**Abstract:** Background and Objectives: Ankle foot complex is the part of the body which is in contact with the ground and it is important to have an intact proprioceptive system in order to maintain postural control. Previous study has established that there is significant difference between ankle proprioception in pregnant women in their third trimester and non-pregnant women. There is lack of literature regarding when the ankle does the ankle proprioception gets affected during pregnancy and whether this change reverts back during postpartum and hence this study. Method: A cohort of 70 primiparous women were included in the study and the women were followed through 12th week, 24th week, 32nd week, immediate postpartum and 6 weeks postpartum. The ankle repositioning error was measured using photography method and was analyzed using UTHSCSA Image tool software. Repeated measures ANOVA was used to measure the differences across various time periods. Results: It was found that there was a significant differences (p<0.001) in ankle repositioning error in pregnant women across the trimesters and in the postpartum period and the value did not reach the first trimester value even after six weeks postpartum. Conclusion: Ankle proprioception was significantly affected across the various trimesters of pregnancy with the peak variability observed in the third trimester and the value did not reach back to the first trimester value even after 6 weeks postpartum.

**Key Words:** Pregnancy, Reposition error, Falls

**Introduction:** The proprioceptive input from the ankle joint plays a key role in maintaining the postural stability. The ankle foot complex is the body part which is in contact with the ground and provides this key sensory information which in turn is processed by the central nervous system. Thus if ankle proprioception gets affected, it may remarkably have an effect on the postural control.(1,2) Pregnancy brings about structural, anatomical and physiological changes in a woman’s body.(3) Among the musculoskeletal changes, the effect of hormones on the ligament and joint laxity is well known.(2,4) Postural sway changes in pregnant women has been studied extensively and it has been reported that the pregnant women rely on visual cues than on proprioceptive cues to maintain their postural stability.(5) Under the inverted pendulum framework, which explains the control of postural sway, it is understood that the ankle plantar flexors work extensively to maintain the postural stability in pregnant women.(6,7) This may also lead to early fatigue of the muscles around the ankle joint. Previous studies have evaluated the relationship between altered postural control and fatigue in the plantar flexors and it was found that fatigue in plantar flexors could also be considered as one of the reasons for the altered postural control during pregnancy.(8,9)

The increasing prevalence of falls among pregnant women is imposing an alarming threat to the overall health of the pregnant woman and her fetus.(10-14) The altered sensory input from the vestibular and proprioceptive systems along with the joint laxity is considered as one among the intrinsic...
actors leading to falls during pregnancy. This joint laxity along with increased interstitial fluid volume may lead to reduced coordination and kinesthetic sensation of the weight bearing joints. (15)

Previous study on ankle proprioception demonstrated significant difference between pregnant and non-pregnant women. (16) But there is lack of literature regarding, when these changes happen during the course of pregnancy. Also there is less understanding whether these changes revert back during postpartum. Hence we aimed to look at the change in ankle proprioception through pregnancy and postpartum.

Materials and Methods

A Cohort study was conducted in which 70 primiparous women were followed up at 12th week, 24th week, 32nd week, at immediate postpartum period and at six weeks postpartum. The study was approved by institutional research committee and Manipal University ethics committee (UEC/88/2010) and participants gave a written informed consent before participating in the study. Pregnant women between 20-35 years of age were included in the study. Women with severe pedal edema which restricts the ankle range of motion, history of arthritis, history of recurrent ankle sprains were excluded from the study.

After explaining the entire procedure to the participant, she was made to sit in a high sitting position on a plinth with their feet hanging. Markings were placed at the lateral aspect of base of fifth metatarsal, tip of lateral malleolus and 5 cm above lateral malleolus on the shaft of fibula. A Sony cybershot 16 megapixel digital camera was placed sixty centimeters away from the participant’s feet on a foot stool perpendicular to the ankle.

The tester moved the women’s’ ankle into the complete ranges of dorsiflexion and plantar flexion for ten times and positioned the ankle in a particular position. This was considered as the target angle. The women were instructed to feel the position for fifteen seconds and remember it. The target angle was then photographed. The participant was then asked to move the ankle for ten times by herself and then reposition the ankle in the target angle. This position was again photographed and the images were transferred to a computer. The images were then analyzed using UTHSCSA Image tool software version 3.0 to measure the difference between the initial and the final angle. UTHSCSA Image tool software version 3.0 was used to measure the range of motion at the ankle as the usual method of measuring the ankle range of motion using a goniometer may not give accurate results. (17)

The difference between the initial and final angle (ankle reposition error) was noted and was further analyzed. The average of the three readings was recorded as the final reading. The pregnant women were followed up at different trimesters of pregnancy and the reading in the immediate postpartum period was taken on the 3rd postnatal day in case the woman delivered by normal vaginal delivery and on the 6th postoperative day in case the woman delivered by caesarian section. This was done in order to rule out the influence of pain and discomfort when the women were made to sit on the plinth. The final reading was taken at 6 weeks postpartum.

