

Anatomic relationships of psoas muscle: clinical applications to psoas hitch ureteral reimplantation

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OBJECTIVE: The objective of the study was to examine the anatomic relationship of the genitofemoral and femoral nerves to the psoas major muscle.

STUDY DESIGN: Dissections were performed in 17 unembalmed female cadavers. Point A was used as the approximate location for placement of psoas hitch sutures and as the reference point from which all measurements were taken. Measurements included the width of the psoas major muscle, psoas minor tendon, genitofemoral nerve branches, and femoral nerve. The relative location of the genitofemoral and femoral nerves to point A and the presence or absence of a psoas minor tendon were documented.

RESULTS: The psoas minor tendon was absent on at least 1 side in 11 specimens (64.7%). The median width of the psoas minor tendon was 7 mm (range, 3–11.5 mm). The median width and depth of the psoas

major muscle was 21.5 mm (range, 10–35 mm) and 20.0 mm (range, 11.5–32 mm), respectively. The median width of the genitofemoral nerve was 2 mm (range, 1–4.5 mm) and that of the femoral nerve was 6.3 mm (range, 5–10.5 mm). Overall, 54 genitofemoral nerve branches were identified in 17 cadavers, 30 medial (55.5%), 22 lateral (40.7%), and 2 directly overlying point A (3.7%).

CONCLUSION: The exact location for the placement of the psoas hitch sutures will vary, depending on the location of the ureteral injury and the anatomy of the psoas muscle and surrounding structures. A thorough understanding of this regional anatomy should optimize the placement of psoas hitch sutures during ureteral reimplantation procedures and help avoid nerve and vessel injury.

Key words: femoral nerve, genitofemoral nerve, nerve injury, psoas hitch, ureteral reimplantation

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The reported rates of ureteral injury associated with gynecological surgery for benign conditions range from 0.1% to 1.7%.¹⁻⁷ However, rates of up to 7.3% have been reported when concurrent hysterectomy and prolapse surgery are performed.⁷ Prompt intraoperative recognition and management of ureteral injury is important to avoid long-term sequelae.³ Intraoperative repair of these injuries requires specialized knowledge

of anatomy to avoid further iatrogenic injury.

The psoas hitch ureteral reimplantation procedure is an effective means to decrease tension at the ureter reimplantation site when distal ureteral injury results in a significant loss of ureteral length.⁸⁻¹¹ Exact placement and location of psoas hitch anchoring sutures will vary, depending on the location of the ureteral injury and psoas muscle anatomy.

Traditional descriptions advise the mobilization of the bladder and fixation to the psoas muscle at or above the level of the common iliac bifurcation.^{12,13} However, scarce data are available to determine the precise location of fixation sutures, depth and width of suture bites, and variability in the associated regional anatomy. In addition, although some advocate placing the sutures directly through the psoas major muscles, and others recommend using the tendon of the psoas minor as the anchoring site. However, congenital absence of the psoas minor tendon can

be as high as 73% based on cadaver data.¹⁴

The anatomic location of the lumbar plexus branches relative to the psoas muscle make these nerves especially vulnerable to injury during psoas hitch procedures. The importance of avoiding the genitofemoral and femoral nerves during psoas fixation is consistently described.^{11,12,15} The genitofemoral nerve, which arises from the ventral rami of the first and second lumbar nerves (L1, L2), emerges from the anterior surface of the psoas major muscle.¹⁶ The genital and femoral branch of this nerve supply sensation to the upper anterior thigh as well as the skin of the anterior scrotum in men and mons pubis in women.

The genital branch passes through the deep inguinal ring and enters the inguinal canal. In women, the genital branch accompanies the round ligament through the inguinal canal and attaches to the skin of the mons pubis and labia majora. The femoral branch courses adjacent to the external iliac artery,

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passes underneath the inguinal ligament, and supplies the skin of the upper anterior thigh.

The femoral nerve, the largest branch of the lumbar plexus, arises from the dorsal divisions of the ventral rami of the second, third, and fourth lumbar nerves (L2-L4).¹⁶ It descends through the fibers of the psoas major muscle and emerges inferiorly and lateral to the muscle prior to passing beneath the inguinal ligament. The femoral nerve provides motor and sensory innervation to the anterior compartment of the thigh and sensation to the medial aspect of the leg.

