-analysis[30] found that shock-absorbing insoles are unsuccessful at preventing any of the aforementioned injuries.

Only three out of the five studies[3,28,33] examining the effectiveness of biomechanical FOs[28,33,58] or shock-absorbing insoles[3,59] at reducing overall overuse injuries in military recruits reached statistical significance. While the authors[58] found a 34% reduction in the combined incidence of MTSS, PFPS, Achilles tendinopathy, and PF (the most common overuse injuries in long-distance runners and military recruits) with the use of contoured prefabricated biomechanical FOs, the finding failed to reach statistical significance ($p = 0.098$) likely due to the sample being too small. Gardner et al.[59] did not find statistically significant reductions in overall injury incidence using a viscoelastic insole; however, their use of this type of insole was criticized as viscoelastic insoles were not shown to have a statistically significant effect on vertical impact forces when compared to a conventional running shoe insole.[60] Schwellnus et al.[3] found a statistically significant reduction in the incidence of overall injuries and MTSS in 1511 military recruits, using a flat neoprene insole as their experimental condition, rather than true FOs. They did not find a significant reduction in stress fractures ($p > 0.05$), likely because of the lack of contours in the flat insole.[32]

Stress fractures are the most severe and disabling of overuse injuries, with a complex aetiology.[3] However, FOs are a common and effective prevention strategy for these injuries. Repeated high ground reaction forces and poor alignment of the bones in the foot, primarily at the subtalar and midtarsal joints, have shown to contribute to the development of stress fractures.[3] A prospective study conducted by Milgrom et al.[31] assessed the use of molded prefabricated biomechanical FOs made of a shock-absorbing material, to prevent the incidence of stress fractures in military recruits. They found a significant reduction in the incidence of femoral stress fractures among the subjects wearing the FOs, which is important as these stress fractures can often go unnoticed and progress into a fully displaced fracture.[31] One confounding variable in that study was the lack of sufficient sleep during the training camp, likely contributing to the development of more stress fractures and reducing the effectiveness of the FO intervention.[22] Another study[32] on military recruits found the use of molded (FOs with contours) and/or posted (modifying FOs by adding extra "posts" to displace load differently) biomechanical FOs resulted in significantly lower overall stress fractures than a normal insole (p = 0.037), which resulted in 27% of subjects suffering a stress fracture. Soft FOs were found to reduce injuries 5% more than semi-rigid FOs (only 10.7% of subjects suffered stress fractures as compared to 15.7%, respectively), and presented slightly greater comfort scores.[32] A molded, or molded and posted, FO may therefore be the best type of biomechanical FO because of its ability to attenuate vertical loading associated with each foot-strike.[52] No difference was found between a prefabricated or custom semi-rigid biomechanical FO for preventing overuse injuries.[23,33] These findings suggest that consideration of FO material and construction (with contours) are likely important factors in the prevention of overuse injuries, as they relate to loading. Despite this, the use of a prefabricated FO may be more economical than a custom FO as there is no difference in preventative benefits.[23,33]

Treatment

Swift and pain-free recovery is a universal goal for patients, regardless of how their overuse injuries occur. FOs may play a role as first-line or continual treatment in various overuse injuries,[24] by expediting one's recovery, decreasing resultant pain,[24,29,30] or restoring function.[24,25,29,30] A 2006 systematic review and meta-analysis[22] concluded that there was insufficient evidence to recommend FOs in the treatment of overuse injuries; however, a more recent review[24] shows several populations that would benefit from their use in rehabilitation. Some of those populations include the commonly seen LE overuse injuries, PF and PFPS, as well as painful pes cavus (high arch). The favourable response seen amongst these populations may be due to the FO correcting underlying patho-mechanics of the foot or through improved shock-absorption.[22,25,27]

