RESEARCH ARTICLE

Risk of Spermatic Cord Injury During Anterior Pelvic Ring and Acetabular Surgery: An Anatomical Study

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Abstract

Background: Anterior pelvic ring surgery includes a variety of plating techniques and insertion of retrograde superior pubic ramus screws. Anterior acetabular surgery also includes fixation through an ilioinguinal or Stoppa approach. These exposures risk injury to the spermatic cord and accompanying genital branch of the genitofemoral nerve. The primary aim of this study was to identify the distance between the midline and the spermatic cords in adult male cadaveric specimens. The secondary aim was to determine spermatic cord diameters and measure the distance between the spermatic cord and implant during instrumentation of a retrograde superior pubic ramus medullary screw.

Methods: Extended Pfannenstiel and Stoppa approaches were performed on 18 embalmed male cadavers bilaterally. Spermatic cord characteristics were recorded and a number of measurements were performed to determine the distance of implants and the midline from the spermatic cord.

Results: The average distance between the midline and spermatic cords was 34.2 mm. The average distance between the spermatic cord and implant was 18.2 mm. Eleven of the thirty-six dissections had abnormalities including cord lipomas and inguinal hernias. The average cord diameter was 18.6 mm. The average cord diameter in those with abnormalities was 24.9 mm and 16 mm in those without abnormalities, this difference was statistically significant.

Discussion: Due to the proximity of the spermatic cord, the surgeon should either formally expose the cord or limit lateral dissection from the midline during Pfannenstiel and Stoppa exposures. Similarly, the surgeon should use soft-tissue sleeves and oscillating drills to avoid injury to the contralateral spermatic cord during the insertion of retrograde superior pubic ramus medullary screws.

Key Words: Acetabular surgery, Ilioinguinal approach, Retrograde ramus screw, Spermatic cord, Stoppa

Introduction

Anterior pelvic ring fracture surgery includes a variety of fixation techniques including plating, external fixation, and insertion of retrograde superior pubic ramus medullary screws (1-4). Anterior acetabular surgery also includes reduction and fixation through an ilioinguinal or Stoppa approach (5-8). These exposures risk injury to the spermatic cord and accompanying genital branch of the genitofemoral nerve as they pass anterior to the superior pubic ramus [Figure 1].

Both the Pfannenstiel and Stoppa approaches access the anterior pelvic ring through the central raphe of the rectus abdominus muscle (5, 9, 10). Identification of this interval requires dissection anterior to the external oblique aponeurosis and medial to the spermatic cords. Because neither approach requires direct identification of the spermatic cord, the cord may be injured inadvertently when dissection, retraction, or other maneuvers extend too lateral from the midline. However to our knowledge, the average distance from the pubic symphysis to the spermatic cord has not been previously reported. The spermatic cord may also be injured during

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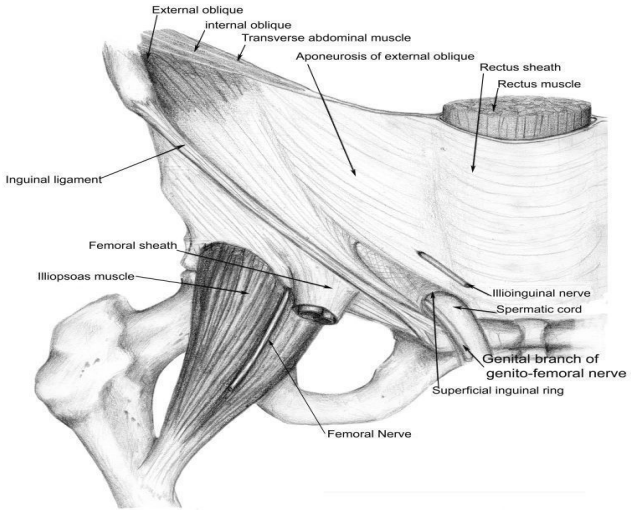

Figure 1. Normal Inguinal Anatomy. The external (superficial) inguinal ring is an opening in the external oblique aponeurosis. It is the end of the inguinal canal and allows passage of the spermatic cord and the genital branch of the genitofemoral nerve. The ilioinguinal nerve course is variable. It often pierces the external oblique aponeruosis cephalad to the superficial ring, but sometimes exits through the external inguinal ring along with the spermatic cord. As the spermatic cord descends to the testicle, it travels anterior to the external oblique aponeurosis, lateral to the pubic symphysis, and anterior to the superior pubic ramus.

dissection, drilling, or placement of retrograde superior pubic ramus implants. To facilitate the appropriate oblique trajectory, the retrograde medullary screw is inserted through a small incision routinely located anterior to the contralateral pubic tubercle (3, 4). As a result the retrograde screw may be in close proximity to the spermatic cord [Figure 2]. Thus, injury may occur if the spermatic cord is medially located expanded in size due to pathological conditions, or if the incision is located inappropriately. To our knowledge average distance between the implant and the spermatic cord has not been previously reported.

