Anatomical Landmarks for Femoral Nerve Block: A Comparison of Four Needle Insertion Sites

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The site for needle insertion in femoral nerve block varies significantly among various descriptions of the technique. To determine the site with the highest likelihood of needle-femoral nerve contact, femoral nerve block was simulated in a human cadaver model (17 femoral triangles from 9 adult cadavers). Four 20-gauge 50-mm-long styletted catheters were inserted at four frequently suggested insertion sites for femoral nerve block. At the levels of inguinal ligament and the inguinal crease, the catheters were inserted adjacent to the lateral border of the femoral artery and 2 cm lateral to the femoral artery. During anatomical dissection, we studied the number of catheter-nerve contacts for each of the four insertion sites, and relationships between the femoral nerve and other anatomical structures of relevance to femoral nerve block. Insertion of the needle at the level of the inguinal crease, next to the lateral border of the femoral artery resulted in the highest frequency of needle-femoral nerve contacts (71%). Of note, the femoral nerve was significantly wider (14.0 vs 9.8 mm) and closer to the fascia lata (6.8 vs 26.4 mm) at the inguinal crease than at the inguinal ligament level. We conclude that needle insertion at the inguinal crease level immediately adjacent to the femoral artery produced the highest rate of needle-femoral nerve contacts. The main factors influencing this result include the greater width of the femoral nerve and the more predictable femoral artery-femoral nerve relationship at the inguinal crease level, compared with the inguinal ligament level. **Implications:** Insertion of a needle at the inguinal crease level and immediately adjacent to the lateral border of the femoral artery results in a high rate of needle-femoral nerve contact.

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The femoral nerve block remains an infrequently used anesthesia technique despite its many clinical indications (1). Possible obstacles to its wider use may include unfavorable local practice settings (2), the need for additional blocks, and inconsistent surgical anesthesia, which are frequently reported with this method (3–5). Suggested needle insertion sites vary widely among published descriptions of the technique (6–9). However, it is not known whether these insertion sites are equally effective for prompt localization of the femoral nerve. In this study, based on human cadaver models, we compared the frequency of needle-femoral nerve contacts on single needle insertions at four frequently used insertion sites. We also studied the spatial relationship among anatomical structures of relevance to femoral nerve block, and postulated how these relationships might influence the performance of the block.

Methods

This experiment was performed on the lower extremities of nine adult cadavers, all dead between 6 and 18 mo. All had been embalmed for anatomical purposes using a solution of phenol (13%) as the principal fixative, and glycerin (28%) for retention of water content. Cadavers were positioned supine on the dissecting table with the long axes of the legs horizontal to the table and the feet forming a 90° angle to the horizontal plane. The anterior superior iliac spine, pubic tubercle, and the midline of the pubic symphysis were marked by colored pins. The inguinal crease was identified as a skin fold distal to the inguinal ligament and parallel to it, medially intersecting the junction of the scrotal (labial) fold with the thigh (Fig. 1).

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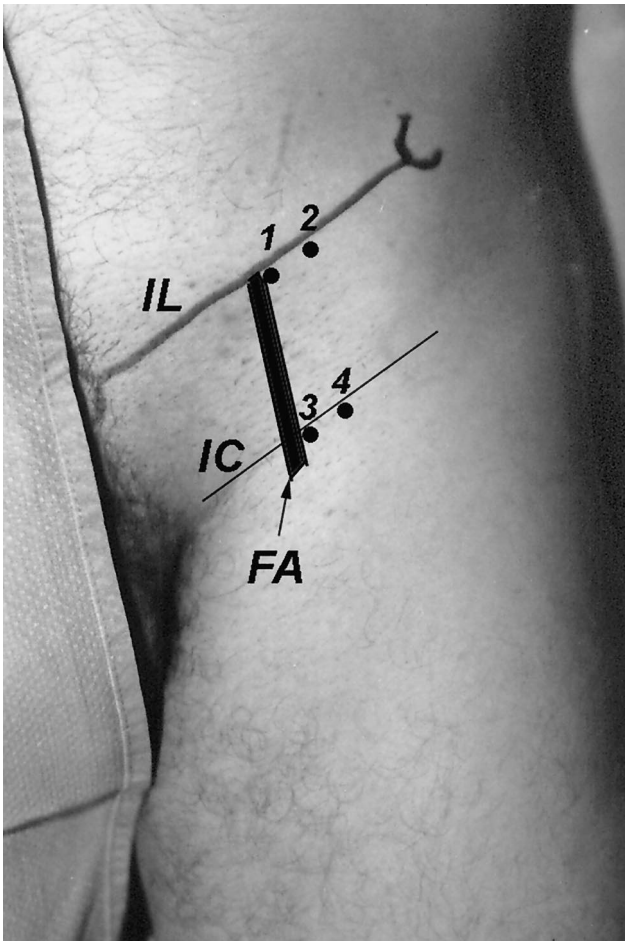

