A NEW PORTABLE METHOD FOR THE MEASUREMENT OF PRESSURE-DISCOMFORT THRESHOLD (PDT) ON THE FOOT PLANT

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INTRODUCTION
The overpressures that occur on the foot plant are one of the most common causes of pain and discomfort associated to the use of footwear. In spite of this fact, there have been a few studies about the effect that certain levels of pressure have over the foot comfort. A new portable method of measuring pressure-discomfort threshold (PDT) on the foot plant has been developed. An external pressure is applied manually over the foot plant and the threshold when the pressure sensation becomes uncomfortable is recorded. The purpose of this study was: (1) to test this new methodology for measuring PDT on the foot plant, (2) to evaluate the PDT distribution on the foot plant, (3) to investigate whether there is any difference regarding sex in the PDT pattern or in the foot plant values.

REVIEW AND THEORY
Different methods have been used to measure the pressure sensitivity on diverse body zones. For example, Fransson-Hall et al. (1993) studied the sensitivity of the hand-to-surface pressure. There are also numerous articles about the evaluation of the sensitivity of the foot of patients with neuropathy, especially in diabetic patients (Sosenko et al. 1990, Tassler et al. 1995). Nevertheless, the values yielded by these studies are the threshold of sensitivity to surface pressure, not comparable to the discomfort threshold. There are few studies about the effect of the pressure on the foot comfort, some authors (Marriott et al. 1981) described the pressure applied to the foot before discomfort as being from 3 to 20 kPa. However, these studies analysed the data corresponding to the application of a uniform pressure on the whole foot and their values are much lower than those measured on the foot plant during gait (400 kPa) or while running (600 – 700 kPa).

PROCEDURES
The equipment for the recording pressure sensitivity of the foot plant consisted of a commercial manual dynamometer, EFG 1-2 of Salter. An aluminium cylindrical cap with a contact flat surface of 1.3 cm$^2$ and round edges has been adapted to the dynamometer. The subject had a push-button to indicate when he/she started to feel discomfort due to pressure application. Both systems were connected to a computer by means of a data acquisition card. The subject was lying down over a stretcher with the right foot barefoot. The points to be tested were marked on the foot plant and the subject was instructed to push the switch in the instant when he/she felt discomfort, not waiting to feel pain. At the same time, the subject asked the examiner to stop applying the load. Pressure was applied five times in a minute in each zone. Letting an interval of 6 seconds between consecutive applications. The sequence pressure application was randomised, but closed zones were not tested in a consecutive way. Thirteen points on the foot plant selected for their functional meaning and because they were easily identifiable were studied for each subject (figure 1). For this study 85 subjects were tested (42 women and 43 men). The parameters studied were the maximum pressure registered when the subject asked to stop the load and the pressure when the subject pushed the switch. The first parameter was chosen because it was more robust.
Two analyses, for men and women separately, were done. Intraclass coefficient of correlation, ICC(2,1) (Shrout et al. 1979), was used to study the reliability of the five measures per zone. Subjects with a coefficient lower than 0.65 were discarded. The PDT values for the different zones were normalised dividing by the mean value and the ICC(2,1) was used again to establish the consistency of the PTD pattern. Analysis of variance (ANOVA) for the PTD was applied first, with the zone as factor; then using sex as factor. The significant level was establish in $\alpha<0.05$.

RESULTS AND DISCUSSION

This new method is capable of discriminating between the sensitivity of different zones on the foot plant and between different subjects. In general terms, the PDT values are similar to that observed in normal walking (figure 2). Different subjects had equivalent PDT pattern, the ICC obtained for the men normalised values was 0.55 and 0.47 for women; a higher variability was observed in women.

No statistical differences were found between the mean PDT values of men and women for the different zones, but for all the points, men presented statistically higher PDT mean. This method will permit to determine limit values for the pressures that appear in the foot plant for the diverse human activities, as well as to obtain the PDT pattern distribution for different subject groups, being the starting point for the design of insoles with better comfort and health characteristics.

REFERENCES