A FOOTTYPE CLASSIFICATION WITH CLUSTER ANALYSIS ON PLANTAR PRESSURE DISTRIBUTION DURING BAREFOOT JOGGING

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INTRODUCTION

The foot provides stabilisation, shock absorption, balance and propulsion during stance phase, but how these functions are realised is still not fully understood[1]. Plantar pressure measurements have the potential to unravel the relations between foot structure and foot function. It is a common belief that different functional foot types exist, but a classification into functional foot types is mostly based on morphological characteristics, measured in a static position [2,3]. Dynamical measurements, linked to the functional behaviour of the foot, may provide a better basis for a classification system. The aim of the present study was to develop a foot type classification based upon dynamical plantar pressure measurements.

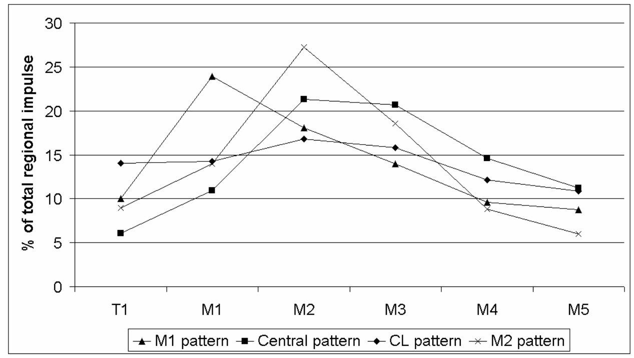

Figure 1: Relative regional impulses for the four loading patterns.

METHODS

Plantar pressure data were collected from 215 healthy subjects (age: 18.3 ± 1 years; 129 men and 86 women) . A footscan pressure plate (RsScan Int. , 2m x 0.4m x 0.02m, 10sensors/ 4cm², dynamic calibration with AMTI force plate) was mounted in the middle of a 16.5m long running track. The subjects ran at a speed of 3.3m/s (± 0.17m/s). Three stance phases were measured for each side. For each trial, eight important anatomical areas (medial en lateral heel, metatarsal I-V and the hallux) were identified on the footprint. For each area descriptive statistics (mean, SD) were calculated for relative regional impulses (% of summed impulses of all subareas, RI_R). To classify into foot types, a K-means clustering analysis was used, based on the relative regional impulses of the forefoot. A multivariate ANOVA with post-hoc Tukey test was used to study differences between the four clusters.

RESULTS AND DISCUSSION

With the K-means cluster analysis, four clusters of pressure patterns were identified (figure 1): (a) Medial M_2 pattern with large pressure loading underneath M_2 (b) Central-lateral pattern with a more overall scattered pressure loading, (c) Central pattern with larger pressure loading underneath M_3 and M_2 and (d) Medial M_1 pattern with a large pressure loading underneath M1. Significant differences were found between the four clusters for peak pressures, regional impulses, relative regional impulses and some timing factors. In three of the four patterns and certainly in the M_2 pattern, M_2 sustains high impulses, since specific characteristics of this metatarsal make it a cantilever during push off. The forefoot contact phase (when meta's make contact) for the M_1 pattern is significant shorter in duration compared to other foot types, which could indicate a fast initial plantar flexion and initial eversion. [4] The high pressure loading on the first metatarsal might also arise from a rigid first ray, which then sustain allmost all pressure loading during push off.

The pressure load patterns found in the present study are very similar to the pressure patterns found by Hughes et al (1993) [5], which were based on peak plantar pressure underneath the forefoot of 100 adults in a walking condition. Although peak pressures and pressure-time integrals are higher in running, the distribution of the pressure over the foot is comparable to that of walking. This could indicate that in both locomotion forms, similar loading mechanisms exist.

CONCLUSIONS

An interpretation of foot types was suggested by classifying four foot types on differences in dynamical plantar pressure distribution. Further research combining plantar pressure data with morphological measurements and 3D kinematic data is expected to get a better insight in the functional behaviour of the different foot types.

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