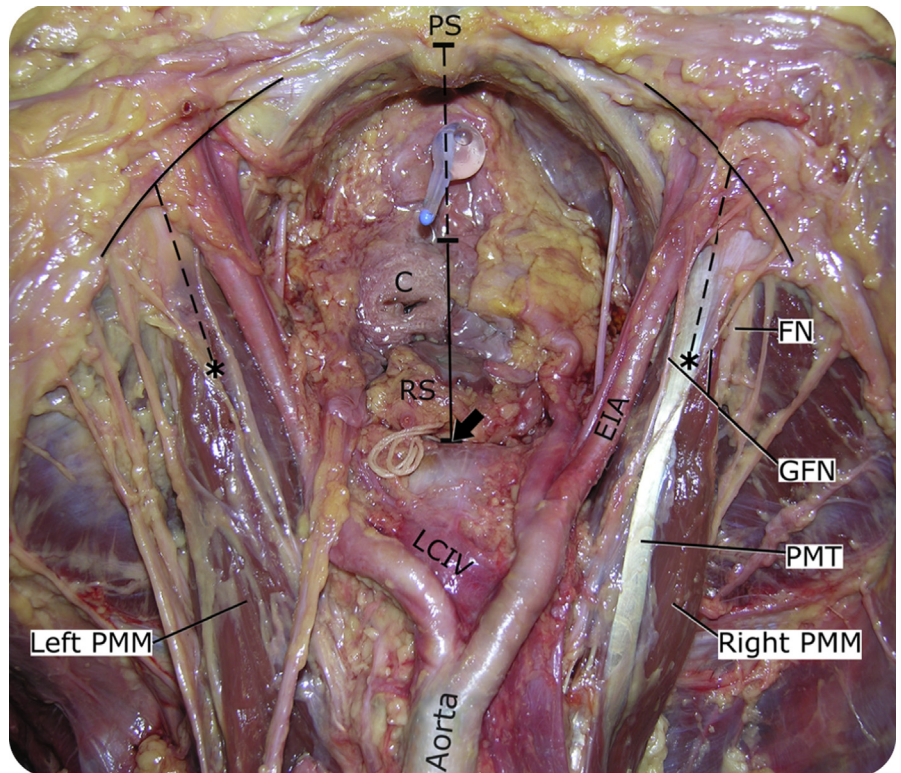
Although infrequent, genitofemoral and femoral neuropathy following psoas hitch procedures have been reported.¹⁷⁻²¹ In a retrospective study, hypoesthesia, acute pain and impaired flexion of the thigh were described as the psoas syndrome.²¹ Currently no consistent guidelines exist for determining the optimal location for psoas fixation that would avoid nerve injury. Thus, the objective of this cadaver study was to further characterize the anatomic variation between the genitofemoral and femoral nerve with the psoas major muscle and psoas minor tendon.

MATERIALS AND METHODS

Unembalmed cadavers were obtained from the Willed Body Program at the University of Texas Southwestern Medical Center. This study was deemed exempt by the University of Texas Southwestern Medical Center Institutional Review Board in accordance with the Code of Federal Regulations, Title 45. Age, race, height, weight, and cause of death were obtained for all cadavers.

In all specimens, a low transverse anterior abdominal wall incision was made for intraperitoneal entry. The incision was extended laterally toward the anterior superior iliac spines and superiorly to the level of the ribs to further expose the posterior abdominal wall. The bowel was removed at the level of the rectosigmoid to facilitate visualization. The peritoneum overlying the psoas muscles was sharply and bluntly dissected to expose the muscles, nerves, common and external iliac vessels, and

FIGURE 1
Superior view of abdomen and pelvis: relationship of point A to nerves



Superior view of the abdomen and pelvis in an unembalmed cadaver illustrating the relationship of the PMM to the PMT, FN, and GFN branches. The asterisk indicates the location of point A on the midportion of the PMM. The curved lines indicate the inguinal ligaments, and the dashed lines indicate half the length of the anteroposterior diameter of pelvic inlet, measured from the PS to the mid sacral promontory (black arrow). The presence (right side) and absence (left side) of the psoas minor tendon are noted.

C, cervix; EIA, external iliac artery; FN, femoral nerve; GFN, genitofemoral nerve; LCV, left common iliac vein; PMM, psoas major muscle; PMT, psoas minor tendon; PS, pubic symphysis; RS, rectosigmoid.

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the sacral promontory. The fascia overlying the psoas and iliacus muscles was sharply dissected to expose other branches of the lumbar plexus.

Determining point A

Point A represented the approximate location for placement of psoas hitch sutures. This site was arbitrarily determined based on preliminary cadaver dissections. In these dissections, the contralateral side of the bladder was mobilized and the apex elevated and positioned along different points on the anterior surface of the psoas major muscle. The anteroposterior (AP) diameter of the pelvic inlet was measured from the sacral promontory to the upper

margin of the pubic symphysis. A distance equal to half the length of the AP diameter was measured, starting from the inguinal ligament and traveling cephalad along the longitudinal axis of the psoas muscle.

Point A was marked at the midwidth of the muscle (Figure 1). This distance was not a direct estimation of ureteral length, nor was it used to estimate location of ureteral injury. The use of half the distance of the AP diameter allowed for an arbitrary yet standardized measurement to help mark point A on the psoas muscle cephalad to the inguinal ligament. Given that the inguinal ligament courses superiorly from its medial attachment at the pubic

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