

Changes in running kinematics and kinetics in response to a rockered shoe intervention

Authors: Boyer KA, Andriacchi TP

Summary: Following a suggested link between ambulatory mechanics and injury development, interest has increased in the development of footwear aimed at modifying patterns of human locomotion. Foot orthotics designed to alter medial-lateral stability are commonly, and sometimes controversially, prescribed to treat a variety of running-related injuries. Recent interest has focused on the development of minimalist interventions that involve altering the anterior-posterior (AP) plane of the shoe. This US study evaluated changes in kinematics and kinetics at the ankle, knee and hip in 19 healthy adult volunteers while running in a shoe with a sagittal plane curvature (Masai Barefoot Technologies MBT-M walk shoe), and while running in a flat soled shoe (New Balance 658). Kinematics and kinetics were quantified using an optoelectronics system and a force plate. The study tested the hypothesis that changes in kinematics and kinetics would be significant at the ankle, but minimal at the knee and hip while running in the MBT shoe. The results demonstrated that the general pattern of sagittal plane joint motion was the same in the MBT and control shoes, and showed no significant differences in knee and hip-joint kinematics during the stance phase of running. Ankle dorsiflexion angles at heel-strike and mid-stance were significantly ($p \leq 0.01$) greater in the MBT shoe compared with the control, while at toe-off the ankle was significantly ($p < 0.03$) less plantar-flexed in the MBT shoe compared with the control shoe. The ankle plantar and dorsiflexion moments and peak-ankle-joint power were significantly ($p \leq 0.003$) lower with the MBT shoe relative to the control shoe.

Comment: Previous research suggested that shoes might be a powerful tool for manipulating human movement and thus preventing injuries. Despite a large body of literature in the area it remains unclear how and why the human musculoskeletal system adapts to external influences at the foot/ground interface. It has been suggested that experimental evidence of these effects is lacking in part because of the limited conditions under which the adaptations and interventions are studied. The rockered sole of the MBT shoe used in this investigation provided an opportunity to investigate a condition far outside the normal range of shoe designs and yet the kinematic differences for the knee and hip joint were not significant. These results suggest it is possible to accommodate substantial changes in the curvature of the sole by changes in the motion and forces sustained at the ankle and these alterations can occur with minimal change to the knee or hip motions or moments. Changes in shoe sole geometry may offer potential therapeutic opportunities for conditions at the ankle without substantial risk to the knee or hip.

Reference: *Clinical Biomechanics*. 2009;24:872-6

<http://tinyurl.com/yczb99l>

Risk factors for failure of transmetatarsal amputation in diabetic patients: a cohort study

Authors: Younger ASE et al

Summary: This study investigated factors affecting wound healing following transmetatarsal amputation (TMA) in patients with diabetes. Twenty-one diabetic patients who were revised to transtibial amputation (TTA) within the first year of undergoing a TMA were compared with a matched cohort of 21 patients who had undergone a successful TMA. The factors compared included patient demographics, local conditions in the foot and systemic issues. Results demonstrated that blood glucose control, as measured by HbA1c, was the most important single factor predicting the success of TMA. The need for debridement after TMA was also found to be a significant predictor of failure of TMA and there was a trend towards significance for duration of ulcer prior to TMA and smoking status. There was no significant between group difference for all other variables, including vascular status or renal failure. As a result of their findings, the investigators state that they currently do not perform any elective or emergency surgery on patients with a HbA1c > 8 , unless the surgery is to save life or limb.

Comment: This Canadian study would be of interest to both clinicians and researchers who are interested in risk factors affecting wound healing in diabetic patients with a TMA. Obtaining good diabetic control in patients requiring amputation for foot infection may prevent failure of TMA and the need for subsequent below-knee amputation. Smoking may have a deleterious effect on the course of foot ulcers and patients with foot ulcers who are smokers at the time of presentation must be warned about the risks of TTA, or at least the risk of an increased time for TMA to heal.