The aims of this study are to: 1) identify the distance between the spermatic cord and the midline, 2) identify the average spermatic cord diameter, and 3) determine the distance between the contralateral spermatic cord and the implant during insertion of retrograde superior pubic ramus screws.

Materials and Methods

Eighteen embalmed male cadaveric specimens were dissected using an extended Pfannenstiel incision from the pubic symphysis to the anterior-superior iliac spine bilaterally. All soft tissues anterior to the rectus abdominus sheath and external oblique muscles were removed. The spermatic cord and the genital branch of the genitofemoral nerve as they exited the external (superficial) inguinal ring were identified. Spermatic cord diameters and any obvious abnormalities (hernias and lipomas) were identified. The shortest distance from the midline to the spermatic cords was measured at the cephalad-most aspect of the palpable pubic symphysis. Next, the rectus abdominus muscle was incised longitudinally through the central raphe and released from its pubic insertion. The deep dissection proceeded laterally, completing the release of the rectus abdominus muscle and inguinal ligament from the pubic tubercle. With the pubic tubercle exposed, the technique previously described by Routt et al to insert a 0.062 Kirshner wire into the superior pubic ramus was performed (4). The shortest distance between the inserted Kirshner wire and the contralateral spermatic cord was recorded (4). This technique was duplicated for the contralateral ramus. Student-T test was used to compare the differences between normal and aberrant cords.

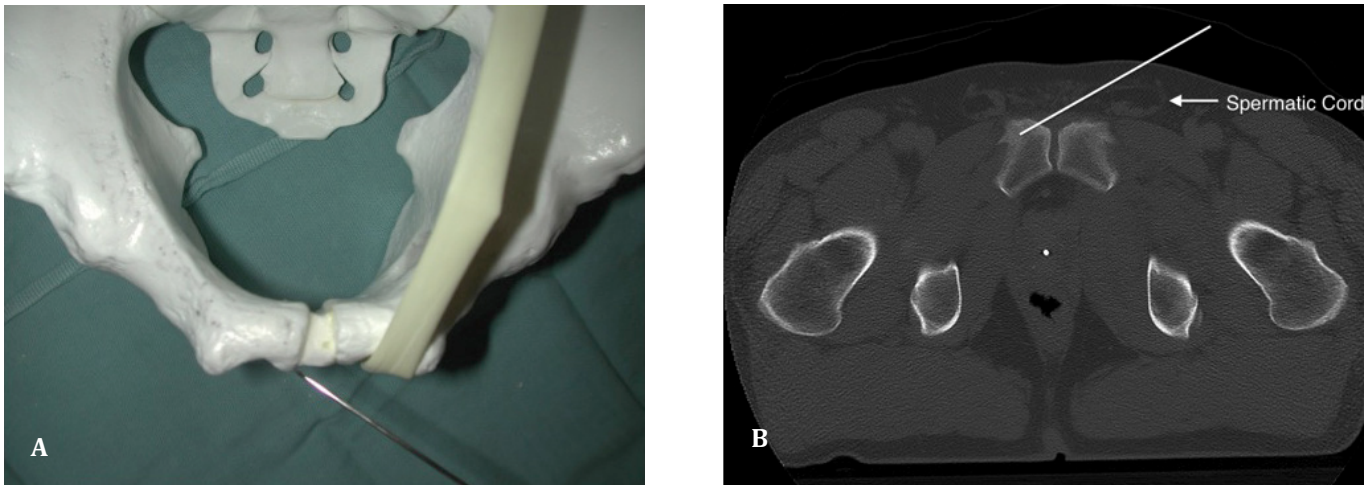

Figure 2. Spermatic Cord and Retrograde Ramus Screws. a) The Kirshner wire simulates the trajectory of the drill bit and screw. The penrose drain simulates the course of the spermatic cord. b) CT scan shows the spermatic cord in cross section and proximity to the pubic tubercle. The trajectory of the drill bit and screw (white line) requires a stab incision over the contralateral pubic tubercle. Subcutaneous dissection allows the drill bit and screw to enter the ipsilateral pubic tubercle. The drill bit and screw are in close proximity to the contralateral spermatic cord.

