The psoas major muscle (PM) is the only paraspinal muscle that arises anteriorly to the lumbar spine and crosses the hip joint. Although the PM is considered an important hip flexor, its role as a lumbar spine mover/stabilizer is still not fully understood. Several investigators have detailed the gross muscle anatomy of PM to gain an understanding of its spinal function. However, a comprehensive architectural analysis of the PM has not been published. Moreover, length-tension and passive mechanical properties of the muscle have never been reported. The purposes of this study were to:

a) determine the PM architectural properties in a relatively young population,

b) measure in vivo sarcomere length operating range, and

c) determine the passive mechanical properties of the human psoas muscle.

We hypothesized that due to the PM's role as a hip flexor, its architecture would be characterized by long fibers and a small physiological cross-sectional area compared to posterior paraspinal muscles, and that its sarcomere length operating range would be similar to muscles in the lower extremity.

Methods: The lower one half (T12 to toes) of thirteen cadaveric specimens was harvested. The PM was isolated from each vertebral level, permitting architectural measurements of mass, normalized fiber length ($L_f$), physiological cross-sectional area (PCSA), and fiber length-to-muscle length ratio ($L_f/L_m$). Separately, to determine PM sarcomere length operating range, sarcomere lengths were measured in vivo from intraoperative biopsies taken with the hip joint in flexed and extended positions. Additionally, single fiber and fiber bundle tensile properties as well as the molecular weight of the PM titin protein were measured from the intraoperative biopsies.

Results: Average muscle mass was 249.79 ± 18.43g and average normalized $L_f$ of 12.70 ± 2cm, yielded an average PCSA of 18.45±1.32cm², and an average $L_f/L_m$ of 0.48 ± 0.06. Intraoperative sarcomere length measurements revealed that the muscle operates from 3.18 ± 0.20 µm with hip flexed at 10.7±13.9° to 3.03 ± 0.22 µm with hip flexed at 55.9±21.4°. Passive mechanical data demonstrated that the elastic modulus of the PM muscle fibers (37.44 ± 9.11 kPa) and bundles (55.3 ± 11.8 kPa) were similar to those of the erector spinae muscles.

Conclusions: The architectural design of the PM demonstrates that its average fiber length and passive biomechanical properties resemble those of the lumbar erector spinae muscles. The PCSA of the PM was larger compared to the longissimus and iliocostalis and smaller compared to multifidus. Additionally, PM sarcomere lengths were confined to the descending portion of the length-tension curve allowing the muscle to become stronger as the hip is flexed and the spine assumes a forward leaning posture. These findings suggest that the human PM has architectural and physiologic features that support its role as both a flexor of the hip and as a dynamic stabilizer of the lumbar spine.