Reference: *Foot Ankle Int*. 2009;30(12):1177-82

<http://tinyurl.com/ybm67bk>

Ultrasound guidance for intra-articular injections of the foot and ankle

Authors: Khosla S et al

Summary: Ultrasound is increasingly being used in procedures requiring intra-articular injections. This US study compared the accuracy of dynamic ultrasound guided intra-articular injection with conventional palpation and fluoroscopic guidance in the ankle and foot. Fourteen lightly embalmed cadaver specimens that were free from osteoarthritis were used for the study. A foot and ankle orthopaedic surgeon was enlisted to place a 0.22-gauge needle into the first and second tarsometatarsal joints (TMT), subtalar joint, and ankle joint using clinical palpation as a guide. Needle placement was then assessed by ultrasonography and if not correctly within the joint, the needle was re-directed under ultrasound guidance. Fluoroscopic images were then used to document needle placement. The results demonstrated that palpation was 100% accurate in subtalar and ankle joint injections. In contrast, using the palpation technique, only 3/14 and 4/14 needles were successfully placed within the first and second TMT joints, respectively. Ultrasound guidance increased needle placement accuracy in the TMT joints, with 10/14 and 8/14 needles successfully placed in the first and second TMT joints, respectively. When this data was grouped, ultrasound was found to be significantly ($p = 0.003$) more accurate for needle placement than palpation in the midfoot.

Comment: Intra-articular needle placement has historically been undertaken with the aid of palpation and confirmed with joint-fluid aspiration or fluoroscopy. This technique is difficult to apply to the small joints of the foot and ankle. The current study demonstrated a significant advantage of dynamic ultrasound guidance for intra-articular needle placement in these joints, but demonstrated that clinical palpation alone is adequate for the ankle and subtalar joint. It also appears that the accuracy of ultrasound is comparable to fluoroscopy in the first TMT joint without the risks of radiation. Dynamic ultrasound can be readily available in a clinic setting with a relative ease of technique. The authors point out that while a certain level of training is necessary for proper use of ultrasound, the depth of training required is obtainable for the musculoskeletal physician. The authors note that while the accuracy of ultrasound demonstrates its role in therapeutic and clinical use, it does not yet approach the level needed for decision making regarding arthrodesis, and that fluoroscopy remains the gold standard for this application.

Reference: *Foot Ankle Int*. 2009;30(9):886-90

http://www.newsletteronline.com/user/user.fas/s=563/fp=20/tp=37?T=open_summary.50029038&P=summary

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Prediction of anthropometric foot characteristics in children

Authors: Morrison SC et al

Summary: Pathologic conditions can have detrimental effects on the development and growth of the paediatric foot and in paediatric practice there is a need for the establishment of growth reference values. This UK study aimed at providing normative growth reference values and used multiple regression to evaluate the effects of multiple predictive variables such as age, height, bodymass and gender on anthropometric characteristics of the peripubescent foot. Two hundred 9-12 year old children were recruited for the study and three anthropometric measurements of the paediatric foot were recorded (forefoot width, foot length and navicular height). Multiple regression analysis was undertaken and results showed that coefficients for height, bodymass and gender all had significant ($p \leq 0.05$) relationships for the prediction of forefoot width and foot length. Height was also found to be significant ($p \leq 0.05$) for the prediction of navicular height, while coefficients for gender and bodymass were not.

Comment: It is known that genetic predisposition, environmental conditions, and time affect the growth and development of the foot. For clinicians involved in the management of the paediatric foot, it is of utmost importance to monitor the development and growth of the foot and to be aware that such growth is synchronized with the body and not with the leg. The authors acknowledge that the socioeconomic background of participants and the effect that it has on the growth and development of the foot need to be assessed. The effect of ethnicity on the growth and development of the foot would also provide interesting findings for clinicians based here in New Zealand.

Reference: *J Am Podiatr Med Assoc.* 2009;99(6):497-502

<http://tinyurl.com/yas6rfrn>

Use of low-frequency electrical stimulation for the treatment of plantar fasciitis

Authors: Stratton M et al

Summary: The use of low-frequency electrical stimulation to increase blood flow by eliciting muscular contraction in soft tissues has been investigated in recent research studies. The efficacy of low-frequency electrical stimulation combined with stretching exercises and foot orthoses in individuals diagnosed as having plantar fasciitis for less than 6 months was evaluated in this US randomized clinical trial involving 26 subjects aged 18 to 65 years. Participants were assigned to one of two treatment groups: a treatment group receiving low-frequency electrical stimulation in addition to stretching and orthoses or a control group receiving only stretching and orthoses. Treatment response was assessed using a visual analog scale to determine first-step morning pain and a validated outcome measure was used to monitor changes in daily activity levels. Participants were assessed before starting treatment, after 4 weeks of treatment, and 3 months after stopping treatment. Participants in both the experimental and control groups demonstrated pain reduction and improvements in functional activity levels after 4 weeks and 3 months.

