

# Foot & Ankle Research Review

Making Education Easy

Issue 2 - 2009

## In this issue:

- > *Improved flat foot assessment tool*
- > *Increased midfoot pressure in diabetics*
- > *Mechanical changes in the diabetic heel*
- > *Diabetic neuropathy: reduced ankle roll-over*
- > *Children's foot shapes: 3D analysis*
- > *Diabetic foot ulcer: multidisciplinary approach*
- > *Vulnamin® gel for leg ulcers*
- > *First foot ulcer: healing critical for QOL*
- > *Foot pain: custom orthoses*
- > *Osteomyelitis prognosis: MRSA vs MSSA*

## Welcome to the second edition of Foot & Ankle Research Review.

The first edition was well received. The Foot & Ankle Review has been established to help make life easier for New Zealand professionals working in this area. Every month around 10,000 scientific publications are printed worldwide containing a multitude of new studies. Many are devoted entirely to the foot and ankle. In short, keeping up is hard and requires significant time to screen out what is irrelevant to your practice or your country. In essence, we aim to save you time sorting the 'wheat from the chaff' so you can spend more time doing what you're best at.

Foot & Ankle Research Review is a summary of what we think are some of the most significant new papers, plus a local commentary on why they are important and how they can potentially affect practice.

I have chosen two particular themes that would be of interest to those practitioners dealing with diabetes and children's foot problems. I have recommended two articles. The first one relates to the use of custom orthoses and footwear on foot pain and plantar pressure in diabetic peripheral arterial disease (Burns et al, *Diabetic Medicine*. 2009;26(9):893-9) and the second article describes a new approach to children's footwear based on foot type classification (Mauch M et al, *Ergonomics*. 2009;26(9):893-9).

The Review also provides website links to the abstract or fully published papers where possible so you can make your own judgements. The creation of this publication would not have been possible without support from our sponsors and to them we give our thanks. If you have discovered or been involved in what you think is significant global research, please let us know and we will consider it for inclusion next time. If you have colleagues or friends within New Zealand who would like to receive our publication, send us their contact email and we will include them next issue.

I hope you find the second edition of Foot & Ankle Research Review stimulating reading, and we welcome your feedback.

Kind regards,

Professor Keith Rome

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## The paediatric flat foot proforma (p-FFP): improved and abridged following a reproducibility study

**Authors:** Evans AM et al

**Summary:** The aim of this Australian study was to assess the reproducibility of a recently developed paediatric flat foot clinical-care pathway (FFP). From a study population of 140 children, aged 7-10 years, 31 were identified as having bilateral flat feet with a bilateral Foot Posture Index (FPI-6) score of  $\geq 6$ . A same subject, repeated measure research design was used which examined the reliability of the FFP in the 31 subjects, as rated by three examiners. The results demonstrated less-than-desirable inter-rater reliability, arbitrarily set at an intra-class correlation coefficient (ICC) of 0.7, with approximately half of the items failing to meet the set ICC standard. Removal of items with an ICC  $< 0.7$  results in a revised paediatric FFP (p-FFP) which is a shorter, more relevant and reproducible instrument for the clinical assessment of flat foot in mid-childhood.

**Comment:** The research presented is of importance to those practising in the field of paediatrics. The findings of this study suggest that the modified p-FFP is a more reproducible and reliable tool for the assessment of flat foot in children, than the previously developed version: the paediatric flat foot clinical pathway. The modified tool, which does not include those items with demonstrably poor inter-rater reliability, is both simpler and less time consuming to use. The findings of the study support the use of the p-FFP as a clinical tool for the assessment and evaluation of this common childhood condition. However, the study did have limitations and it is recommended that if the p-FFP were to be used in future research studies of flat foot in childhood, the intra-rater and/or if appropriate inter-rater reproducibility of the tool should be tested.

