Ultrasound Assessment of Abdominal Muscle Thickness in Women With and Without Low Back Pain During Pregnancy

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Abstract

Objective: The aim of this preliminary study was to determine the differences in abdominal musculature thickness, within 1 month of delivery, in women who experienced back pain during pregnancy compared with those who did not.
Methods: B-mode ultrasound imaging was used to measure abdominal muscle thickness on 76 postpartum participants who participated in a larger study; 47 women experienced back pain during pregnancy, and 29 did not. Participant data were stratified by group, and primary comparisons were based on these grouping across the abdominal muscles, including rectus abdominis (upper and lower fibers), external oblique, internal oblique, and transversus abdominis. Means and standard deviations were also used to set parameters for future studies.
Results: In the present study, there was no difference in any abdominal muscle thickness between groups. Women with low back pain were significantly shorter (165.19 ± 6.64 cm) than women who did not have from back pain during pregnancy (169.38 ± 7.58 cm). All other demographics, such as age, weight, and date tested postpartum, were not significantly different between groups.
Conclusion: The results of this study showed no variation in abdominal muscle thickness in women who had back pain during pregnancy and those who did not. (J Manipulative Physiol Ther 2017;xx:0-6)
Key Indexing Terms: *Spine; Back Pain; Pelvic Pain; Postpartum*

Introduction

Pregnancy-associated musculoskeletal complaints are common, with 25% to 90% of women reporting low back and/or pelvic pain related to pregnancy.[1-8] Pregnancy-related back pain can be troublesome for an expectant mother in terms of intensity and resulting disability.[6,7] The presence of back pain during pregnancy has been correlated with sleep disturbances, use of pain medication, and disturbances to activities of daily living, such as standing for 30 minutes.[1,4,7] Although the etiology of pregnancy-related back pain is not clear, several factors have been implicated, including altered posture, hormonal changes, muscle fatigue, and muscle imbalance.[8-11]

Although little research has been done relating core muscular insufficiency, imbalance, or weakness to back pain during pregnancy, this topic has generated much attention in the nonpregnant population.[12-16] The abdominal musculature, including the transversus abdominis (TrA) and oblique muscles, form a "brace" around the abdomen, which can assist with spinal stability.[12] In the nonpregnant population, recruitment of the core stabilizing muscles, including the TrA, appears to be altered in those with low back pain.[13-15] Previous studies during or immediately after pregnancy have reported changes in gross morphology of the abdominal musculature, including thickness,[17,18] length,[19] and separation width and angles of insertion of the rectus abdominis (RA),[20] as well as the ability of these muscles to stabilize the pelvis both during and after pregnancy. Therefore, it is conceivable that the postural and biomechanical changes that occur during pregnancy[11,21] as a result of the growing fetus may contribute to alterations of the abdominal musculature, thus causing back pain at this time.

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Little quantitative data exist regarding the patterns of muscular adaptation in pregnant women who have back pain during pregnancy and those who do not. Several methods of assessing muscle have been used to contrast those who are asymptomatic and those with back pain, including relative strength, endurance, and recruitment timing with varied results. More recently, ultrasound imaging of muscles[14,22] has been promising in defining morphologic differences between asymptomatic and low back participants. Moreover, we have used this technology in our lab to determine the difference in abdominal thickness in nulliparous women and those within 1 month of giving birth.[18] Using a subset of data from a larger study, the purpose of this study is to determine differences in abdominal thickness (external oblique [EO], internal oblique [IO], TrA, upper rectus abdominis [URA], and lower rectus abdominis [LRA]), immediately after pregnancy, in women who experienced back pain during pregnancy compared with those who did not. We hypothesized that those women who had back pain during their pregnancy would have thinner abdominal muscles than those who did not. Therefore, the aim of this preliminary study was to determine the differences in abdominal musculature thickness, within 1 month of delivery, in women who experienced back pain during pregnancy compared with those who did not.

Methods

Participants

Participants for the present study were a subset of individuals from a previous study.[18] Briefly, participants were recruited through word of mouth and posters placed within the academic institution, in local obstetrician and gynecology offices, and in local business organizations. Postpartum women between the ages of 20 and 40 were eligible for participation. Postpartum women within 1 month of a normal vaginal delivery and asymptomatic nulliparous controls were included. The decision to evaluate women within 1 month after delivery came from the work of Coldron et al.[17] Exclusion criteria included a history of abdominal surgery, with the exception of childhood appendectomy or herniorrhaphy, and those with significant trunk deformity such as scoliosis identifiable on inspection. The Research Ethics Boards of the Canadian Memorial Chiropractic College (Approval Number 092012) and Sunnybrook Health Sciences Centre (Project Identification Number 193-2009) approved the present study.

