

EVALUATION OF THE MEDIO-LATERAL PLANTAR PRESSURE DISTRIBUTION IN BAREFOOT JOGGING AS A RISK FACTOR FOR EXERCISE RELATED LOWER LEG PAIN

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INTRODUCTION

When studying the aetiology of sports and running related overuse injuries, a broad spectrum of possible risk factors are present. Exercise related lower leg pain (ERLLP) includes shin splints, shin pain, medial tibial stress syndrome, periostitis, compartment syndrome and stress fractures. This overuse problem is common for runners, track athletes and athletes participating in jumping sports. Previous retrospective studies (1) about ERLLP showed an excessive dynamic foot pronation and a more pronated foot alignment for subjects with ERLLP. The recent prospective study of Willems et al (2) identified the following risk factors derived from gait analysis in barefoot jogging: a greater maximal subtalar eversion position, more eversion excursion, an increased mean eversion velocity and increased maximal eversion velocity. In the latter prospective study, also plantar pressure characteristics were studied for both groups and the results indicated an increased loading underneath the medial side of the foot during foot flat phase. The purpose of the study was to elaborate further the medio-lateral pressure distribution underneath specific areas of the foot sole during the stance phase, with focus on the foot flat phase.

METHODS

In the light of a prospective study (2), a group of 220 physical education students performed an extensive gait analysis before they started their study program. These students were followed during 2 years (90 freshman in 2001-2002) or 1 year (130 freshman in 2002-2003). During this period 118 students remained uninjured and could function as control group. Another group of 19 students had complains of ERLLP, 6 of them unilateral and 13 bilateral.

A footscan pressure plate (RsScan Int. , 480Hz, 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 (\pm 0.17m/s). Three left and three right stance phases were measured. For each trial, eight important anatomical areas (medial en lateral heel, metatarsal I-V and the hallux) were identified on the footprint.

236 uninjured legs were compared with 32 injured legs for the medio-lateral component of the center of pressure, scaled to foot width (COPx) and for medio-lateral pressure ratios, one containing pressure areas of the whole foot sole (foot ratio = $[(HM+M1+M2)-(HL+M4+M5)]$) (2) and a forefoot ratio, based on the pressure underneath the metatarsal regions (FFR= $[(M1+M2)-(M3+M4+M5)]$). The evolution to these ratios during stance phase were calculated for the two groups. A multivariate test (MANOVA) was used to analyse the difference between the curves of the uninjured and injured populations for the studied variables.

RESULTS AND DISCUSSION

Figure 1 shows the curves for the COPx, foot ratio and forefoot ratio for subjects with ERLLP and the control group. During the foot flat phase, from forefoot flat (FFF) until heel off (HO) (3), the COPx graph is more medial located for the ERLLP group, but this medial trend was not found to be

significant. As during foot flat phase, the plantar pressure moves fast from heel toward forefoot, the COP – including the pressure over the whole foot sole – may not be the most sensitive measure to identify increased medial loading in the foot flat phase. The curves of the foot ratio indeed indicated a more medial shift of pressure distribution with significant differences (level .05) between the two groups for each time point (every 2% of stance phase) within the foot flat phase (from 20% until 45%). The

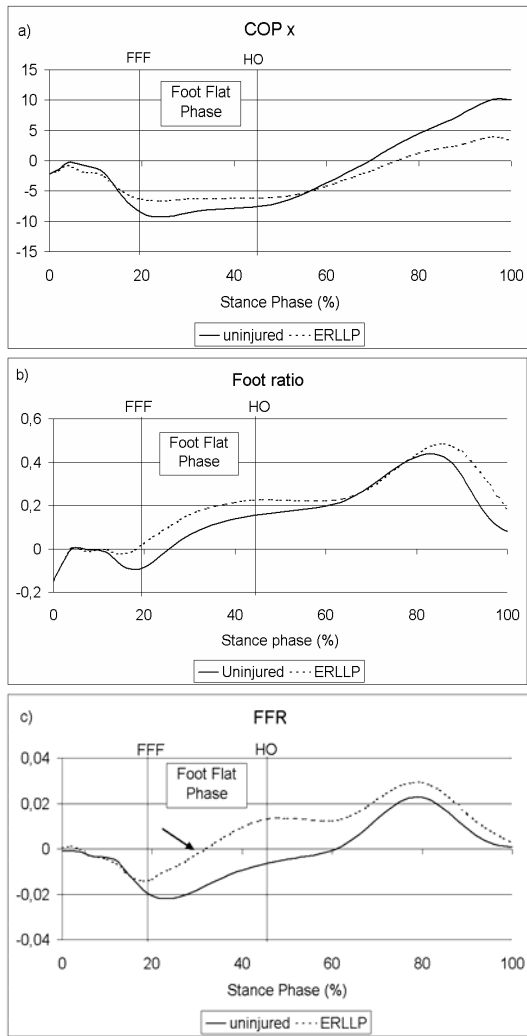


Figure 1 : Evolution during stance phase of the (a) medio-lateral component of the center of pressure (COPx), (b) foot ratio and (c) forefoot ratio for subjects with ERLLP and a control group. Forefoot flat (FFF) and Heel Off (HO) are indicated onto the timing axis. Positive values on the Y-axis agree with medial location, negative values with lateral location.

forefoot ratio even makes the difference between the two groups more clear and was found to be significant different between 22 and 56% of stance phase with level of significance of .05 and between 30 and 44% of stance phase with level of significance of .01. Not only the difference between the two groups became clear in the FFR graph, the curve of the ERLLP showed a fast medial shift of pressure distribution (see arrow in figure 1c) which could relate with the increased eversion velocity found by Willems et al (2). Moreover the fast medial shift ends up in sort of a platform, what could indicate a prolonged pronation (4). However, after 70% of stance phase, one might be careful with the interpretation of the curves, since then some metatarsals lose contact with the ground, emphasising the role of the hallux during push off, distorting the meaning of the actual FFR curve. This explains the difference in the last third of the COPx graph and in the two graphs of the ratios.

CONCLUSION

Beside alignment and kinematic data, plantar pressure provides interesting insights in gait related risk factors of overuse injuries. Moreover, ratios with specific pressure areas in their calculations, may provide more detailed information over which part of the foot is involved in some gait related risk factors.

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