CLASSIFICATION OF FOREFOOT PLANTAR PRESSURE DISTRIBUTION IN PATIENTS WITH DIABETES: A NOVEL PERSPECTIVE FOR THE MANAGEMENT OF THE DIABETIC FOOT

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INTRODUCTION and AIM

Gait conditions, associated to Diabetes Mellitus (DM), are most frequently assessed with plantar pressure measurement (PPM) equipment because elevated pressures are considered as a major risk factor of ulceration [1,2]. The aim of this study was to identify groups with similar forefoot loading patterns and to verify if specific groups of diabetic patients (PwDM) could be isolated from non-diabetic persons (Ctrl).

PATIENTS/MATERIALS and METHODS

97 PwDM and 33 non-diabetics (age 45-70 years, BMI 20-40, oedema score<2, no active foot ulcer or amputation, no history of orthopaedic lower limb surgery or no Charcot neuroarthropathy) were included. Barefoot PPM were measured with aFootscan® pressure plate (2.8 sensors/cm², 200Hz), embedded in a 10m walkway. Five bilateral dynamic footprints were recorded at self-selected speed. Subsequently, a semi-automatic total mapping technique was applied identifying 10 regions of interest (ROI): hallux (T1), toes 2 to 5 (T2-5), metatarsal heads 1 to 5 (M1-5), midfoot (MF), medial (HM) and lateral heel (HL). Force-time integral and peak force were extracted for all ROI, except for MF and T2-5. Relative regional impulses (RrI) were calculated considering the remaining 8 ROI. Kmeans cluster analysis was applied on RrI of 6 forefoot segments (M1-5 and T1) to pursue a classification for the PwDM group, the Ctrl group and both groups together. Benchmarking for optimal number of classes was based on silhouette coefficient.

RESULTS

Cluster analysis led to identification of 3 distinct groups when considering only the Ctrl group. For the PwDMgroup, and the computation considering both groups together, 4 distinct groups were isolated (Fig.1). Cluster 4 consisted of feet of PwDM only, with a specific plantar pressure distribution pattern. The relevance of the reported clusters was supported by ANOVA statistics indicating significant differences between different ROI and different clusters (Table 1). Furthermore, the results showed good face validity with the history of ulceration.

Table 1: Significant differences of total regional impulse between the 4 clusters for the 8 regions of interest (ROI).

ROI (%)	Medial M1 pattern Cluster 1		Central Pattern Cluster 2		T1-M1 pattern Cluster 3		Lateral M4-M5 pattern Cluster 4		p-values
	PwDM	Ctrl	PwDM	Ctrl	PwDM	Ctrl	PwDM	Ctrl	
N of feet	41	8	99	41	24	17	30	0	
HL	14.3 (4.1)*[2,4]		11.8 (3.7) *[1]		13.2 (3.0)		11.5 (4.3) *[1]		< 0.001
HM	15.9 (5.0) *[2,4]		13.8 (3.5) *[1]		14.8 (3.1) *[4]		12.3 (4.5) *[1,3]		< 0.001
T1	5.7 (4.3) *[3]		6.3 (4.2) *[3,4]		19.6 (4.5) *[1,2,4]		3.8 (4.4) *[2,3]		< 0.001
M1	24.4 (6.6) *[2,3,4]		10.4 (3.7) *[1,3]		12.9 (4.4) *[1,2]		11.1 (5.9) *[1]		< 0.001
M2	13.9 (4.9) *[2,4]		18.6 (4.5) *[1,3,4]		12.5 (3.8) *[2]		10.2 (4.5) *[1,2]		< 0.001
M3	11.5 (3.7) *[2]		17.5 (3.0) *[1,3,4]		11.8 (2.5) *[2]		11.9 (5.8) *[2]		< 0.001
M4	7.8 (2.9) *[2,4]		12.3 (3.4) *[1,3,4]		8.9 (3.1) *[2,4]		15.7 (12.8) *[1,2,3]		< 0.001
M5	6.5 (4.1) *[2,4]		9.2 (3.7) *[1,3,4]		6.4 (3.5) *[2,4]		23.5 (7.6) *[1,2,3]		< 0.001

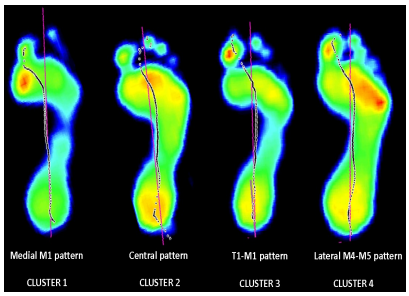

Fig.1: Forefoot loading pattern clustering

DISCUSSION and CONCLUSIONS

A new era seems to emerge in diabetic foot medicine which encompasses the classification of patients with DM according to their biomechanical profile. Classification of the plantar pressure distribution might serve as an effective tool in determining the most optimal offloading or redistribution strategy.

REFERENCES

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