Ultrasound Procedure and Data Collection

On induction into the study, participants were scheduled for a single assessment, which lasted up to 30 minutes. A brief history and measure of height, weight, age, date of parturition, and presence or absence of low back pain were collected. With each assessment, participants were given an information sheet regarding the research project and information on ultrasound imaging. At this time, each participant was given the opportunity to ask questions and signed the informed consent document. All participants provided consent and all information was kept confidential.

Ultrasound methodology has been reported elsewhere.[18] Participants were positioned in a supine recumbent position and the abdomen was draped to expose from below the xiphoid process to above the suprapubic bone. Palpation of the soft tissues about the suprapubic, xiphoid, and anterior superior iliac spine, along with visualization of the umbilicus, was used to define the neighborhoods and orientation for imaging transducer placement. Each target muscle within the image was confirmed by use of standard movements consistent with daily activities that are known to preferentially activate them.[23,24]

Images from the right side of the abdomen were obtained based on the assumption of symmetry and the work of Rankin et al.[22] A total of 5 measures were taken (1 for each muscle) per participant. Before obtaining the images, the ultrasound was used to scan the muscle to ensure uniformity and identify landmarks.[25] Three regions were explored and imaged for the measurement of muscle depth (transverse diameter):

1 Anterolateral abdominal—a point slightly medial (approximately 1 finger breadth) and superior (approximately 1 finger breadth) to the anterior superior iliac spine.[25-27] This region captured the EO, IO, and TrA. Once the ultrasound was placed in the appropriate region, TrA was identified by asking the patient to perform a slow Kegel exercise; mentally visualizing an effort to draw the vaginal tissues into the body, resulting in a sequential activation of the TRA followed by the oblique muscles. Once the TrA was identified, the fascial planes and fiber orientations for the EO and IO were clearly evident, making them easily distinguishable on the screen.[24] The image was frozen at the end of the exhalation, and the participant resumed a relaxed supine posture. Starting with EO, then IO, and finally TrA, digital measures of muscle thickness were obtained by taking a vertical measure from the inside edge of each superior fascial border to the inside edge of the corresponding inferior fascial border, at approximately midpoint of the muscle belly (Fig 1).
2 Mid-upper abdominal parasagittal—a point approximately midway between the umbilicus and the lower ribs lying along the midclavicular line.[25-27] This region captured the URA and the linea alba. Once the ultrasound probe was placed in the appropriate region, the patient was asked to lift her head from the examination table to identify the URA. The patient returned her head to the table, the image was frozen at the end of the next exhalation, and the

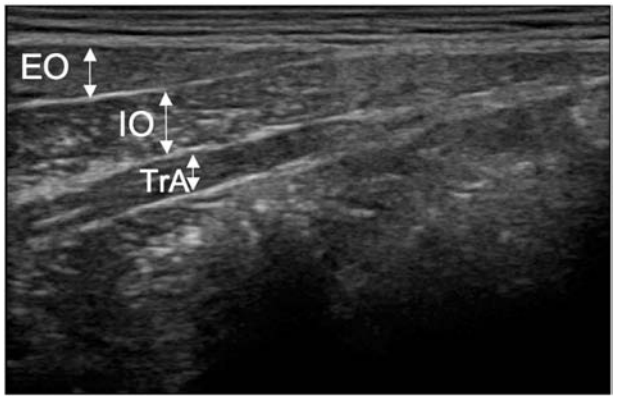

Fig 1. *Anterolateral abdominal region, capturing the external oblique (EO), internal oblique (IO), and transversus abdominis (TrA).*

Fig 3. *Mid-lower abdominal parasagittal region, capturing the dimension of the lower rectus abdominis (LRA).*

participant was asked to resume a relaxed supine posture. Digital measures of URA muscle thickness were obtained by taking a vertical measure from the inside edge of the superior fascial border to the inside edge of the inferior fascial border, at approximately the midpoint of the muscle belly (Fig 2).

3 Mid-lower abdominal parasagittal—a point between the pubic bone and umbilicus laying along the midclavicular line and approximately in line with the anterolateral measure.[25-27] This region captured the dimension of the LRA. Once the ultrasound probe was placed in the appropriate region, the patient was asked to lift her head from the examination table to identify the LRA. The patient returned her head to the table, the image was frozen at the end of the next exhalation, and the participant resumed a relaxed supine posture. Digital measures of LRA muscle thickness were obtained by taking a vertical measure from the inside edge of the superior fascial border to the inside edge of the inferior fascial border, at approximately the midpoint of the muscle belly (Fig 3).

