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The effect of a maternity support belt on static stability and posture in pregnant and non-pregnant women

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Purpose: Physical and hormonal changes during pregnancy are thought to affect balance and injury risk, with increased numbers of falls being reported. A maternity support belt (MSB) has been suggested to stabilize the pelvis and to enhance balance. The purpose of this study was therefore to investigate the effect of an MSB on postural stability in different trimesters of pregnancy.
Methods: Postural stability was assessed in the first (T1, n = 30), second (T2, n = 30) and third trimester (T3, n = 30) of pregnancy and compared to non-pregnant controls (n = 30), using a portable force plate. Postural sway during quiescent standing with and without applying an MSB was characterized by analyzing path length, velocity, amplitudes and area. Subsequently, anterior and posterior limits of stability (LoS) were determined.
Results: Postural sway during quiescent standing did not change with pregnancy. However, LoS performance was reduced already in T1, before body mass significantly increased. The MSB led to a small improvement in the LoS while slightly increasing postural sway in anterior-posterior direction and shifting the center of pressure posteriorly during quiescent standing.
Conclusion: While impairments in balance already occurred early in pregnancy before body mass significantly increased, they were subtle and only measurable in exacerbated conditions. This challenges the assumed necessity of balance enhancing interventions in pregnant women. Although the MSB significantly affected body posture, the magnitude of the LoS improvement using the MSB was very small. Thus, it remains debatable if the MSB is a meaningful tool to increase balance during pregnancy.

1. Introduction

Physical activity has been shown to significantly reduce the risk of pregnancy associated diseases e.g. high blood pressure, gestational diabetes and back pain (Nascimento et al., 2012; Ritchie, 2003), which is why current guidelines recommend moderate physical activity during pregnancy (Evenson et al., 2014). However, increased exercise and daily physical activity such as cycling to work or walking may increase the risk of falls (Vladutiu et al., 2010). It has been described that 27% of 2847 investigated pregnant women have fallen during pregnancy (Dunning et al., 2003). Also, 64% of 44 falls in pregnant women have led to injuries (Vladutiu et al., 2010).

Some of the physical and hormonal changes during pregnancy which affect the properties of the musculoskeletal system are also likely to influence the injury risk. The location of the center of mass (CoM) shifts in the posterior direction (Opala-Berdzik et al., 2010) and the gait pattern changes displayed by a decreased step width and an increased double support phase (Bertuit et al., 2015), which are known strategies to maintain balance. The spinal posture adapts leading to an increased thoracic kyphosis or lumbar lordosis (Betsch et al., 2015; Michonski et al., 2016). Furthermore, postural stability has been observed to change during pregnancy, with an increased postural sway in the anterior and posterior direction (Jang et al., 2008; Oliveira et al., 2009) and a decline of dynamic stability particularly in the advanced stages of pregnancy (Inanir et al., 2014) being reported.

Hormonal changes such as an increased level of relaxin have been shown to increase the laxity of ligaments in the pubic area (Ritchie, 2003). This contributes to the widening of the symphysis during childbirth (Ritchie, 2003; Vollestad et al., 2012). However, pelvic joint laxity is at the same time discussed to decrease the stability of the pelvis and to negatively influence postural stability.

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A maternity support belt (MSB), which is similar to a flexible elastic kidney belt, has been shown to reduce pelvic mobility in pregnant women with pelvic girdle pain (Mens et al., 2006). Although the underlying mechanism is not yet sufficiently understood, it is believed that an MSB or another type of flexible belt induces a lateral compression on the articular surfaces of the sacroiliac joint (Mens et al., 2006), leading to a measureable reduction in the sagittal rotation (Sichting et al., 2014; Vleeming et al., 1992). Since the MSB may reduce mobility in the sacroiliac joint, it is also suggested to have a beneficial effect on postural stability. As yet, only one study has investigated the effect of an MSB on postural stability in pregnant women (Cakmak et al., 2014). This study did indeed detect a positive effect of the MSB on balance performance using the Biodex Balance System. Our study aims to confirm their results, while applying more commonly used balance tests such as postural sway and limits of stability which allow the comparison with other studies on balance in pregnant women. In addition, we include a control group, to allow a more comprehensive interpretation of the results and randomize the test order to exclude sequence effects.

The aim of the present study is therefore to assess the effect of an MSB on postural stability in pregnant and non-pregnant women by investigating postural sway and limits of stability. We hypothesize that postural stability in pregnant women can be improved using an MSB.

