Foot segments mobility and plantar pressure in
the normal foot

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Background
The foot is generally regarded as a flexible structure which can adjust its flexibility in response to variable
dynamic conditions in different phases within different
motor tasks. In gait, both kinematics and baropodometry
have shown to be affected by functional and structural
factors [1]. In fact pressure distribution can be seen as
the effectiveness of the musculoskeletal system in absorb-
ing the ground reaction forces via the foot and its joints.
Excessive foot pressure may develop into calluses, which
become sites of peak pressure and pain. The relationship
between foot joints mobility and plantar pressure has not
been thoroughly investigated. Aim of this study was to
combine a multi-segment kinematics model [2] and baro-
podometric analysis based on anatomical masking [3],
to investigate correlations between intersegmental kine-
matics and regional baropodometric parameters in the
normal foot.

Materials and methods
Ten able-bodied subjects (26.8 ± 6.9 years; 67.5 ± 12.6 Kg)
voltuneered in the study. An eight-camera motion system
(Vicon, UK) was used to track foot segments during the
stance phase of level walking, according to an established
protocol (Figure 1, top) [2]. Simultaneously, a pressure
plate (Novel, Gmbh) recorded foot plantar pressure over
three repetitions. An anatomical-based selection of areas
of interest was employed to divide the pressure footprints
in seven subareas (Figure 1, bottom) [3]. Maximum of
mean and peak pressure, of vertical force, contact-area
and -time, and pressure- / force-time integrals, were deter-
mained for each subarea. The relationship between range of
motion (ROM) of each foot joint and baropodometric
parameters in each subarea was investigated using Pear-
son’s and Spearman’s coefficients.

Results
Most of the statistically significant correlations (p<0.05)
between foot joints ROM and baropodometric para-
eters were moderate (|R| =0.36 – 0.67). In general,
mean and peak pressure at rearfoot and forefoot were
negatively correlated with the amount of motion at the

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ankle and tarso-metatarsal joints (Figure 2). In contrast, pressure at the hallux and midfoot were positively correlated with the ROM of the joints across the midfoot. Strong correlation was found between ROM of the medial longitudinal arch angle (J7) and pressure-time-integral at the forefoot (Spearman Rho = - 0.93, p<0.05).

Conclusions
According to the sample of normal feet analyzed in this study, those feet presenting smaller joint mobility are associated with larger pressure at the rear- and forefoot. A trend for decreased pressure at the midfoot and toes was also detected in feet with a stiffer medial longitudinal arch.

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