Fig 2. *Mid-upper abdominal parasagittal region, capturing the upper rectus abdominis (URA).*

Ultrasound gel was applied liberally to the areas of imaging to ensure good sonic coupling between the transducer (Ultrasonix RP) and skin. The Ultrasonix RP (Ultrasound Medical Corp, Burnaby, BC, Canada) unit was used for trunk muscle image capture. A 60-mm linear array transducer captured images using a frequency range of 6 MHz to 14 MHz and depth of 4 to 10 cm based on patient stature and image optimization. A cine-loop image captured the validating maneuver for each muscle. On completion, the gel was removed from the surface of the skin using a paper towel and dried. The total time for the imaging session was less than 30 minutes.

Data Analysis

This is a descriptive study used to quantify the range of changes in abdominal muscles in order to anticipate changes in muscle dimension as a result of pregnancy. The primary comparisons were based on groupings of postpartum women who experienced back pain during their pregnancy and those who did not for thickness across the 4 muscles measured (EO, IO, TrA, RA) at rest. Means and standard deviations were calculated and unpaired 2-tailed *t* tests were used to examine for difference between groups.

No previous data were available to estimate sample size or effect size (means and standard deviations) for this type of comparison; therefore, we estimated a large effect size. The hypothesized effect size is 0.8, significance level of 0.05 (type 1 error), and type 2 error of 0.2. Using these numbers, the necessary sample size was calculated to be n = 26 per group.[28]

Results

A total of 76 postpartum participants participated in the study, 47 (61.8%) who experienced back pain (BP) during pregnancy and 29 (38.2%) who did not (NBP). There were no

Table 1. *Comparison of Baseline Values in Women (Within 1 Month of Giving Birth) Who Experienced Low Back Pain During Pregnancy and Those Who Did Not Experience Low Back Pain During Pregnancy*

Baseline Values			
	Back Pain (n = 47)	No Back Pain (n = 29)	*P*
Postpartum date	23.87 (SD = 7.07)	23.83 (SD = 6.38)	.98
Age, y	32.47 (SD = 4.23)	33.93 (SD = 3.23)	.11
Height, cm*	165.19 (SD = 6.64)	169.38 (SD = 7.58)	.01
Weight, kg	69.00 (SD = 6.64)	65.84 (SD = 8.57)	.14

Table 2. *Muscle Thickness (mm) of Women (Within 1 Month of Giving Birth) Who Experienced Low Back Pain During Pregnancy and Those Who Did Not Experience Low Back Pain During Pregnancy*

Mean Thickness (mm)			
	Back Pain (n = 47)	No Back Pain (n = 29)	*P*
Upper rectus	8.30 (SD = 2.02)	8.26 (SD = 1.52)	.91
Lower rectus	8.97 (SD = 2.72)	8.77 (SD = 1.37)	.71
Transversus abdominis	4.22 (SD = 1.72)	3.64 (SD = 1.22)	.13
External oblique	4.75 (SD = 1.54)	4.68 (SD = 1.50)	.86
Internal oblique	6.89 (SD = 2.02)	7.33 (SD = 1.44)	.32

significant differences in postpartum day tested, age, or weight between groups; however, those with back pain tended to be taller than those who did not ($P = .01$) (Table 1). The relative pattern for abdominal thickness in the present study was the same for both groups, with RA being the thickest, followed by IO, EO, and TrA. There were no differences in any abdominal thickness between the 2 groups (Table 2).

Discussion

Back pain during pregnancy has been reported by up to 90% of women[1-3] and has been implicated as the period of initial onset for chronic low back pain in many parous women.[8] The etiology of back pain during pregnancy is unclear; however, it has been proposed that it may be due in part to altered biomechanics in the lumbar spine, pelvis, and supporting musculature as a result of the growing fetus.[8-11] Previous studies have determined that the morphology of abdominal musculature differs between pregnant or postpartum women compared with nulliparous or nonpregnant women, as well as at varying stages during pregnancy; however, the majority of this research focused on the RA.[17-20] As far as we know this is the first study to examine the morphology of 4 abdominal muscles (RA, EO, IO, and TrA) between participants with and without low back pain during pregnancy.

The present study determined that abdominal thickness of any of the investigated muscles was not significantly different between groups. These results are similar to Rostami et al.,[7] who compared the lateral abdominal muscles in women with and without low back pain who were between 12 and 39 weeks' gestation.[7] They suggested that their findings put more emphasis on the role of other factors contributing to pregnancy-related back pain and less on the strength and thickness of core stabilizing muscles.[7] Rostami et al.[7] also suggested that the thickness of the lateral muscles before pregnancy may play a more important role in pregnancy-related back pain.[7] Neither the present study nor that of Rostami et al.[7] evaluated for this, but it should be considered in future studies.