A systematic review of FOs in the treatment of PFPS[38] concluded that biomechanical FOs resulted in a significant reduction in pain after 8 weeks, as compared to flat insoles ($p < 0.05$). Both Eng and Pierrynowski[39] and Johnston and Gross[40] reported a similar reduction in pain and stiffness related to PFPS; however, Eng and Pierrynowski[39] suggested that using biomechanical FOs in conjunction with vastus medialis strengthening would result in greater reductions in pain and stiffness than the vastus medialis strengthening exercises alone. A proper pair of shoes is likely also required to maximize the benefits of any FO.[48] This can include any well-fitting, new to moderately used shoes that are appropriate for the demands of the chosen activity (e.g., not wearing hiking shoes to play tennis). One study[61] on mid-portion Achilles tendinopathy in 140 adult subjects compared eccentric calf strengthening plus either a custom FO or sham insole. The authors found no additional benefit of FOs if the patient was already doing an eccentric calf strengthening program. However, since there was no reduction in effectiveness of the strengthening program if FOs were worn, FOs can continue to be worn without negative consequences.

FOs should be included in an evidence-based conservative treatment approach (i.e., non-invasive/non-surgical) for PF.[26,34-37] FOs, either as a standalone or as an adjunct to Achilles tendon stretching, may help to attenuate the tensile forces placed on the plantar aponeurosis, and at the very least reduce injurious loading to allow healing to occur.[34] Pfeffer et al.[26] reported a significant treatment effect with the use of prefabricated biomechanical FOs in combination with Achilles tendon stretching for proximal PF, compared to custom FOs or stretching alone.

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Three other studies similarly found no difference between prefabricated and custom FOs in the short-term treatment of PF in normally active adults.[34-36] One of those studies,[35] however, found that neither the custom nor the prefabricated FO showed any long-term benefits over a sham insole made of thick foam. The lack of significant long-term differences may be attributed to a reduction in the loads experienced by the foot from the shock-absorbing quality of the sham insole — likely involved in the aetiology of LE overuse injuries.[26] Baldassin et al.[36] suggest that ethylene vinyl acetate be used to make FOs for its cheapness and effectiveness. Only one study[37] found custom FOs were better than prefabricated FOs at treating PF; however, both were still better than the control insole, thereby favouring prefabricated FOs for their relative cheapness.

The value of these findings[26,34-37] suggests that for mild to moderate PF, a relatively cheap off-the-shelf FO provides similar treatment benefits to custom FOs, and greater benefits than stretching alone, perhaps through reduced shock on each ground contact.[62] However, for more severe or debilitating symptoms, it may be necessary to modify activities that stress the injured tissues. Examples include slowing down the rate of training progression[5], running on softer surfaces, and beginning a strengthening and stretching routine with FOs as adjunct treatment, to allow healing to take place.[62]

Intrinsic Foot Muscle Strengthening in Place of Foot Orthoses?

IFM strengthening has been proposed as both a treatment and prevention strategy that focuses on the role of the IFM in upholding the MLA.[7–9,11,13–15,42] IFM play a significant role in the maintenance of the MLA and control of pronation in gait, assisting the function of the bones that make up the arch, surrounding ligaments and plantar aponeurosis, neural subsystems, and extrinsic foot muscles (mainly tibialis anterior, tibialis posterior, and the peroneals),[7–9,11,13–15,42] collectively known as the "foot-core".[13] Earlier studies[7,15] helped to confirm the crucial function of the IFM by using either a local anaesthetic to block the nerve to the IFM,[7] or pre-fatiguing the IFM[15] to decrease their contribution capability. Researchers observed a significant drop in navicular height (surrogate measure for height of the MLA) in the experimental conditions as compared to the non-blocked/non-fatigued leg. This showed that the MLA could not be upheld to the same degree without the contribution of the IFM. A study by Kelly et al.[63] added support by demonstrating an increase in EMG activity of the IFM when increasing loading of the foot, continuing even to 1.5x body weight. More studies are likely required to assess loading above 1.5x body weight, as these loads are common in activities such as running and jumping.

