PLANTAR PRESSURE DISTRIBUTION DURING THE MENSTRUAL CYCLE OF YOUNG WOMEN

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INTRODUCTION

In general, women in sports are more prone to hip and knee related injuries than men (Ireland and Hutchinson, 1995; Hewett, 2000). Some studies identified different motion patterns as well as balance and walking strategies between genders (Malinzak et al. 2001; Decker, 2003; Hurd et al. 2004). Hennig and Milani (1993) found a relationship between body weight and the peak pressures under the longitudinal arch of women's feet during walking. Looking at differences between male and female runners a similar trend was found. Midfoot loading and the amount of rearfoot pronation were increased for the women (Hennig, 2001). Although females demonstrated a greater ligament laxity than males, there were no significant differences in ligament strength during the menstrual cycle phases (Pollard et al., 2002a & Pollard et al., 2002b). Contrary to these findings Yack et al. (2002) showed an apparent influence of the phase in the menstrual cycle and performance on a stepping activity. Looking at the relationship of sex hormones and ligament laxity during the menstrual cycle Schultz, et. al. (2004) found that estradiol, progesterone and testosterone each contribute to knee laxity across the cycle. However, this relationship is quite variable between subjects. Clearly, there is a necessity to look at normative biomechanical data during the menstrual cycle as well as to control if different hormonal levels influence static and dynamic movement conditions. These should be of interest to identify risk factors, prevent injuries occurrence and establish a specific training orientation for women. The main goal of this study was to collect static and dynamic biomechanical data during the menstrual cycle of healthy women. Secondly differences for the measured parameters between the different phases of the menstrual cycle should be investigated.

METHODS

Forty-Eight Subjects (16 women not taking hormonal and 32 taking hormonal contraceptive) with a mean age of 23 ($\pm$ 2.27) years with no musculoskeletal injuries during the last 6 months consented to participate in this study. Anthropometrical, functional (ROM during passive plantar flexion with increasing load) and plantar pressure distribution data were collected two times during the menstrual cycle (1^{st} to 3^{rd} day of menses and ovulation or middle of the cycle). The order of data collection was randomized. Plantar pressure distribution data were colleted with an Emed SF System (resolution of 4 sensors/cm^2) during static (half-body weight and full-body weight standing on the right leg during 10 seconds) and gait (five trials using the second step method). All tasks were also performed with an additional load of 25 % of the subject's body weight. The plantar surface of the foot was divided into 10 regions using the PRC mask. Both, data collection phase during the menstrual cycle and body weight and additional load conditions were randomized for all subjects. Menstrual cycle phase variable differences were determined with paired *t-tests*.

RESULTS

Looking at foot anthropometry and ROM during plantar flexion no significant differences were found during the menstrual cycle. Although there was no difference found between the contact area comparing both phases of the menstrual cycle for the static conditions with body weight, the total contact area of the foot increased during the middle phase of the cycle for the dynamic walking trials. Peak pressure values (kPa) increased for the heel areas during half body weight and whole body weight tasks. The relative load (%) analysis revealed that there was a load increase during the middle of the

menstrual cycle, especially at the full body static condition (Figure 1a and 1b).

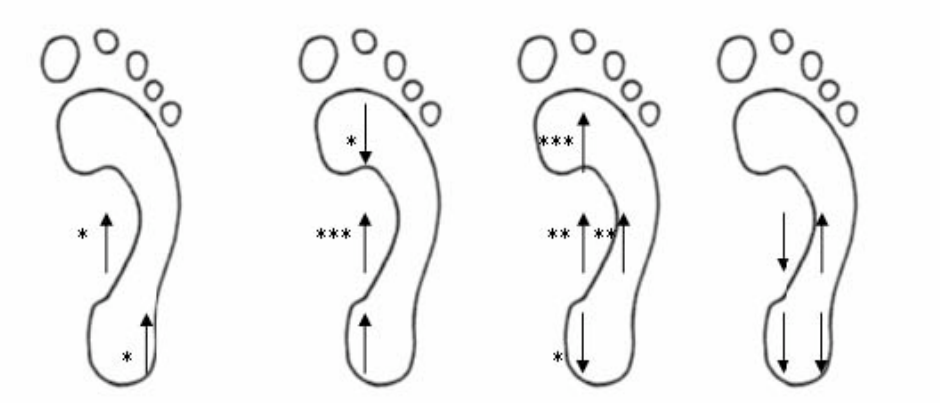

FIGURE 1: Relative Load (%) during a) half body weight and b) during full body weight standing. Pressure difference during standing with and without additional weight (kPa) with c) half body weight and d) full body weight. *p≤0,05 **p≤0,01 ***p≤0,001
↓decrease during ovulation and middle of the cycle
↑increase during ovulation and middle of the cycle

Significantly increased plantar loads under the medial midfoot region were present in most static experimental conditions (Figure 1a, 1b, 1c). These results suggest that plantar pressure parameters during static conditions are influenced by the different phases during the menstrual cycle. The increased loads under the medial midfoot during the middle of the menstrual cycle suggest that through hormonal influences the laxity of the ligaments increases. This is represented by a lowered longitudinal foot arch with higher medial midfoot pressures.

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