2. Methods

2.1. Participants

For the study 90 healthy pregnant (30 ± 4 years) and 30 healthy non-pregnant women (28 ± 6 years) were recruited. The pregnant women were allocated to groups by trimesters according to their week of pregnancy (WoP) (T1: 1–13 WoP, T2: 14–26 WoP, T3: 27–40 WoP) (Gätje et al., 2015). Each group included 30 women and the mean WoP were 12 ± 2 WoP for T1, 22 ± 3 WoP for T2 and 32 ± 4 WoP for T3. Women with a multiple pregnancy, pregnancy associated symptoms such as gestational diabetes and present or past disorders potentially influencing postural stability were excluded from the study.

The study had local ethics committee approval (Charité Universitaetsmedizin Berlin), and appropriate informed consent was obtained.

2.2. Study design

Postural stability was assessed in a static condition. The participants stood barefoot in a neutral position with a straight body posture and adjacent arms on a portable force plate (Type 9260AA6, 60 × 50 cm, Kistler, Switzerland). The feet were positioned straight at a predetermined line marked on the force plate and were kept parallel and hip-width apart. The stability test started in a rest position, standing as motionless as possible. After 10 s the participants were instructed to lean in the anterior or posterior direction, moving their CoM safely within the maximum range, without changing their base of support. The maximum range had to be achieved within the next 10 s. Before the first measurement, the participants performed practice trials to ensure that the procedure of the test was sufficiently understood. Subsequently, the stability test was conducted twice with and without using an MSB in a random order. The MSB (Givereldi) is similar to a flexible, elastic kidney belt, which is made out of an elastic cotton fabric (Flack et al., 2015). Three different sizes of MSB, small, medium or large, were used. The belt was placed on the lower lumbar region and between the pubis and the umbilicus (Cakmak et al., 2014). The participants were instructed to fasten the MSB closely, while feeling comfortable. The correct fit was regulated by hook- and loop-fasteners.

The data were acquired with the software BioWare 5.3.0.7 using a sampling rate of 200 Hz. The data were filtered using a 10th order digital low pass Butterworth filter at a 7 Hz cut-off frequency (Jang et al., 2008; Opala-Berdzik et al., 2014, Opala-Berdzik et al., 2015) and analyzed with MATLAB (R2012a, 64 Bit, The Mathworks, Natick, USA).

2.3. Postural sway

Postural sway was analyzed for the first 7.5 s standing in the rest position. The sway magnitude was determined by the total path length, the overall sway velocity, the sway amplitudes in anterior-posterior (A-P) and medio-lateral (M-L) direction and by the sway area calculating the 95% confidence ellipse (Duarte and Freitas, 2010).

2.4. Location of the center of mass

The location of the CoM during the rest position was estimated by the mean position of the Center of Pressure (CoP) in the anterior-posterior direction. A CoP of 0% foot length is located at the toes, 100% of the foot length equates to the calcaneus.

2.5. Limits of stability

The limits of stability (LoS) were assessed during leaning in the anterior and posterior direction. The approach of the CoP to the LoS was defined as the minimum distance (in cm and % foot length) between the maximum achieved range and the predetermined marking on the force plate representing the end of the base of support, which was the longest toe in the anterior direction and the calcaneus in the posterior direction (Catala et al., 2015; Qutubuddin et al., 2007). A smaller LoS indicates a better postural stability.

2.6. Statistical analysis

Statistical testing was performed using IBM SPSS Statistics (Version 21, 32 Bit, IBM, USA). The average of two trials was calculated for each parameter. To assess the effect of the WoP on postural stability, a linear regression analysis was conducted with and without application of the MSB, respectively. To detect differences in the characteristics between the regression lines the intersections of the 95% confidence intervals of the coefficients and the constants were analyzed. Anthropometric differences between the groups (Controls, T1, T2, T3) were investigated using a one-way ANOVA and the Bonferroni post hoc test. Statistical analysis of the postural stability parameters was conducted using a two-way repeated measures ANOVA and the Bonferroni post hoc test, comparing the trimesters of pregnancy to the non-pregnant women with and without using the MSB. The effect size of the MSB was calculated using η^2. The alpha level was set at $\alpha = 0.05$.

3. Results

3.1. Body mass

Body mass and body mass index (BMI) in T2 (mass: $p = 0.008$, BMI: $p = 0.026$) and T3 (mass: $p < 0.001$, BMI: $p < 0.001$) were significantly higher compared to the controls, and in T3 (mass: $p = 0.006$, BMI: $p = 0.008$) significantly higher compared to T1 (Table 1).

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