**Reference:** *J Foot Ankle Res*. 2009;2:25

<http://www.jfootankleres.com/content/2/1/25>

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## Assessment of the effects of diabetes on midfoot joint pressures using a robotic gait simulator

**Authors:** Lee DG, Davis BL

**Summary:** Charcot neuroarthropathy, a disease that results in arch collapse and permanent foot deformity, is one of the more serious complications of diabetes. However, not a lot is known about the aetiology of this condition. It is likely that arch collapse causes increased midfoot joint pressures and that increased joint contact pressures exacerbate the collapse of midfoot bones. This US study assessed peak joint pressure difference between non-diabetic (n = 8) and diabetic (8) cadaver feet during simulated walking. A custom-designed Universal Musculoskeletal Simulator was used to simulate human gait at 25% of typical walking speed. During full stance, four medial midfoot joint pressures were measured dynamically; first metatarsocuneiform, medial naviculocuneiform, middle naviculocuneiform, and first intercuneiform. The results demonstrated that the pressures in each of the four measured midfoot joints were significantly greater in the diabetic feet.

**Comment:** The study hypothesised that joint pressures are higher in diabetics than the normal population. Diabetic cadaver specimens had, on average, 46% higher peak pressures than the controls across all four tested joints, during the simulated stance phase. The increase in midfoot pressures found in diabetic specimens could be due to a limited range of foot joint motion and increased stiffness in diabetic soft tissue. The study findings suggest that individuals with diabetes have higher mechanical stresses on their midfoot joints than control subjects during daily activities. Also, in such individuals, the acceleration of joint problems may result from the application of repetitive high joint pressures. The findings suggest that patients with diabetes may be predisposed to mechanical alterations in the arch of their feet, even without visible signs of midfoot collapse.

**Reference:** *Foot Ankle Int.* 2009;30(8):767-72

[http://www.newsletteronline.com/user/user.fas/s=563/fp=20/tp=37?T=open\\_summary.50028219&P=summary](http://www.newsletteronline.com/user/user.fas/s=563/fp=20/tp=37?T=open_summary.50028219&P=summary)

## Diabetic effects on microchambers and macrochambers tissue properties in human heel pads

**Authors:** Hsu C-C et al

**Summary:** This Taiwanese study examined differences in mechanical properties in heel pad macro-chambers and micro-chambers between patients with type 2 diabetes mellitus and age-matched healthy volunteers. A total of 29 heels in 18 diabetic patients (disease duration 5 months to 20 years) and 28 heels in 16 controls were examined by an ultrasound-based loading device; average subject age 55 years. Unloaded thickness, elastic modulus and strain were measured in heel pads, micro-chambers and macro-chambers. The two groups exhibited similar unloaded thicknesses in all three locations. The maximum strain of the heel pad was also similar for both groups. However, the maximum strain of the micro-chamber was significantly greater ( $p < 0.001$ ) in diabetic patients than control subjects (0.291 vs 0.104) while the maximum strain of the macro-chamber was significantly less ( $p = 0.001$ ) in diabetic subjects (0.355 vs 0.450). Tissue stiffness of the heel pad did not differ between the two groups. However, micro-chamber stiffness was found to be significantly ( $p < 0.001$ ) less in diabetic subjects than in the controls (393 vs 1140 kPa), while macro-chamber stiffness was significantly ( $p = 0.001$ ) greater in the diabetic subjects (239 vs 181 kPa).

**Comment:** Micro-chambers contain predominantly elastic fibres while macro-chambers usually exhibit equal numbers of elastic and collagen fibres. Different biomechanical behaviors are therefore expected in these two layers. Deterioration of the collagen fibres in fibrous septae in the heel pad due to a glycation effect may be the cause of the increased stiffness in the macro-chambers. A decrease of micro-chamber stiffness may result in decreased ability to confine macro-chambers beneath the calcaneus. The increased macro-chamber stiffness may lead to the easy transfer of stress between the calcaneus and the skin. The alterations in mechanical properties of the two anatomical layers may work together to cause diminished cushioning capacities in diabetic heels. It would be of interest to repeat this study in obese diabetic subjects.