Table 1. Distance between midline and spermatic cord

	Average (mm)	Range (mm)	St. Dev.
Right (all cords)	34.9		5.7
Left (all cords)	33.5		6.5
Overall	34.2	22 to 45	
Right (with abnormality)	31.8		7.7
Left (with abnormality)	33.7		7.5
Overall	32.7	22 to 40	
Right (without abnormality)	35.9		5.4
Left (without abnormality)	33.2		6.0
Overall	34.6	25 to 45	

*P-value of overall with abnormility and without abnormality: P=0.51

Results

Demographic data available for the cadavers included: average specimen age 80 years old (range 22-100), average height of 169 cm (range 152-191) and average weight of 64 kg (range 34-114).

At the cephalad most aspect of the palpable pubic symphysis, the average distance between the midline and the spermatic cord was 34.2 mm (range 22 to 45 mm) [Table 1]. The average distance between the midline and abnormal cords was 32.7 mm (range 22 to 40 mm). The average distance between the midline and normal cords was 34.6 mm (range 25 to 45 mm). The difference between the distances to the normal and abnormal cords was not significant (P=0.51).

The average cord diameter was 18.6 mm (range 11 to 26 mm) [Table 2]. We further categorized the spermatic cord diameters into those with and without apparent abnormalities. The mean cord diameter in those with abnormalities was 24.9 mm (range 15 to 28 mm). The mean cord diameter in those without abnormalities was 16 mm (range 11 to 22 mm). This difference was statistically significant (P=0.00001).

During the simulated insertion of a retrograde superior pubic ramus medullary screw, the average distance between the Kirshner wire and contralateral spermatic cord was 18.2 mm (range 11 to 30 mm) [Table 3]. Again, we further categorized these results. The average distance between the Kirshner wire and normal spermatic cords was 18.4 mm (range 11 to 30 mm). The average distance between the Kirshner wire and abnormal spermatic cords was 17.1 mm (range 11 to 25 mm). The difference between the distances from the Kirshner wire to the normal and abnormal cords was not significant (P=0.49).

Discussion

Inguinal canal and spermatic cord anatomy is complex, but must be clearly understood when operating on the anterior pelvic ring. The spermatic cord exits the abdomen and enters the inguinal canal through the internal (deep) inguinal ring [Figure 3]. The deep inguinal ring is located midway between the anterior superior iliac spine and the symphysis pubis, and about 1.25 cm proximal the inguinal ligament (11). The inguinal canal extends from the internal (deep) inguinal ring to the external (superficial) inguinal ring. It averages 4 cm long and is parallel the inguinal ligament. The external (superficial) inguinal ring is an opening in the external oblique aponeurosis, cephalad and lateral to the pubic tubercle [Figure 3]. It gives passage to the spermatic cord and the genital branch of the genitofemroal nerve in the male, and to the round ligament of the uterus and the genital branch of the genitofemoral nerve in the female. The spermatic cord then descends to the testicle, passing anterior to the superior pubic ramus.

The spermatic cord is composed of arteries, veins, lymphatics, nerves, and the ductus deferens (11, 12). The testicular artery supplies the substance of the testes while the ductus deferens is the excretory duct of the testes. Violation of the cord anywhere along its pathway

Table 2. Cord Diameters

	Average (mm)	Range (mm)	St.Dev.
Right (all cords)	18.4		5.1
Left (all cords)	18.8		4.9
Overall	18.6	11 to 28	
Right (with abnormality)	25.8		5.0
Left (with abnormality)	24.0		5.3
Overall	24.9	15 to 28	
Right (without abnormality)	15.3		2.3
Left (without abnormality)	16.6		3.0
Overall	16	11 to 22	

*P-value of overall with abnormility and without abnormality: P=0.00001

Table 3. Distance between k-wire and spermatic cord

	Average (mm)	Range (mm)	St.Dev.
Right (all cords)	17.5		5.0
Left (all cords)	18.8		4.6
Overall	18.2	11 to 30	
Right (with abnormality)	17.0		4.0
Left (with abnormality)	17.2		5.3
Overall	17.1	11 to 25	
Right (without abnormality)	17.8		5.5
Left (without abnormality)	19.1		4.6
Overall	18.4	11 to 30	

