INTRODUCTION:

Atrophy, bilateral asymmetry, and fatty infiltrations have all been suggested as potential causes for LBP. However, it is unclear as to what extent these abnormalities may affect muscle CSA and how they may be involved with the onset of LBP. Some studies have suggested that atrophy of the paraspinal muscles may cause abnormal lumbar kinematics that contributes to LBP. In addition, because of the striking anatomical differences of the pelvis and its associated joints between genders, it is important to discriminate between male and female when developing biomechanical models of the lumbar spine. Differences in muscle recruitment and activation timing have been noted between genders, which could lead to gender specific pathologies. Therefore, the primary objective of this study was to evaluate the CSA of six paraspinal muscles in asymptomatic and symptomatic LBP subjects using MR imaging, with a particular emphasis on gender specific differences that arise in the musculature of the lumbar region.

METHODS:

Analyzed in this study were the bilaterally occurring multifidi, erector spinae, and psoas muscles in lumbar spine at vertebrae L4 and L5. This study evaluated lumbar muscles adjacent to vertebrae L4 and L5 of 19 adult volunteers. Ten asymptomatic, healthy participants (five females, five males) who had never received treatment nor experienced physical limitation in daily activity due to low back pain were selected as healthy controls. In addition, nine subjects (five female, four male) who had experienced at least one symptomatic episode of low back pain within the previous year of being evaluated, but were otherwise healthy, were selected for the patient group. Exclusion criteria for this study were radiological evidence of degeneration, scoliosis, spondylolysis, radioluclhapy, or other vertebral defects. All participants in this study were volunteers recruited from the staff, student and patient populations at both Vanderbilt University Medical Center and the University of Tennessee. Institutional Review Board approval was obtained as well as informed consent for all patients participating in this study (IRB #7393).

Axial T2 weighted fast spin echo MR images were used to segment the outer boundaries of the target muscles. An initial manual segmentation was performed with image processing software defining the outer fascial boundaries of the target muscles (Fig 1 A, B). A semi-automatic segmentation algorithm was employed that 1) corrected for inhomogeneous magnetic field biasing, 2) enhanced the muscle-adipose interface using anisotropic diffusion and edge enhancement, 3) segmentation using a fuzzy c-means clustering algorithm (Fig 1 C-E).

**RESULTS:**

The mean CSA of both the left and right psoas muscles at L4 of symptomatic female subjects tended to be significantly less than asymptomatic subjects (p = 0.01). Similarly, the right multifidi at L4 of symptomatic female subjects was significantly less than asymptomatic subjects (p = 0.05). No other significant inferences were made concerning the female musculature of healthy and LBP subjects. The only significant findings for the male population were observed in the left erector spinae muscles (p = 0.012); while the right erector spinae fell just below the 95% alpha threshold with a significance of p = 0.062. No other significant observations were found for the other four paraspinal muscles between symptomatic and asymptomatic subjects.

**DISCUSSION:**

The results of this study provided confirmation of the discrepancy in girth of the psoas and erector spinae muscles between genders, which gives reason to why gender-specific analysis must be performed when investigating the lumbar muscles. Additionally, these results indicated that individuals symptomatic of low back pain tended to show decreased CSA’s of several, but not all, of the paraspinal muscles. Females suffering from LBP exhibited less muscles girth bilaterally in psoas, while in the males no significant observation was made. However, males tended to have less muscle CSA in the erector spinae, while females showed no difference in that muscle. These muscle specific decreases suggest that the etiology of LBP may be gender specific.

It is well documented that anatomical differences of the pelvis are prevalent between genders. For example, the subpubic angle is more obtuse in females; the increased width of the female pelvis causes an increased tibiofemoral Q-angle; the acetabulum is more posterior in females relative to the anterior superior iliac spine; and the acetabular axis angle is more medially offset in females. Viewed with a holistic perspective, spinal function is largely impacted by the synergistic interactions occurring at the lumbo-pelvic region, such as the sacroiliac, lumbosacral, and hip joints. Given the anatomical differences between males and female, these facts would seem to suggest that the overall biomechanic processes behind locomotion and postural stabilization are likewise variable across genders, which would imply that genders bulk specific muscles differently. The results of this study are likewise consistent. Therefore, when treating LBP through muscle strengthening regiments, such as physical therapy, it may be more beneficial to perform training exercises that target muscles notoriously weak between genders.

**SIGNIFICANCE:**

This study introduced a new technique for performing semi-automatic segmentation of the lumbar muscles and, also, observed gender specific muscles with decreased cross-sectional areas. These results will provide advancements in the understanding of LBP and how LBP pain is treated with physical therapy.