

A Comparison Study of Ulcerated and Non-Ulcerated Halluces on the Same Patient Using In-Shoe Pressure Measurements

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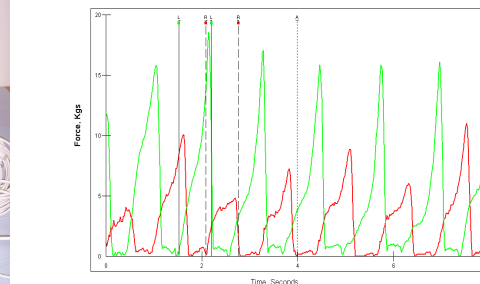
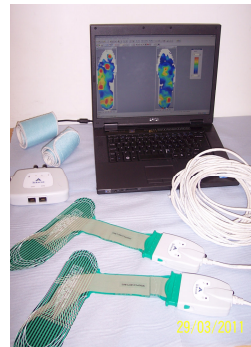
Background: It has been long established that in the presence of diabetic neuropathy the plantar aspect of the hallux is one of the commonest sites for foot ulceration ⁽¹⁾. Although there is no definitive maximum peak pressure or pressure time integral that increases the risk of ulceration it has been shown that prolonged load time and increased plantar pressures as a result of altered biomechanics are associated with delayed healing ⁽²⁾. In-shoe pressure analysis systems can be helpful in identifying the presence of increased pressure, and prolonged contact time during the gait cycle. This can be of particular benefit in non-healing diabetic foot ulceration and can be used to develop an orthotic or offloading device to improve these factors, thus allowing healing.

Aim: To see whether there were differences between in-shoe pressure measurements between a non-healing hallux ulcer and the contralateral intact hallux in the same patient, and identify trends across a cohort with similar unilateral ulcers

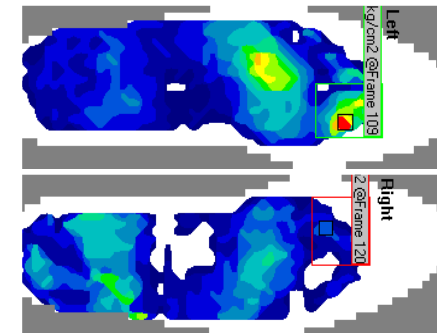
Method: Between 1st February 2010 and 1st Dec 2010 patients with unilateral non healing plantar interphalangeal joint (IPJ) ulceration of the hallux were referred to our pressure analysis clinic. We used the F-scan in-shoe plantar pressure system which has been shown to have adequate reliability for clinical purposes ⁽³⁻⁴⁾. In this study the patient acted as their own control. We compared the Pressure Time Integral (PTI, kg*sec), Peak Contact Pressure (PCP, kg/cm²), and load time (sec) between the ulcerated and non-ulcerated toe. We identified and isolated both halluces and measurements were taken over an average of 7 footsteps (range 4-16) excluding the first and last step in every recording. In this study all patients underwent in-shoe pressure analysis wearing the shoe they most commonly wore without an orthotic. Further to this the angle of dorsiflexion at the first metatarsophalangeal joint was measured. The reference range in patients with diabetes has been reported to be between 68-82° ⁽⁵⁾. Hallux limitus is said to be present when the angle of dorsiflexion is less than 50° ⁽⁶⁾.

Results: 10 patients were identified with plantar IPJ ulceration to the hallux. 5 subjects had their ulcers on the left and 5 on the right foot. All had palpable foot ulcers but were insensate to 10g Semmes Weinstein monofilament. Other results are shown in the table. Biomechanical assessment showed that all had a degree of hallux limitus in the ulcerated foot with the average range of motion in the affected foot being 39.6° (range 20-62°) and non-ulcerated foot normal 68.6° (range 45-74°), p = 0.03.

	PTI (kg*sec)	PTI Range	PCP (kg/cm ²)	PCP Range	Time (sec)	Time Range
Ulcerated	4.01	1.59-5.68	4.72	1.60-13.9	0.42	0.27-0.93
Non-ulcerated	2.84	1.10-5.95	2.75	1.10-6.50	0.41	0.26-0.81
p value	0.004		0.16		0.84	



PTI for Ulcerated (left) vs Non-Ulcerated (right) foot



Conclusion: The results are consistent with current theories demonstrating that both PTI and PCP are elevated in hallux ulceration, however, in this small study only the PTI was statistically significant. It is possible that if we repeated this study with larger numbers, both trends would become significant. The reason why one foot develops hallux limitus remains unknown and is an area for further research. This case series suggests that altered foot function as a result of diabetes is not necessarily bilateral in presentation.

1. Armstrong D, et al. Clinical Efficacy of the First Metatarsophalangeal Joint Arthroplasty as a Curative Procedure for Hallux Interphalangeal Joint Wounds in Patients with Diabetes. Diabetes Care. 2003;26(12):3284-3287 2. Lavery L, et al. Practical criteria for screening patients at high risk for diabetic foot ulceration. Archives of Internal Medicine. 1998;158:157-162 3. Luo ZP, Berglund LJ, An K-N. Validation of F-Scan pressure sensor system: A technical note. Journal of Rehabilitation Research and Development. 1998;35(2):186-191 4. Ahroni JH, Boyko EJ, Forsberg R. Reliability of F-scan in-shoe measurements of plantar pressure. Foot & Ankle International. 1998;19(10):668-73. 5. Payne C, Turner D, Miller K. Determinants of plantar pressures in the diabetic foot. Journal of Diabetes and Its Complications 2002;16(4):277-283 6. Armstrong DG, Lavery LA, Vela SA, Quebedeaux TL, Fleischli JG: Choosing a practical screening instrument to identify patients at risk for diabetic foot ulceration. Archives of Internal Medicine 1998;158:289-292.