Comment: Plantar fasciitis is a common cause of heel pain and some of the most common interventions used for the management of this disorder include plantar fascia-specific stretching, calf muscle stretching and foot orthoses. Other therapeutic modalities suggested for treating plantar fasciitis include iontophoresis, phonophoresis and electrical stimulation. Several studies have suggested that low-frequency electrical stimulation used at a rate of 7 to 50 pulses per second can be used to increase blood flow by eliciting muscular contractions without irritating the involved tissues. The results from this study indicate that regardless of whether low-frequency electrical stimulation is used as an intervention, the use of prefabricated foot orthoses and plantar fascia-specific stretching provide short-term (3-month) pain relief and improvement in functional activity levels in patients with plantar fasciitis. Based on these findings, the efficacy of low-frequency electrical stimulation in the management of individuals with plantar fasciitis is questionable.

Reference: *J Am Podiatr Med Assoc.* 2009;99(6):481-8

<http://www.japmaonline.org/cgi/content/abstract/99/6/481>

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An assessment of strapping techniques commonly used for pronated foot deformities

Authors: Carter K, Chockalingam N

Summary: This UK study investigated the effects of two high-Dye and two low-Dye strapping techniques commonly used to treat pronated foot deformities. Twenty normal adult subjects (mean age 29.7 years) with a pronated foot type were assessed. The subjects first walked across a pressure platform barefoot and then with each of the four strapping conditions applied. Footprints were averaged and then divided into seven areas for analysis. The results found significant differences between strapping and barefoot conditions. Overall, there was a general lateralization of pressures revealing an anti-pronation effect with all four strapping conditions. The most significant changes at the foot pressure areas analyzed were found with low-Dye strap two taping, which was used to limit the degree of calcaneal eversion.

Comment: Strapping is used by clinicians to temporarily control excessive foot pronation and therefore treat pronatory sequelae. The results of this study indicate that low-dye strapping is the most effective of the techniques investigated and these results have been interpreted as an indication of reduced pronation of the foot. While pronation and supination movement was not measured in this study, increased pressure exerted through the lateral column has been reported to indirectly reflect a reduction in pronation and arch restoration. The age group of the sample used in this study was less representative of the population of individuals that tend to develop pathologies associated with a pronatory foot type and participants were asymptomatic, which reduces the relevance of the results to a population that suffer from excessive foot pronation. Subjects were also measured barefoot, which may reduce the validity of findings in a shod population.

Reference: *J Am Podiatr Med Assoc.* 2009;99(5):391-8

<http://www.japmaonline.org/cgi/content/abstract/99/5/391>



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Diagnostic imaging for chronic plantar heel pain: a systematic review and meta-analysis

Authors: McMillan AM et al

Summary: Chronic plantar heel pain (CPHP) is a term used to describe a range of conditions involving the plantar heel. Plantar fasciitis has been reported as the most common cause of CPHP. Many studies have used diagnostic imaging to investigate the involvement of specific anatomical structures in CPHP. Such observations have helped to explain the underlying pathology of this disorder and have been of major benefit in forming an accurate diagnosis and targeted treatment plan. This Australian systematic review was undertaken to investigate the diagnostic imaging features associated with CPHP; study findings were evaluated by meta-analysis where appropriate. The researchers identified 23 appropriate controlled studies investigating the diagnostic imaging appearance of the plantar fascia and inferior calcaneum in individuals with CPHP. The review found that plantar fascia thickness measured by ultrasonography was the most widely reported imaging feature. Meta-analysis of 11 studies involving a total of 379 individuals with CPHP and 434 controls, found that proximal plantar fascia thickness was a mean of 2.16mm thicker in subjects with CPHP than in controls (95% CI 1.6-2.71mm; $p < 0.001$). Further analysis showed that individuals with CPHP were over 100 times more likely than controls to have plantar thickness values of >4 mm (OR 105.11; $p = 0.01$). Additionally, subcalcaneal spur formation was found to be strongly associated with pain beneath the heel, with CPHP subjects significantly ($p < 0.001$) more likely to have such spurs than controls.

Comment: This review highlights the benefits of ultrasonography in diagnosing CPHP. In the clinical management of CPHP, diagnostic imaging can provide objective information by which to either question or confirm the diagnosis of plantar fasciitis. Such information can be of particular value in cases that do not respond to first-line interventions, or when considering more invasive treatments such as corticosteroid injection. While a causal relationship has not been established, the presence of a subcalcaneal spur in patients with CPHP is also likely to be an important finding. In order to better define the role of spur formation and related bony abnormalities in the development of CPHP, further research involving the use of MRI and histological techniques is required.

