Comparison of two different pressure distribution insole systems

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INTRODUCTION

When performing a study with pressure distribution insoles own measured data are often compared with those published in literature even if different measuring systems are used. Sometimes the literature provide some reference data [1] or norm values which are then used to classify the own data. This study deals with difficulties, which may occur when comparing data from different pressure distribution insole systems.

METHODS

Two different well-established insole systems (S1, S2) were compared during different movements of daily activity for a certain number n of subjects: (i) counter movement jump (CMJ) on a force platform FP (Type: 9287C, Kistler, Switzerland, n=50), (ii) walking (n=15), and (iii) descending stairs (n=11). Directly before data acquisition both insoles system were calibrated. Each subject performed six CMJ with each insole system on the force platform so that force and pressure data could be c synchronously. 27±1 steps were performed during treadmill walking at 4.0±0.1 km/h. Descending velocity of the stairs was 85 steps/min and the middle five steps were analyzed. Measuring frequency of the FP was 1000Hz and that of both insole system was 200Hz. For the CMJ trials the jump height h was calculated by the flight time t for both force platform and S1, S2 with

$$h = \frac{gt^2}{8}$$

For each of the foot regions forefoot (fore_f), midfoot (mid_f), and rearfoot (rear_f) of the right foot. two parameters are extracted from the pressure data: (i) p_max, defined by the maximum pressure value occurring during the movement, and (ii) p_ave, here for every time step the values of all sensors within the corresponding region are averaged. p_ave is then defined by the maximum of these mean values during the movement.

Because of partly missing normal distribution, Wilcoxon test was used to check for significant differences ($p<.05$).

RESULTS AND DISCUSSION

Jump height differs significantly between the three measuring systems (Table 1), but these differences are small and therefore not relevant in daily practice. S1 provide significantly lower values for both p_max and p_ave compared to S2, except p_ave during walking. For S1 both p_max and p_ave are significantly lower at the mid_f compared to fore_f and rear_f, whereby the differences between the last mentioned regions are less than 3 N/cm². This effect can also be observed for S2 with respect to p_ave whereas p_max at rear_f is significantly lower compared to fore_f. Thus, during walking S1 and S2 do not differ only with respect to absolute values but also in the load ratio between fore_f and rear_f. For both insole systems, the analyzed pressure values are similar or smaller for descending stairs compared to walking at 4 km/h. The relative differences of p_max between S1 and S2 are larger for descending the stairs compared to walking. For S2 both p_max and p_ave reveal their maximum at fore_f and the minimum at rear_f. This tendency cannot be observed for p_max in S1. So also for descending stairs, the insole systems show different characteristics when comparing mid_f to rear_f.

CONCLUSIONS

The number of measurements executed after the latest calibration might affect the measurement outcome of pressure distribution insoles, so that both systems were calibrated directly before the measurements. However, the partial large differences in the analyzed parameters indicate that researchers must be very careful when comparing own pressure distribution insole data with those in the literature, especially when different insole systems are used. The differences depend not only on different sensors used in different systems but also on varying spatial resolutions. Our results show that especially comparing maximum pressure values seems to be critical. When comparing parameters averaged over several sensors as it was performed in this study by p_ave, the absolute differences between the systems still remain. However, at least the general load characteristics seems to be better comparable. Finally, both analyzed insole systems seems to calculate accurately the height during jumping performances so that the use of a force platform is not compulsory for this purpose.

On the congress several additional parameters are presented to compare both insole systems.

REFERENCES

1. Cavanagh, PR et al., *J Vasc Surg.* **52**:37-43, 2010

Table 1: Analyzed jump heights and pressure values (mean ± SD).
S1 - insole system 1, S2 - insole system 2, FP - force plate, p_max - maximum pressure, p_ave - average pressure, fore_f - forefoot, mid_f – midfoot, rear_f: rearfoot
#: sig. difference between S1 und S2, §: sig. difference between S1 und FP, &: sig. difference between S2 und FP
$: sig. difference between S1 and S2 for all pressure parameters except p_ave in the region mid_f during walking.

system	jump height / cm	Insole pressure during walking at 4km/h, $						Insole pressure during descending stairs, $					
		p_max / N/cm²			*p_ave / N/cm²*			*p_max / N/cm²*			*p_ave / N/cm²*		
		fore_f	mid_f	rear_f	fore_f	mid_f	rear_f	fore_f	mid_f	rear_f	fore_f	mid_f	rear_f
S1	23±5,#,§	22±5	10±4	20±8	7±1	4±1	6±2	14±4	7±1	8±3	5±2	3±1	3±1
S2	21±5,#,&	52±15	21±10	35±14	11±2	4±2	11±2	48±18	20±9	17±5	8±1	6±2	4±1
FP	22±5,§,&												