Statistical analysis:
The data was analyzed using SPSS version 16.0. Descriptive statistics was used for reporting the demographic characteristics and Repeated measures ANOVA was used to report the changes in the ankle repositioning error in during the various measurement periods.

Results

Table 1: Demographic characteristics of the participants (n=70)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>27.98±3.65</td>
</tr>
<tr>
<td>Height(cm)</td>
<td>156.47±5.78</td>
</tr>
</tbody>
</table>

There were significant differences in the body weight and BMI of the participants across the time periods (Table-2)

Table 2: Mean changes in body weight and body mass index among participants across various time periods (n=70) expressed as (Mean ±SD)

<table>
<thead>
<tr>
<th>Variable</th>
<th>12th week</th>
<th>24th week</th>
<th>32nd week</th>
<th>6 weeks postpartum</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (Kgs)</td>
<td>53.86±8.78</td>
<td>58.60±8.68</td>
<td>62.30±9.19</td>
<td>59.81±9.09</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>BMI(kg/m²)</td>
<td>23.08±4.17</td>
<td>25.19±4.18</td>
<td>26.78±4.40</td>
<td>25.61±4.54</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

There were significant differences in the ankle repositioning error of left and ankle joint of the participants across the time periods (Table-3)

Table 3: Mean changes in ankle repositioning error among participants across various time periods (n=70) expressed as (Mean ±SD)

<table>
<thead>
<tr>
<th>Variables</th>
<th>12th week</th>
<th>24th week</th>
<th>32nd week</th>
<th>6 weeks postpartum</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankle repositioning error(L) (in degrees)</td>
<td>2.32 ±1.64</td>
<td>3.01 ±1.76</td>
<td>3.70 ±1.81</td>
<td>3.32 ±1.60</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Ankle repositioning error(R) (in degrees)</td>
<td>2.53 ±1.84</td>
<td>3.38 ±1.92</td>
<td>4.38 ±2.06</td>
<td>3.80 ±1.92</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Discussion

In the present study, we found that the ankle repositioning sense was significantly affected in pregnant women across various trimesters of pregnancy and postpartum. It was observed that the ankle joint proprioception was significantly reduced in the third trimester compared to other trimesters of pregnancy among the primiparous women. These changes in repositioning error could be attributed to the ligament laxity that may occur as the pregnancy advances. (16) The influence of increased levels of relaxin, progesterone and estradiol hormones in the blood during pregnancy on the ligament and joints have been reported in the previous studies. (18-20) We chose only primiparous women to rule out any previous influence of hormones on the ligament or joint
laxity or any other musculoskeletal dysfunctions that could have affected the ankle proprioception.(18) The variation during the third trimester could also be due to the mild swelling that they develop around the ankle and feet which could cloud the inputs coming from the proprioceptors.

In our study we observed that even in the postpartum period the ankle repositioning error does not come back to the initial value as observed in the first trimester. This may be due to the effect of hormonal imbalances that continuous even after delivery. It has been reported that the physiological changes that occurs in the various systems takes approximately six weeks to come back to the pre-pregnancy state. But the values that we have obtained through our study put a new insight into the fact that the proprioceptive system may not reach the pre-pregnancy levels even after six weeks postpartum.

During pregnancy there is an increased anterior mass in the lower trunk which causes a shift of the body’s COG. This along with the increased gravitational moment at the ankle with decreased range of motion of ankle dorsiflexion can lead to initiation of fall risk. It is important to have appropriate detection by proprioceptive receptors of the lower limb joints and its internal processing to prevent falls. But during pregnancy if the ankle proprioception gets affected, the detection, internal processing and the recovery phase of falls also may get affected making the women more prone for falls.(15)

Hence based on the results of this study, we recommend that lower limb joint proprioceptive training especially that of ankle joint should be a part of antenatal and postnatal exercises. This may be included as a part of fall prevention strategy to reduce the rate of falls in pregnant women.

**Conclusion**

The results of the present study suggest that the ankle proprioception was significantly affected in the third trimester during pregnancy and it did not reach to the baseline even at six week postpartum.

**References**