Unlocking the Multidimensionality of Plantar Pressure Measurements for the Evaluation of Footwear in People with Diabetes

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Summary

This study evaluates the multidimensionality of plantar pressure measurements to assess the offloading effectiveness of custom-made footwear in people with diabetes. Traditionally, scalar values such as maximum peak plantar pressure or pressure time integral are used, while analyzing plantar pressure data as a multidimensional parameter might enhance footwear offloading assessment. In-shoe plantar pressure data from 77 participants with diabetes was analyzed using 6 plantar pressure parameters, ranging from scalar to multidimensional. A moderate to strong correlation was found between maximum peak plantar pressure and other scalar parameters, while the correlation with multidimensional parameters ranged from weak to negligible. These findings highlight the possible benefits of incorporating multidimensional parameters in conjunction with scalars, which could enhance the evaluation of footwear offloading effectiveness.

Introduction

The offloading effectiveness of custom-made footwear for people with diabetes is assessed using plantar pressure measurements. While data from these measurements is multidimensional, it is often analyzed using a scalar - mostly maximum peak plantar pressure. Analyzing plantar pressure as a multidimensional parameter might improve offloading assessment of footwear. We aimed to investigate the associations between multiple peak plantar pressure parameters for footwear offloading assessment and determine whether this assessment depends on the chosen parameter.

Methods

In-shoe plantar pressure was measured using Pedar-X in 77 participants with diabetes, peripheral neuropathy and a recent ulcer or amputation history, while walking in their own custom-made footwear. Six peak plantar pressure parameters, both scalar (i.e. PMax, PTI and PGrad) and multidimensional (i.e. PTC, PMap and PTM), were extracted to quantify footwear offloading effectiveness (Fig.1). Footwear was ranked from highest to lowest value per parameter. The associations between all six rankings were compared using Spearman's rank correlation coefficient.

Results

The rank correlation coefficient was moderate to strong between scalar parameters (ρ=0.43–0.70), and weak to negligible between scalar and multidimensional parameters (ρ=-0.08–0.25) (Fig. 2).

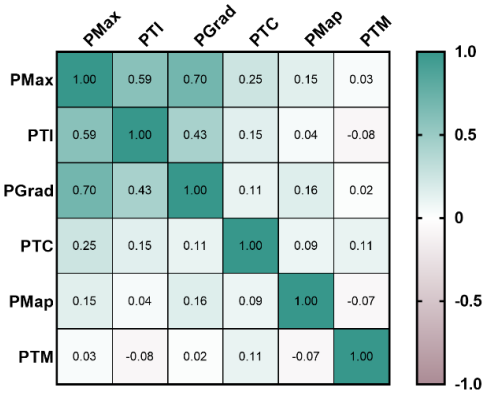

Figure 2: Matrix with correlation coefficients between each of the six parameters using Spearman's rank correlation. A perfect correlation is indicated by 1 or -1, while 0 indicates no correlation.

Conclusions

We conclude that the association between in-shoe peak pressure parameters is low. This indicates that the assessment of offloading effectiveness depends on the chosen parameter. This is the first step in unlocking the potential of a multidimensional approach in plantar pressure analysis, possibly changing how we evaluate footwear offloading effectiveness.

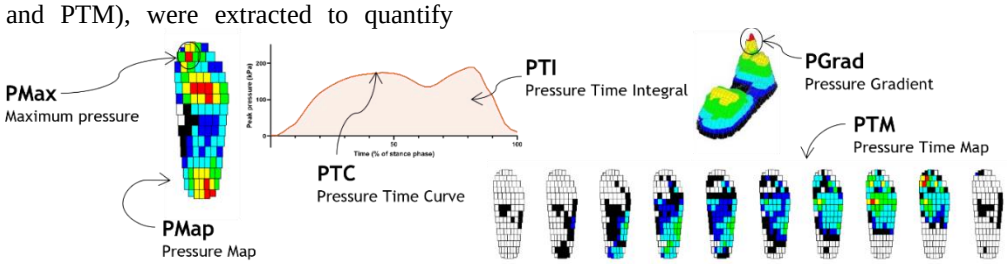

Figure 1: The six plantar pressure parameters. PMax = Maximum Peak pressure; PTI = Peak pressure Time Integral; PGrad = Maximum Gradient change surrounding PMax; PTC = Peak pressure Time Curve: maximum peak pressure for each timeframe; PMap = Peak pressure Map: maximum peak pressure for each sensor; PTM = Peak pressure Time Map: maximum peak pressure for each sensor and each timeframe.