

Changes in Foot Use and Foot Pressure Patterns During Pregnancy

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Introduction: Pregnant women often report various types and locations of pain, typically experiencing musculoskeletal discomfort in the back and lower extremities.³ Low back pain, foot and calf pain, soreness and fatigue in the lower extremities, and muscle strains and cramps are reported throughout pregnancy.^{1,4} No prospective, within-subject, repeated measure design study was found that investigated the relationship between foot use patterns during gait, and lower extremity pain throughout the course of pregnancy and post partum. The purpose of this study is to examine that relationship, and the relationship between foot use patterns, foot type, weight gain, and duration of pregnancy.

Statement of Clinical Significance: Pregnant women often report various types and locations of pain, typically experiencing musculoskeletal discomfort in the back and lower extremities. As many as 75% of women report these problems, yet often these problems go untreated, as obstetricians may lack the understanding and training necessary to determine the causes of foot pain and to treat these causes. It is hoped that this study will allow us to better understand the changes in foot structure and function that occur during pregnancy, toward correction of these problems.

Methodology: Thirteen pregnant women were enrolled in the study. At least once during each trimester, foot plantar pressures were measured bilaterally during barefoot walking. The Parotec[®] System, an in-shoe foot pressure instrument, was used to measure plantar pressure in the participants of our study. This system consists of reusable insoles in varied sizes, a controller unit that interfaces with a Windows[®] compatible computer, and data acquisition and analysis software. The system utilizes reusable 3mm thick insoles to collect data at the foot/shoe interface. There are 24 embedded hydrocell sensors per insole to measure pressure. The hydrocell sensors read the same pressure irrespective of what area of the sensor cell is compressed. The sensors cover 46% of the insole and are arranged to record pressures from what are believed to be the most clinically relevant areas of the foot.⁵

The controller unit collects and stores foot pressure data for 10 steps on a removable PCMCIA compatible memory card. The controller unit is attached to an adjustable waist-belt worn by the subjects and connects to the insoles via two thin cables. Each sensor was sampled at 100 Hz. Data were downloaded to the computer through a serial connection after each trial and viewed with the Parotec System[®] data acquisition and analysis software. The system is capable of recording standing and walking data and calculates peak pressures, center of pressure (COP), pressure duration, patterns of pressure distribution, and repeated pressures over time. The Parotec System[®] has been shown to be reliable and valid for measuring pressures during walking.² The insoles were taped to the subjects feet between two pairs of socks during walking trials. Fifteen steps for each foot were collected for each visit for each subject.

Results: For analysis, the feet were partitioned into three regions: hindfoot, midfoot and forefoot. In each region, peak pressure during walking was identified for each foot. Floor

contact time (stance time) and impulse (force integral) for each foot were also calculated. Data were analyzed using Pearson product moment correlation and an ANOVA. As pregnancy progressed, floor contact times (time with foot contacting the ground) increased ($r=0.39$, $p=0.0007$). Impulse (the integral of the floor contact force) also increased ($r=0.21$, $p=0.0171$). Subjects had increasing hindfoot peak pressure ($r=0.085$, $p=0.0044$) and decreasing forefoot peak pressure ($r=0.13$, $p=0.0121$). See Figures below at right.

Discussion: Consistent progressive changes in foot use and foot pressure patterns were seen during pregnancy. Floor contact times increased, indicating a progressively slower walking speed. Hindfoot peak pressure increased, while forefoot peak pressure decreased. Increasing impulse demonstrates greater overall foot load bearing. Future correlation of these changes with musculoskeletal pain may help us to better understand pregnancy's effect on function of the lower extremities and development of pain.

References

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Figure 1: Floor Contact Times, seconds

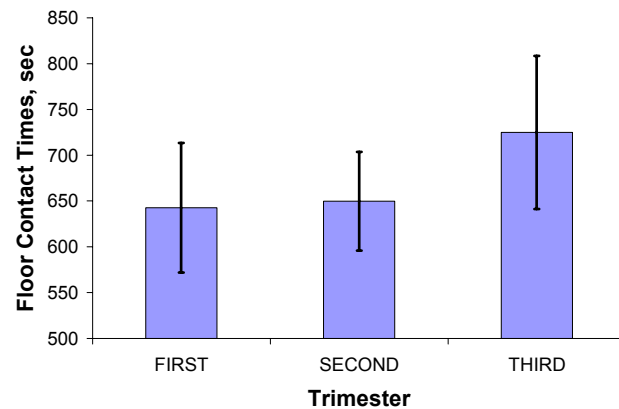


Figure 2: Impulse, N-s

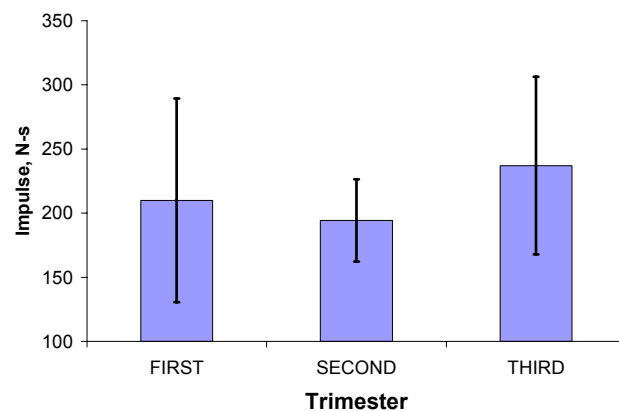


Figure 3: Peak plantar pressure, by trimester