It has been reported in the literature that people with low back pain have differences in abdominal thickness compared with asymptomatic participants.[15,22] Rankin et al.[22] found the relative thickness of the abdominal muscles in asymptomatic nonpregnant populations to be RA > IO > EO > TrA, with the pattern of relative thickness being the same for both genders and scanning sites. They suggested that this may be a simple and useful way of screening individuals with low back pain for muscle imbalances or abonormalities.[22] Examining this group of women with low back pain during pregnancy, it was surprising that the present study found the relative thickness for both BP and NBP participants to be the same, RA > IO > EO > TrA. Therefore, in this particular population, clinicians would likely not be able to use this pattern as a screening tool for pregnancy-related back pain.

Abdominal muscles are only 1 piece of the pregnancy-related back pain paradigm. There are substantial biomechanical, postural, and hormonal changes that occur to a woman's body as the result of pregnancy and as such, the integrated function of each stabilizing muscle group, such as lumbar muscles, pelvic floor muscles, and so on, should be evaluated and taken into consideration before making any definitive conclusions. For example, Pereira et al.[29] examined coactivation between pelvic floor muscles and TrA/IO in primigravid pregnant, primiparous postpartum women, and nulliparous controls via electromyography.[29] They determined that there was coactivation of the TrA/IO and pelvic floor muscles in young asymptomatic nulliparous women. However, this pattern was modified in the other 2 groups, leaving these researchers to infer that pregnancy and postpartum influence muscle physiology, blocking abdominal pelvic synergy.[29]

This study, along with others,[7] have examined the thickness of abdominal muscles during or immediately postpartum and have identified no difference in the thickness of the abdominal muscles in BP and NBP participants. Perhaps the abdominal muscles play less of a role in the etiology of back pain during pregnancy[7] than originally thought. The back pain in this population may be attributed to the health of the muscles before pregnancy, changes in some of the other stabilizing musculature during pregnancy, or other pregnancy-related factors (which are yet to be determined).

Strengths and Limitations

Whereas other research evaluated selected abdominal muscles, we examined all 4 abdominal muscles immediately postpartum to get a better appreciation of changes that may occur as a result of pregnancy. Although this could be considered a strength of the paper, completing measures on both sides of the abdominal wall and low back musculature would give a complete picture of the changes that occur during pregnancy. In addition, the present study did not measure cross-sectional area (CSA) of the involved muscles. It was reported by Coldron et al.[17] that CSA of the RA was reduced by 12 months postpartum, and they suggested their results would have implications for strength and abdominal wall thickness.[17] Measuring the CSA of all abdominal muscles may help inform the development of an effective postnatal exercise programs.

One investigator, a doctor of chiropractic, was trained to obtain the ultrasound measures for the postpartum population. Although the examiner instructed the participants in an identical manner each time, as with any manual data collection, there is an element of examiner error that cannot be ignored. The present study did not perform an intrarater reliability test before data collection, which can be considered a major flaw of the study. However, the ultrasound results are similar to those taken previously in the literature.[7,17]

Future Studies

Future work should examine the change of CSA in these muscles as well as muscles of the lumbar region and pelvic floor. Understanding the changes that occur in all of these muscles during pregnancy may help develop appropriate biomechanical models to better understand the mechanical factors acting on back pain and possibly predict interventions that may prevent and resolve pregnancy-related back pain.

Conclusion

Findings of the present study suggest that there is no difference in abdominal thickness in women who experienced back pain during their pregnancy and those who did not.

Funding Sources and Conflicts of Interest

No funding sources or conflicts of interest were reported for this study.

Contributorship Information

Concept development (provided idea for the research): C.A.W., J.T.

Design (planned the methods to generate the results): C.A.W., J.T.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): C.A.W., J.B., J.N., J.T.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): C.A.W., J.N., J.B.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): C.A.W., J.T., J.B.

Literature search (performed the literature search): C.A.W., J.N.

Writing (responsible for writing a substantive part of the manuscript): C.A.W., J.N., J.B.

Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): J.T., J.B.

Practical Applications

- These preliminary findings suggest there is no difference in abdominal morphology in women who experienced back pain during pregnancy and those who did not.
- Future studies should examine other muscles of the trunk and pelvic floor. Understanding the changes that occur in all of these muscles during pregnancy may help develop appropriate biomechanical models to better understand the mechanical factors acting on back pain.

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