Reference: *J Foot Ankle Res.* 2009;2:32

<http://www.jfootankleres.com/content/2/1/32/abstract>

Plantar pressures in diabetic patients with foot ulcers which have remained healed

Authors: Owings TM et al

Summary: Foot ulcer recurrence is a significant problem in people with diabetic neuropathy. This study aimed to measure in-shoe plantar pressures and other characteristics in a group of patients with diabetic neuropathy who had prior foot ulcers which had remained healed. A total of 49 subjects with prior plantar ulcers of the forefoot (hallux or metatarsal heads) caused by repetitive stress were included in the study. In-shoe and barefoot plantar pressures were measured during walking, and information on activity profiles, self-reported behavior and foot deformity, were collected. The mean barefoot plantar peak pressure at the prior ulcer site was found to be 556 kPa. While the mean pressure was found to be lower than that reported in other publications, the range was large (107–1192 kPa). Mean in-shoe peak plantar pressure, measured with an insole sensor, averaged 207 kPa.

Comment: Foot ulcers and their recurrence are a serious concern to individuals with diabetes. Plantar pressure measurements are commonly used in both research and clinical practice to evaluate risk factors in high-risk patients. In this study, some patients plantar pressures were no longer high enough for these patients to be 'at risk'. However, many of them still had extremely high pressures at prior ulcer sites. Based on in-shoe pressure data, the study authors propose a conservative provisional in-shoe pressure goal of <200 kPa using plantar pressure systems. Other studies have shown that in-shoe pressures can be reduced to the 200 kPa range with appropriately designed prescription footwear interventions. While footwear is frequently prescribed on a trial-and-error basis, the implementation of in-shoe pressure measurement with the proposed 200 kPa value as a target, could lead to significantly improved footwear for patients at-risk for ulceration or re-ulceration.

Reference: *Diab Med.* 2009;26(11):1141-6

<http://www3.interscience.wiley.com/journal/122556025/abstract>

Foot posture influences the electromyographic activity of selected lower limb muscles during gait

Authors: Murley GS et al

Summary: This Australian study investigated the influence of foot posture on lower limb muscle function in 60 individuals aged 18-47 years, with either normal-arched ($n=30$) or flat-arched feet ($n=30$), who were free from pain or disease. There were 15 men and 15 women in each group and subjects were matched for age, height and weight. While participants walked barefoot at their self-selected comfortable walking speed, surface electrodes recorded electromyographic (EMG) activity from tibialis anterior and medial gastrocnemius, and intramuscular fine-wire electrodes recorded EMG activity from tibialis posterior and peroneus longus muscles. The results demonstrated that during contact phase (heel contact to toe contact), the flat-arched group exhibited significantly ($p < 0.05$) increased activity of tibialis anterior and significantly ($p < 0.05$) decreased activity of peroneus longus compared with normal-arched individuals. During midstance/propulsion (toe contact to toe-off), the flat-arched group exhibited significantly ($p < 0.05$) increased activity of tibialis posterior and significantly ($p = 0.03$) decreased activity of peroneus longus compared with the normal-arched group. There were no significant differences between groups in medial gastrocnemius activity. The authors concluded that the observed differences in muscle activity in people with flat-arched feet may reflect neuromuscular compensation to reduce overload of the medial longitudinal arch.

Comment: The link between differences in foot posture and increased risk of injury in the lower limb may arise from abnormal muscle activity. It has been suggested that during gait, the flat-arched foot relies on additional muscular support and that fatigue of these controlling muscles with exercise may result in the development of injuries such as tibial stress fractures. The results presented in this study may have implications for the management of lower extremity overuse conditions. Preliminary evidence indicates that differences in muscle activity may be reversible with intervention. It is still unknown whether functional differences in muscle activation are detrimental or beneficial in relation to injury. In summary, lower limb muscle function is affected by foot posture. Both clinicians and researchers will find this article interesting to read. A good understanding of muscle activity and function is an important component of knowledge in practitioners who undertake biomechanical assessment as part of their clinical routine practice.

Reference: *J Foot and Ankle Res.* 2009;2:35

<http://www.jfootankleres.com/content/2/1/35>

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