**Reference:** *Clin Biomech.* 2009;24(8):682-86

[http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6T59-4WT39VN-1&\\_user=10&\\_coverDate=10%2F31%2F2009&\\_alid=1051959647&\\_rdoc=2&\\_fmt=high&\\_orig=search&\\_cdi=4997&\\_sort=r&\\_docanchor=&\\_view=c&\\_ct=13&\\_acct=C000050221&\\_version=1&\\_urlVersion=0&\\_userid=10&\\_md5=d4f5ff59d78fb187dab2d01096640ffe](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T59-4WT39VN-1&_user=10&_coverDate=10%2F31%2F2009&_alid=1051959647&_rdoc=2&_fmt=high&_orig=search&_cdi=4997&_sort=r&_docanchor=&_view=c&_ct=13&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&_md5=d4f5ff59d78fb187dab2d01096640ffe)

## Role of ankle mobility in foot rollover during gait in individuals with diabetic neuropathy

**Authors:** Sacco ICN et al

**Summary:** This study investigated ankle range of motion during neuropathic gait and its influence on plantar pressure distribution at two phases during stance (heel-strike and push-off). This study involved 15 adult patients with type 2 diabetes of >5 years duration who exhibited diabetic neuropathy (score of >6 on the Michigan neuropathy screening instrument questionnaire) and 16 controls. Dynamic ankle range of motion and plantar pressures were acquired synchronously during walking. Plantar pressures were evaluated at forefoot, midfoot and rearfoot during the two phases of stance. Diabetic subjects walked using a significantly ( $p < 0.001$ ) smaller ankle flexion at heel-strike and a significantly ( $p < 0.001$ ) smaller ankle range of motion in both support phases compared with controls. The diabetic group exhibited significantly higher ( $p = 0.0002$ ) peak pressure values in the midfoot at push-off phase when compared to heel-strike phase. However, the control group showed similar values of peak pressure in midfoot during both stance phases.

**Comment:** The ankle mobility reduction observed in neuropathic subjects could be associated to altered plantar pressure distribution. This study demonstrated that the midfoot and forefoot play a different role in subjects with neuropathy by receiving higher loads at push-off phase. This is probably due to smaller ankle flexion at stance phase. This may explain the higher loads in anterior regions of the foot observed in subjects with diabetic neuropathy, and confirm an inadequate foot roll-over associated to the smaller ankle range of motion at the heel-strike phase.

**Reference:** *Clin Biomech.* 2009;24(8):687-92

[http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6T59-4WF8SD7-1&\\_user=10&\\_coverDate=10%2F31%2F2009&\\_rdoc=16&\\_fmt=high&\\_orig=browse&\\_srch=doc-info\(%23toc%234997%232009%23999759991%231439081%23FLA%23display%23Volume\)&\\_cdi=4997&\\_sort=d&\\_docanchor=&\\_ct=19&\\_acct=C000050221&\\_version=1&\\_urlVersion=0&\\_userid=10&\\_md5=4bf02accfb22e9ec91b215f892a3a856](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T59-4WF8SD7-1&_user=10&_coverDate=10%2F31%2F2009&_rdoc=16&_fmt=high&_orig=browse&_srch=doc-info(%23toc%234997%232009%23999759991%231439081%23FLA%23display%23Volume)&_cdi=4997&_sort=d&_docanchor=&_ct=19&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&_md5=4bf02accfb22e9ec91b215f892a3a856)

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## A new approach to children's footwear based on foot type classification

**Authors:** Mauch M et al

**Summary:** The purpose of this study was to develop a new approach to children's footwear using a foot type classification on the basis of five foot measures that are relevant in shoe design; ball-of-foot length, ball width, ball angle, instep height, and heel width. The feet of 2867 German children, aged 2-14 years, were measured using a 3-D foot scanner. Cluster analysis was then applied to classify the feet into three different foot types; robust (31%), intermediate (29%), slender (40%). Further analysis revealed a high proportion of robust and intermediate feet in smaller feet (sizes 25-29), while the slender foot type was more represented in the larger sizes (36-41).

**Comment:** Current shoe designs generally do not allow for the comprehensive 3-D shape of the young foot, they are therefore not able to reproduce the wide variability in foot morphology. The characteristics of foot types differed regarding their volume and forefoot shape both between and within shoe sizes. The new approach differs from previous systems as it uses a foot typing system to capture the variability of foot morphology. This system allows for the multifaceted differences in the shape of children's feet and paves the way for the unimpaired development of young feet. Providing well-fitting shoes that meet the anatomical requirements of the feet can reduce consequential costs of treating future foot problems and their complications. This means both an economic benefit, and a presumed improvement in the quality of life and well-being.

