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The role of shear stress in the aetiology of diabetic neuropathic foot ulcers

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Introduction

Several biomechanical studies have been conducted in the last decade to investigate the aetiology of plantar ulcers in presence of Diabetes (D) and Peripheral Neuropathy (PN) [1]. Great renewed interest has been lately showed towards shear stresses during gait [2,3]. In this case, the major difficulty lays in technology, since it is still hard to obtain reliable and meaningful measurements by using the available measurement systems. The authors' validated methodology [4] is here re-proposed, and the results of its further applications to the analysis of PN shear stress are here briefly reported.

Methods

A compound instrument was made at ISS (Rome, Italy) by superimposing a resistive pressure platform (4 sensors/cm^2; pressure resolution 15.2 kPa; 100 Hz) on a Bertec force plate (force resolution 2 N, moment resolution: 0.3 Nm), and a mathematical model was implemented whose input are local vertical forces and global shear forces. Output of the model are estimated local shear forces and free moment [4]. The measurement system was used to investigate 61 barefoot D patients (34 PN, 21 matched controls = C). Three subareas – heel, metatarsals and hallux – were geometrically identified by making reference to the lines at 40% and 70% of the total length perpendicular to the bisecting line of the foot [3].

A similar prototype was then developed at the University of Padova (Italy), and the mathematical procedure replicated. In this case a 6-cameras BTS motion capture system (60–120 Hz) synchronized with two Bertec force plates and integrated with two Imago resistive pressure platforms (1.56 sensors/cm^2; 150 Hz) were used. The foot subareas were defined by projecting the anatomical landmark positions onto the plantar pressure footprint [5]. 38 patients were analyzed: 10 C,14 diabetics (D), 14 PN. Three subareas were again selected, rearfoot, midfoot, forefoot [5].

Results

There was a good agreement between the main results of the two studies, the most interesting finding being the increased peak of the lateral component of shear force under the metatarsal region (LMR, Figure 1). In the first study, mean values and SD for LMR (%N) were 4.4 ± 2.1 for PN patients and 3.9 ± 2.1 for C. In the second study the mean and SD values (%N) were 7.7 ± 3.0 for PN patients and 6.7 ± 2.7 for C. The relative increase with respect to C was 20.4% in the first study and 20.7% in the second one.

Conclusion

The above studies confirm the need of a deep biomechanics analysis of the diabetic foot including vertical and shear forces during gait. The results from the two studies

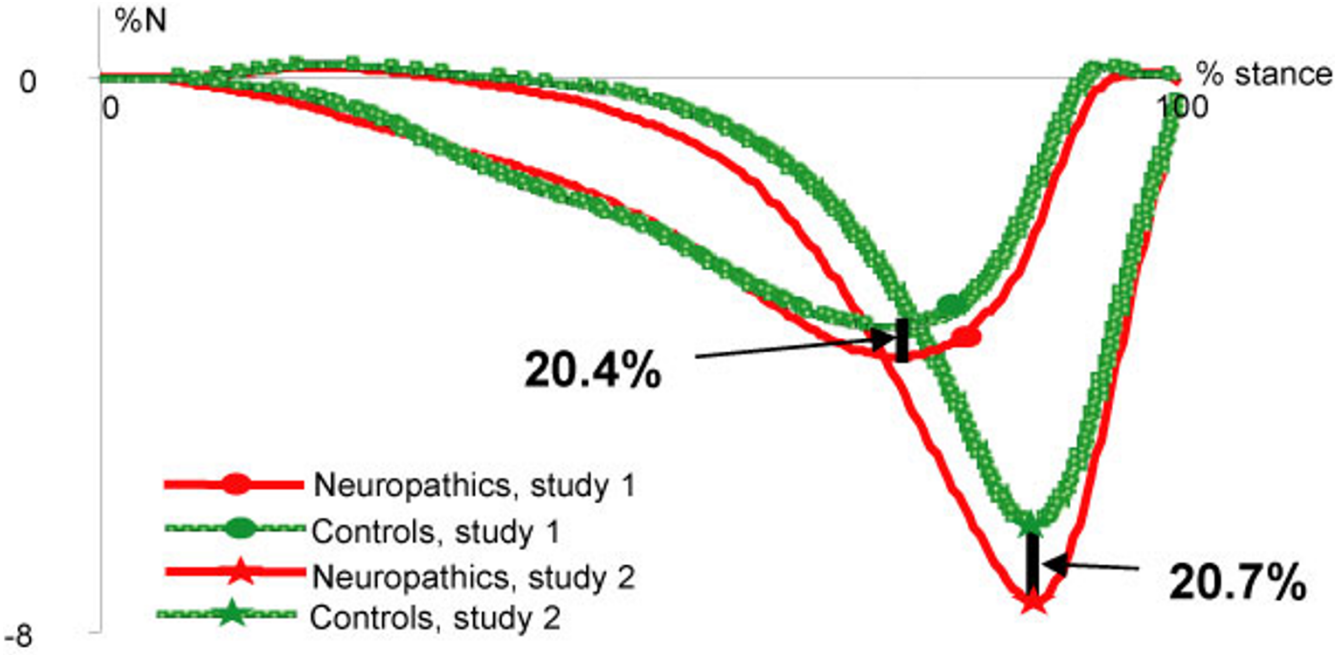

Figure 1
Lateral shear forces under the metatarsal region.

were in a good agreement, absolute differences mainly due to partially different subarea selection and adopted technologic solution. Further reliable measurement instrumentation and foot models should be validated and applied, also including in-shoe measurements, and the analysis of motor tasks more demanding than level walking.

References

1. Cavanagh P, *et al.*: Edited by: *Bowker JH, Pfeifer MA. The Diabetic Foot, St. Louis*; 2001:125-196.
2. Ledoux WR: *Foot and Ankle Motion Analysis* Edited by: *Harris GF,s et al. CRC Press*; 2008:317-345.
3. Giacomozzi C, *et al.*: *Diabetes Care* 2002, **25:**1451-1457.
4. Giacomozzi C, Macellari V: *IEEE Trans On Rehab Eng* 1997, **5(4):**322-330.
5. Sawacha , *et al.*: *Gait & Posture* 2006, **24:**S2-S3.