*P-value of overall with abnormality and without abnormality: P=0.49

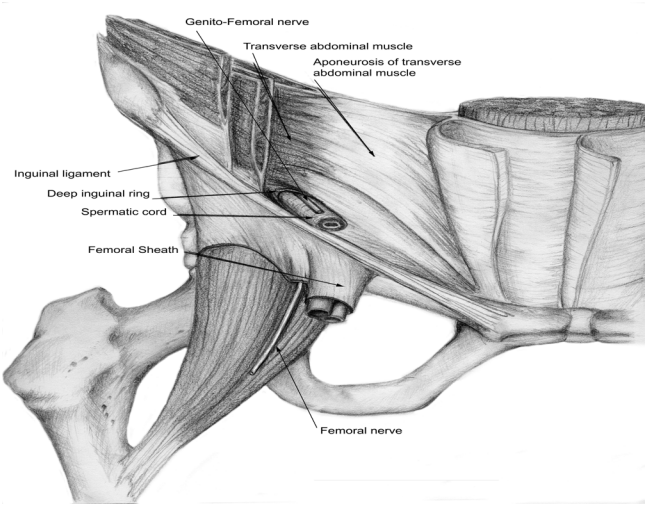

Figure 3. Inguinal Anatomy Deep Layer. The transverses abdominus muscle lies below the internal oblique muscle. The internal (deep) inguinal ring is an opening in the transverses abdominus muscle and is the origin of the inguinal canal.

can injure testicular blood flow and/or interrupt the continuity of the ductus deferens.

In addition to understanding normal inguinal anatomy, the surgeon must also be aware of inguinal canal and spermatic cord abnormalities. The most common abnormalities include inguinal hernias and spermatic cord lipomas (13-17). These anatomical variations alter the normal location and size of the cord, increasing the risk of injury during surgical procedures.

Both the Pfannenstiel and Stoppa approaches risk injury to the spermatic cord when superficial dissection or retraction extends too far laterally. To our knowledge the distance between the midline and spermatic cords has not been reported. In this study, the average distance between the midline and spermatic cord was 34.2 mm. However, several cords were as close as 22 mm to the midline. These findings emphasize the importance of preoperative planning to assess the spermatic cord and its contents on the injury pelvic CT scan and then avoiding indiscriminate dissection and excessive retraction away from the midline during Pfannenstiel and Stoppa approaches. We did not find a significant difference between distances to normal compared to abnormal cords.

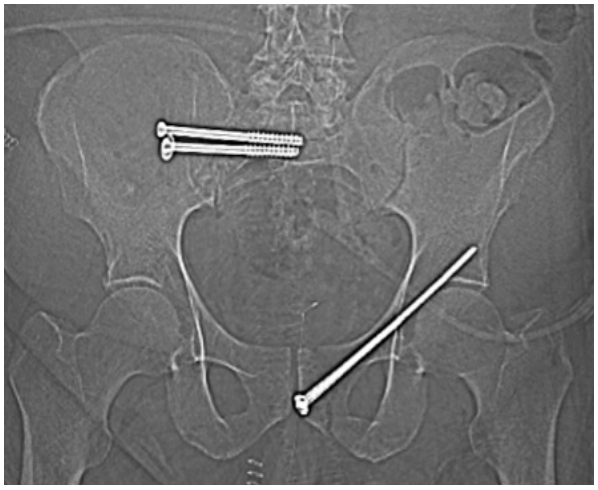

Figure 4. Retrograde Superior Ramus Screw. AP Pelvic radiograph showing retrograde screw stabilization of the superior ramus component of a pelvic ring injury.

The spermatic cord may also be injured during insertion of percutaneous retrograde superior ramus screws. These screws stabilize the superior pubic ramus component of pelvic ring injuries and also the ramus region of anterior column acetabular fractures [Figure 4]. To facilitate the appropriate oblique screw trajectory, the screws are routinely inserted through a small incision over the contralateral pubic tubercle. However, this incision places the drill bit and screw in close proximity to the contralateral spermatic cord. The spermatic cord may be lacerated by a deep skin incision or injured during implant insertion. To our knowledge the distance between the implant and the spermatic cord has not been previously reported. In this study, the average distance between the Kirshner wire and spermatic cord was 18.2 mm. However, distances ranged from 11 mm to 30 mm. This illustrates the variability of the anterior ring and spermatic cord anatomy. We did not find a significant difference between distances from the implant to normal vs. abnormal spermatic cords.

During both the preoperative planning and then intraoperative technical aspects of treating pelvic ring and acetabular injuries the orthopedic surgeon must be aware of possible inguinal abnormalities and the relative location of the spermatic cord during anterior pelvic ring surgery. The spermatic cord was as close as 22 mm to the midline and as close as 11 mm to the Kirshner wire. To avoid inadvertent spermatic cord injury, the surgeon should reference these minimum distances rather than the averages. Due to the proximity of the spermatic cord, the surgeon should minimize superficial dissection away from the midline during Pfannenstiel and Stoppa approaches. Similarly, during insertion of percutaneous retrograde superior ramus screws, the surgeon should use soft-tissue sleeves and an oscillating drill to avoid injury to the nearby spermatic cord.

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