**Reference:** *Ergonomics*. 2009;52(8):999-1008

<http://www.informaworld.com/smpp/content~db=all~content=a913305214>

## A multidisciplinary diabetic foot protocol at Chiang Mai University Hospital: cost and quality of life

**Authors:** Rerkasem K et al

**Summary:** The Taiwanese study compared responses to the short-form 36 questionnaires (SF-36) about health-related quality of life and the cost of medical care for 56 patients receiving diabetic foot protocol (DFP) care from August 2005 to March 2007 and 40 patients who had received standard care from August 2003 to July 2005. The DFP is a multidisciplinary approach to care for diabetic foot ulcer. The standard protocol involved the treatment of foot ulcer independently by specialists. The average total cost of treatment for DFP care patients was significantly ( $p=0.02$ ) lower than that for standard care patients. Diabetic foot protocol care patients had significantly ( $p\leq 0.05$ ) higher scores on the SF-36 for the physical health dimension and mental health dimensions than standard care patients (45.7 vs 37 and 61.3 vs 54, respectively).

**Comment:** This study would be of interest to those working in diabetic multidisciplinary teams. The foot protocol care package included education about diabetic foot disease, its complications, prevention and prescription of custom-made foot orthoses. The findings demonstrated that DFP care gave patients a better quality of life and was less expensive than standard care. On the basis of these findings, DFP care can improve outcomes for patients with diabetic foot ulcer. The consensus is that a multidisciplinary approach for patients with diabetic foot ulcer is effective in reducing the number of leg amputations and the study authors recommend a multidisciplinary approach for the treatment of such patients.

**Reference:** *Int J Lower Extr Wounds* 2009;8:153-56

<http://ijl.sagepub.com/cgi/content/abstract/8/3/153>

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## Effectiveness and safety of a novel gel dressing in the management of neuropathic leg ulcers in diabetic patients: a prospective double-blind randomized trial

**Authors:** Abbruzzese L et al

**Summary:** The aim of this Italian randomised clinical trial was to evaluate a novel gel formulation, containing amino acids and hyaluronic acid (Vulnamin® gel; Errekappa, Milan, Italy) when used together with elasto-compression bandaging for neuropathic leg ulcers. Thirty patients, with either type 1 or 2 diabetes mellitus who had had a frank neuropathic leg ulcer for >3 weeks, were randomised into two groups. The study group (n=15) received Vulnamin® gel, while the control group received the inert gel vehicle. Healing time was significantly ( $p<0.05$ ) less for patients who received Vulnamin® gel, compared with controls (60.4 vs 79.9 days). There was, however, no difference between the groups in the number of infective complications or other adverse events. Vulnamin® gel recipients also reported significantly ( $p<0.05$ ) greater patient satisfaction, and a greater reduction in ulcer area and ulceration score at 4 weeks.

**Comment:** Neuropathic leg ulcers affect more than 10% of patients with diabetic peripheral neuropathy and represent the most frequent cause of ulceration of the leg in these individuals. Though their pathogenesis is well known to be related to chronic neuropathic oedema, the management of neuropathic leg ulcers, mainly based on elasto-compression, is still controversial. Neuropathic leg ulcers exhibit lower healing rates than non-diabetic venous leg ulcers. Although this study demonstrated a significant reduction in healing time with the use of Vulnamin® gel with elasto-compression, further work is needed as only 30 subjects were evaluated and there is a need to compare other more commonly used dressings.

**Reference:** *Int J Lower Extr Wounds*. 2009;8:134-40

<http://ijl.sagepub.com/cgi/content/abstract/8/3/134>

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## Quality of life in people with their first diabetic foot ulcer: a prospective cohort study

**Authors:** Winkley K et al

**Summary:** This UK prospective cohort study involved 253 patients with diabetes who were experiencing their first foot ulcer. In order to assess quality of life in these subjects, Medical Outcomes Study 36-Item Short Form Health Survey (MOS SF-36) scores at baseline and 18 months were assessed. The study recorded baseline demographics, diabetes characteristics, depression, and diabetic foot outcomes and mortality. Among the study group there were 40 deaths (15.8%), 36 amputations (15.5%), 99 ulcer recurrences (43.2%), and 52 non-healing ulcers (21.9%). The survey response rate of survivors at 18 months was 78% (n=157). There was a 5- to 6-point deterioration in mental component summary scores in people who did not heal or had recurrent ulcers.