By strengthening the muscles that uphold the MLA, proper shock attenuation and transference of forces through the foot and LE kinetic chain can be restored, reducing the risk of subsequent overuse injuries.[7,11,44,63] Several studies[8,9,11,13,14,42,44] have demonstrated that the "Short-Foot" exercise is better than the "Towel-Curl" exercise for increasing neuromuscular recruitment of the IFM (e.g., abductor hallucis and flexor hallucis brevis), while preventing the contribution of the larger extrinsic foot muscles. However, it may be necessary to perform the exercise deliberately (establishing a mind-muscle connection) and ensure progression to unilateral training when appropriate (start seated, then move to standing two-legged, then one-legged, then jumping, etc.), otherwise imbalances between dominant and non-dominant legs may develop.[8,42] Direct IFM strengthening for four to eight weeks has been shown to alter static foot alignment,[11] including a reduction in hallux valgus angle through non-surgical means,[44] increase anatomical cross-sectional area of the IFM (determined through ultrasound[10,12,14] or MRI[44]), increase maximal isometric force production of the IFM (determined through either custom foot dynamometers[12,14] or a pressure platform[44]), improve dynamic foot function through greater usage of the windlass mechanism responsible for coordinating pronation and supination during gait,[11] and improve performance in running and both vertical and horizontal jumping (measured using force plate analysis of vertical and antero-posterior impulses) in those with asymptomatic pes planus.[44]

In those with symptomatic pes planus, there is significantly less development of the IFM and extrinsic foot muscles, and therefore less force production capability, muscular endurance, and subsequent control of MLA deformation.[10,44] Walking in minimalist shoes has been found to be as effective as direct IFM strengthening exercises (e.g., the "Short-Foot" exercise) at increasing maximal isometric contraction strength and size of the IFM.[12] While this method may be more convenient as it does not require additional exercise, there can be an associated injury risk if one switches to minimalist shoes too suddenly, due to increased loading of smaller musculature.[12]

Recommendations as a Kinesiologist

FOs have garnered both research and clinical success in the prevention and treatment of several LE overuse injuries; however, improved results have been demonstrated through the combination of FOs and an appropriate strengthening intervention. For foot injuries, direct IFM training is typically neglected within the rehabilitation process, with FOs being prescribed as a band-aid solution without addressing the underlying problem: patho-mechanics of the foot.[13] Recent evidence reveals the promise of IFM strengthening as another (p)rehabilitation strategy for LE overuse injuries. While there is still a need for higher quality studies on FOs as well as confirmatory research on IFM strengthening to make definitive claims, combining FOs and IFM strengthening is likely the most effective prevention and treatment approach for LE overuse injuries in the meantime.[9,10,13,14,26] Improving the isometric strength of the IFM will aid the foot's built-in ability to attenuate and transfer force between the ground and the rest of the kinetic chain during daily life or physical activity, and should be the primary focus of rehabilitation. FOs should be used merely as an adjunct modality, or during early, painful stages of an injury.[13]

People with the same patho-mechanical condition may respond differently to the same FO interventions, possibly due to individual differences in the sensitivity threshold of plantar surface mechanoreceptors in their feet.[54] These receptors detect inputs (e.g., pressure, skin stretch, vibrations) from the foot-shoe-ground interaction to allow our body to produce the appropriate movement output.[54] Therefore, a more functional assessment, both statically and dynamically,[16] as well as a trial period with an off-the-shelf FO before investing in a custom FO, is warranted.[47] This serves to ensure a unique fit for each individual. Also, because the research has shown little or no difference between custom and prefabricated FOs for both the treatment and prevention of overuse injuries,[34-36] it may be more economical to start out with an off-the-shelf FO, as it may provide sufficient benefits at a fraction of the cost. The practical use of orthotics may not always reflect the evidence-based applications, and clinical judgement must be used based on a patient's needs and wants. FOs may even be justified if they solely ease the patient's concerns regarding current or future injuries.[28] Therefore, an optimal FO is one that is comfortable, delays muscle fatigue, improves performance,[54] and is used in conjunction with an IFM strengthening program.

Disclosures

None.

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