IN-SHOE PRESSURE DISTRIBUTION: AN ALTERNATIVE APPROACH TO ANALYSIS

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INTRODUCTION

In a typical analysis of in-shoe pressure distributions, areas of particular interest are selected by the application of masks to the raw data. Each masked area is scanned for pressure peaks and statistical analyses are applied to the peak values. The purpose of this paper is to describe an alternative approach to analysis, in which whole pressure distributions are treated as analyzable objects and comparatively little information is discarded.

METHODS

Instead of applying masks, we have developed a procedure in which data from all the cells of a pressure-sensitive insole are processed iteratively. Raw pressure data from a single step are processed to determine distributions of peak pressure, peak rate of loading, impulse and contact time. Data from multiple steps in a trial are averaged on a cell by cell basis. Sums and sums of squares for each cell are retained at each stage of processing in order to facilitate later statistical analysis. Depending on the experimental model, mean differences, t-tests, analyses of variance and other statistics can also be calculated on a cell by cell basis. Both data and statistical results are presented graphically, typically as contour maps.

EXAMPLE

Figures 1 and 2 show an example of this procedure applied to the results of a study of the effects of walking speed and cushioning on in-shoe pressure distribution. Forty-two male subjects walked on a motorized treadmill at 1.0 and 2.0 m s^{-1} in a cushioned running shoe and a minimally cushioned shoe. In-shoe pressure distributions were recorded using a Novel gmbh Pedar® insole system. For each subject-condition, data from five non-consecutive steps of the left foot were retained for analysis. Subject-condition means, condition means and standard deviations were calculated for each data cell. Differences between the means of each condition were tested using two-way repeated measures analysis of variance.

With increased walking speed, pressure under the foot increased in the heel and distal forefoot regions but decreased significantly in the proximal forefoot (Figure 1). No significant differences were found in the medial proximal arch area. Softer cushioning reduced pressure under the calcaneus (Figure 2) but significantly increased pressure in peripheral regions of the heel. In the forefoot, cushioning significantly decreased peak pressure in lateral regions but peak pressures on the medial margin increased significantly.

DISCUSSION

Walking speed and cushioning do not affect plantar load distributions uniformly. The application of masks to pressure distributions results in a large portion of the collected data being discarded, including the specific location of pressure peaks and potentially useful information changes that are not correlated with maximum values. In the example used here, the observation that cushioning not only reduces peak pressures but also redistributes load to other regions of the plantar surface might not have been made with a conventional analytical approach.

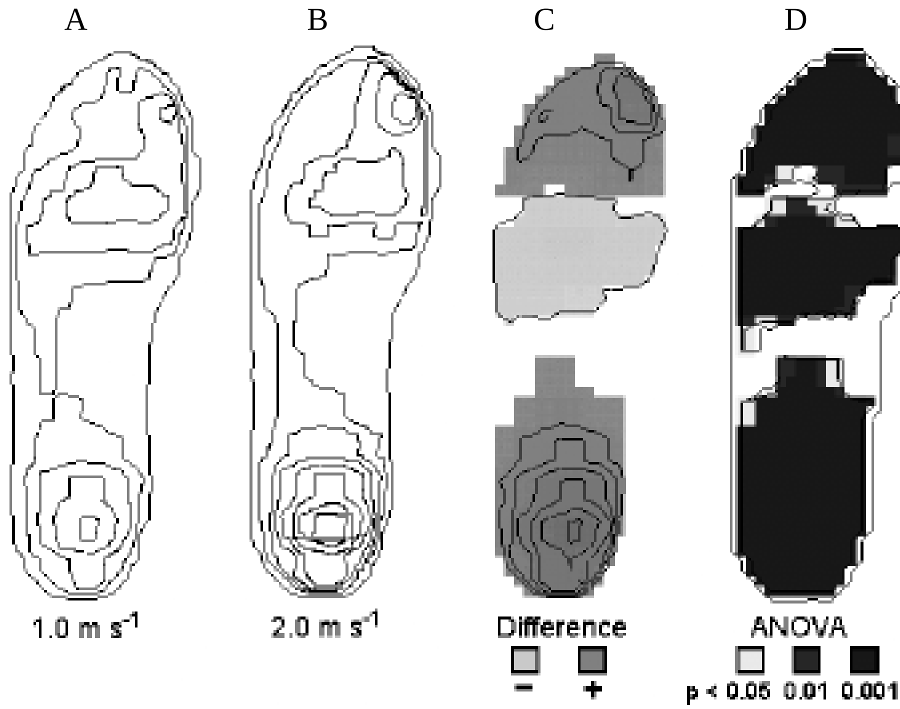

Figure 1: Effect of walking speed on in-shoe peak pressure distribution
(A), (B) Mean peak pressure distributions (contour interval = 50 kPa). (C) Mean difference between speeds (contour interval = 25 kPa) (D) Analysis of variance results.

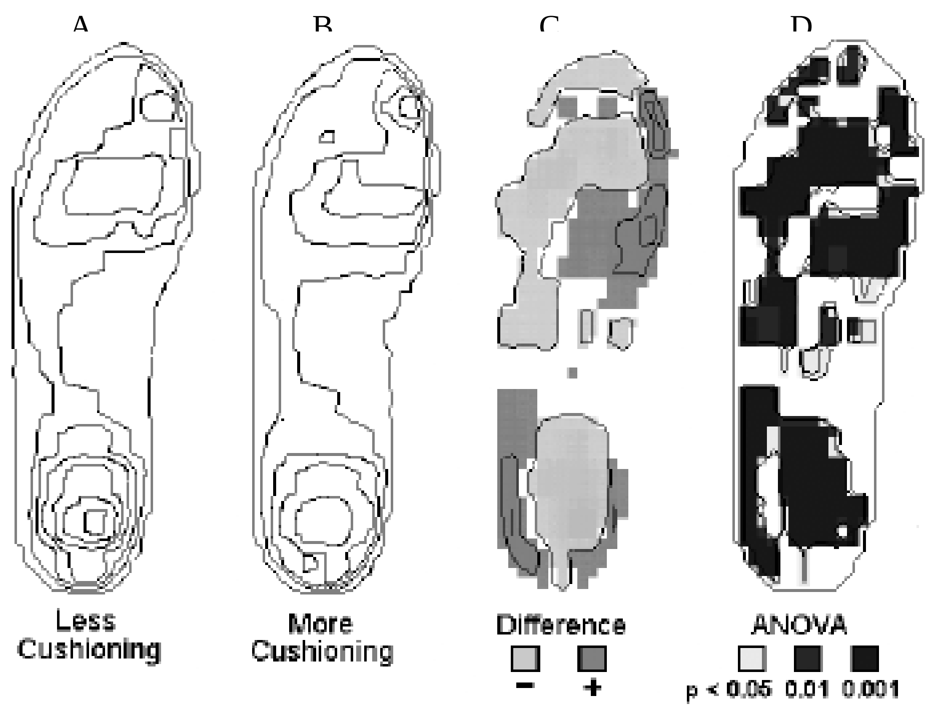

Figure 2: Effect of cushioning on in-shoe peak pressure distribution during walking
(A), (B) Mean peak pressure distributions (contour interval = 50 kPa). (C) Mean difference between speeds (contour interval = 25 kPa). (D) Analysis of variance results.