**Comment:** The study revealed that overall scores on the SF-36 physical functioning, mental health and general health quality-of-life domains deteriorated during 18 months, but only in those who individuals who experienced further complications. Those who healed without any further adverse outcomes continued to perceive their quality of life as the same. This study highlights the importance of healing first ulcers and that a failure to do so risks the loss of an opportunity to protect perceived quality of life. For individuals at high risk, or with complications, increased attention to strategies to maintain or improve quality of life, such as social rehabilitation, is required.

**Reference:** *J Am Podiatr Med Assoc.* 2009;99:406-14

<http://www.japmaonline.org/cgi/content/abstract/99/5/406>



Independent commentary by Professor Keith Rome, School of Podiatry, AUT University, Auckland.

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## Randomized trial of custom orthoses and footwear on foot pain and plantar pressure in diabetic peripheral arterial disease

**Authors:** Burns J et al

**Summary:** The efficacy of custom orthoses on foot pain and function was investigated in this randomised, single-blind, sham-controlled Australian trial involving 61 diabetic patients with peripheral arterial disease. Participants were randomly assigned to either custom foot orthoses (n=30) or sham insoles. Both groups also received standardised walking footwear. The primary outcome was foot pain and function, which was measured at baseline and 8 weeks using the Foot Health Status Questionnaire (FHSQ). At 8 weeks, foot pain and function scores had significantly ( $\leq 0.015$ ) improved from baseline in both groups, with a 12.9 point improvement in pain score and a 14.6 point improvement in function in the custom orthoses group, and a 19.2 point improvement in pain and a 12.1 point improvement in function in the sham group; the difference in pain-score improvement between these groups was not significant. Custom orthoses were found to reduce pressure significantly ( $p < .001$ ) more than the sham.

**Comment:** Both groups experienced a significant improvement in pain and function. The high-quality walking footwear provided to both groups may explain this finding. Footwear should have greater emphasis as the clinical intervention in future studies of foot pain relief. This study focused on a particular type of customised foot orthoses, fitting the general definition of a custom device: removable in-shoe device milled or moulded from an impression of the foot and fabricated according to practitioner-prescribed specifications. Other types of 'custom-made' foot orthoses may produce a different effect in the diabetic population and the effects of these, along with different types of footwear, should be investigated.

**Reference:** *Diabet Med.* 2009;26(9):893-9

<http://www3.interscience.wiley.com/journal/122527976/abstract>

## Are diabetic foot ulcers complicated by MRSA osteomyelitis associated with worse prognosis? Outcomes of a surgical series

**Authors:** Aragon-Sanchez J et al

**Summary:** This study compared the outcomes of surgical treatment of osteomyelitis caused by methicillin-sensitive *Staphylococcus aureus* (MSSA) with cases caused by methicillin-resistant *S. aureus* (MRSA). From a total of 185 consecutive patients with diabetes and foot osteomyelitis undergoing surgery within the first 12 hours of admission at a single hospital, 60 were identified as having MSSA and 35 were identified as having MRSA. MRSA bone infection was associated with a significantly ( $p=0.02$ ) higher body temperature and white blood cell count than MSSA and patients with MRSA infection underwent significantly ( $p=0.04$ ) more surgical procedures than those with MSSA. Limb salvage was achieved in 93.6% of the patients, with no significant difference in limb salvage rates between the two groups. There was no significant difference in healing times between the two groups.

**Comment:** MRSA foot infection has been associated with prolonged time to healing. While the MRSA group in this study had a median healing time 30 days longer than the MSSA group, this difference was found to be not significant. Patients with MRSA osteomyelitis underwent more surgical procedures to resolve infection. However, the two groups showed no significant differences in the final outcome of surgical treatment or mortality. The small number of cases in this study may have limited the statistical conclusions about the true differences between the two groups. However, the results suggest that when treatment is based on early and aggressive surgical treatment, MRSA bone infections are not associated with a worse prognosis. It is possible that the virulence of strains of *S. aureus* may be related more with genetic factors than with methicillin resistance itself.

**Reference:** *Diabet Med.* 2009;26(5):552-5

<http://www3.interscience.wiley.com/journal/122302322/abstract>

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