INTRODUCTION

More than 27% of women fall while pregnant [1, 2]. Falls are a leading cause of trauma-related hospital admissions during pregnancy [3]. Changes in gait during pregnancy have been hypothesized to be a reason for increased falls. Several authors have examined pregnancy-related alterations to gait mechanics, such as increased anterior pelvic tilt, hip flexion, and stance phase hip adduction, as well as a wider base of support [4]. We previously reported increased thoracic extension and greater frontal plane movement of C7 during gait and increased movement of the center of mass in the third trimester [5, 6]. Also, Wu et al. reported a reduction in thoracic and pelvic rotational ROMs in late-stage pregnancy [7].

Little research has examined biomechanical differences between pregnant women who fall and those who do not. Pregnant fallers exhibit an attenuated response to a perturbation to standing balance, while pregnant non-fallers respond similarly to non-pregnant women [8]. However, torso kinematics between pregnant fallers and non-fallers have not been examined. The purpose of this study was to determine if pregnant fallers exhibit different torso kinematics and step width during gait than pregnant non-fallers and non-pregnant control women. Given that we have previously found increased movement of C7 with advanced pregnancy [5], we hypothesized that pregnant fallers would demonstrate increased mediolateral motion of the C7 and L3L4 spinal segments, greater angular ranges of motion of the thorax and pelvis and a smaller step width.

METHODS

Forty one pregnant women (age: 29.5±4.9 yrs, hgt: 1.7±0.7 m, 2nd tri. mass: 74.7±12.1 kg, 3rd tri. mass: 81.6±11.0 kg) and 40 non-pregnant controls (age: 26.5±6.4 yrs, hgt: 1.7±0.6 m, mass: 66.0±8.9 kg) participated. Data were collected on the pregnant women in the middle of their 2nd and 3rd trimesters and on the control women in the week following menses.

Informed consent was obtained during the subjects’ first visit. At each visit, pregnant subjects were surveyed about their history of falls while pregnant. A fall was defined as a loss of balance such that another part of the body other than a foot touched the ground. Fifteen pregnant subjects were classified as ‘fallers’ by having at least one fall and 14 as ‘non-fallers’. Twelve pregnant subjects withdrew from the study prior to their 3rd trimester visit. Their data are not included in this analysis.

Kinematic data were recorded with an 8 camera movement analysis system (120 Hz). A modified Helen Hayes marker set was used. Specifically, to examine torso kinematics, markers were placed on the posterior aspects of C7 and the L3L4 spinal segments. Additionally, markers were placed on the acromion processes, manubrium, xiphoid process, T10, and bilateral ASIS and PSIS landmarks. Markers placed on the most posterior aspect of the heel were used to assess step width.

Right foot heel contact (RHC) and left foot toe off (LTO) were determined from force plate data (1080 Hz). The 3D angles of the thorax (i.e. upper torso) and pelvis were determined at RHC. The frontal plane movement of the C7 and L3L4 markers and the ranges of motion of the thorax and pelvis during gait were determined between RHC and LTO.
width was calculated as the distance between the heel markers in the lab-referenced frontal plane. Average walking velocity was calculated from the L3L4 marker.

Variables were organized into three categories for statistical analysis: linear ROM variables, angular position at heel-contact variables, and angular ROM variables. The linear ROM variables consisted of the frontal plane movement of C7 and L3L4 and step width. The angular position at heel contact variables included the angle of the thorax and pelvis about the local X-axis (flexion/extension), Y-axis (lateral lean), and Z-axis (rotation). Similarly, the angular ROM variables included the 3D ROMs of the thorax and pelvis from RHC to LTO.

A multivariate analysis of covariance (MANCOVA) was performed on each category of data (α=0.05). The independent variables were trimester and fall group (i.e. pregnant faller, pregnant non-faller, and non-pregnant control). Walking velocity was the covariate in each analysis. If significant differences were found among fall groups, a Tukey post-hoc analysis was performed (α=0.05). The effect of “trimester” has been reported elsewhere [5].

RESULTS AND DISCUSSION

Pregnant fallers exhibited less thoracic lateral lean at RHC when compared to the pregnant non-fallers and controls (pregnant fallers: 0.1±2.3°, pregnant non-fallers: 1.6±2.7°, controls: 1.1±2.6°, p=0.001). Pregnant fallers also demonstrated less thoracic rotational ROM (p=0.036) during the gait cycle when compared to the pregnant non-fallers (pregnant fallers: 7.0±2.4°; pregnant non-fallers: 7.8±2.9°), although neither group was significantly different from the controls (7.5±2.4°).

Pregnant non-fallers demonstrated greater values on several variables than pregnant fallers and controls. Step width was greatest in the pregnant non-fallers (9.9±4.0 cm) compared to the pregnant fallers (8.1±2.9 cm) and controls (8.7±3.5 cm) (p=0.001). Pregnant non-fallers demonstrated greater thoracic rotation at RHC (2.8±3.7°) than the pregnant fallers (0.6±3.9°) and controls (0.9±3.4°) (p=0.001). Compared to pregnant fallers and controls, pregnant non-fallers exhibited greater frontal plane ROM of the thorax during the gait cycle (pregnant non-fallers: 4.8±2.8°, pregnant fallers: 4.2±2.6°, controls: 4.1±1.9°, p=0.03).

In every variable that differed between pregnant fallers and non-fallers, the magnitude of that variable was greater in the pregnant non-fallers, implying that pregnant non-fallers demonstrate greater torso movement than do the pregnant fallers. This may be indicative of greater torso flexibility or less rigidity that would allow the pregnant non-fallers to be more likely to successfully overcome a trip or a slip. Also, the greater step width of the pregnant non-fallers would increase the base of support, thus increasing stability. Increased step width was also noted by Foti et al. [4].

It is unlikely that this greater frontal and transverse plane movement in pregnant non-fallers is related to abdominal size (i.e. circumference) or weight gain because pregnant fallers and non-fallers did not differ on either of these factors [8]. Wu et al. reported truncated torso rotations during gait in advanced pregnancy [7], but did not compare between fallers and non-fallers.

CONCLUSION

Pregnancy-associated alterations to gait biomechanics differed between in pregnant fallers and non-fallers. These differences may be indicative of a more rigid trunk and greater instability in the pregnant fallers.

REFERENCES


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