Figure 1. Anatomical landmarks for femoral nerve block; needle insertion sites. IL = inguinal ligament (line between the anterosuperior iliac spine and the pubic tubercle), IC = inguinal crease (a natural skin fold 4–6 cm below the inguinal ligament), FA = femoral artery, numbers 1 through 4 = needle insertion sites.

The skin and fat of the anterior thigh were removed to the level of the fascia lata to identify the femoral triangle with its borders: sartorius muscle laterally, adductor longus muscles medially, and inguinal ligament superiorly (10). Subcutaneous tissue was removed gradually until the anterior wall of the femoral artery was identified. At this level, the femoral nerve could not be identified in any of the cadavers. Four needles with 20-gauge 50-mm-long catheters over the needle were inserted through four different insertion sites to simulate the femoral nerve block (Fig. 1, Table 1). The needles with catheters were advanced perpendicularly to the horizontal plane to a depth of 50 mm or until bone was contacted. The needles were then removed, but the catheters were left *in situ*. Further anatomical dissection of the inguinal triangle was conducted to determine the number of catheter-femoral nerve contacts for each of the four insertion sites. The contact between the catheter and the femoral nerve was considered positive if the catheter had contacted or pierced the femoral nerve. During anatomical dissections, preservation of the fascia lata was given special attention to facilitate precise measurements of the distances from fascia lata to femoral nerve and femoral artery.

Table 1. The Incidence of Needle-Nerve Contacts After Simulation of Femoral Nerve Block at Four Different Insertion Sites

	%
Inguinal ligament	
Adjacent to FA*	12
20 mm lateral to FA†	24
Inguinal crease	
Adjacent to FA	71
20 mm lateral to FA‡	0

FA = Femoral artery, inguinal ligament = a ligamentous stretch between the anterior-superior iliac spine and medial pubic tubercle, inguinal crease = a skin fold distal to the inguinal ligament and parallel to it, medially intersecting the junction of the scrotal (labial) fold with the thigh.
* $P < .05$; † $P < .01$; ‡ $P < .001$.

After dissection of the femoral triangles was completed, the sizes of the femoral artery and femoral nerve were obtained and distances of the femoral nerve to femoral artery and fascia lata were measured (Table 2). Because the femoral nerve has an oval-like profile, the shortest femoral nerve-femoral artery and femoral nerve-fascia lata distances were used.

Data are expressed as means ± SD for continuous measures. The differences in the spatial relationship (distances) of the relevant anatomical structures at the inguinal ligament and inguinal crease levels were analyzed using the paired *t*-test. As the needle-femoral nerve contacts were evaluated in the same 17 cadaver legs, analyses were conducted by a series of McNemar's χ^2 tests (one leg was excluded because extensive scarring in the femoral region precluded precise measurements). The relationships of the four insertion sites were tested in all pair-wise combinations. For instance, the number of needle-femoral nerve contacts at one point (e.g., insertion at the inguinal ligament and adjacent to the femoral artery) was compared to the number of contacts observed at each of the other three insertions. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS for Windows, version 5.0.2, Chicago, IL).

Results

The study material comprised 17 femoral triangles from nine cadavers (four female, five male) of average body frame and nutrition. As shown in Table 1, the proportion of needle-femoral nerve contacts when the needle was inserted at the inguinal crease and immediately to the lateral border of the femoral artery was significantly higher than that observed at any of the other three tested points. Moreover, the rates of

Table 2. Relationship of the FN and the FA to the Surrounding Structures in the Femoral Triangle at Various Levels

Distance (mm)	Level		*P* value
	Inguinal crease	Inguinal ligament	
FA–fascia lata	3.2 ± 1.5	19.7 ± 6.4	<0.01
Femoral nerve–fascia	6.8 ± 2.7	26.4 ± 7.0	<0.01
Femoral nerve width	14.0 ± 2.0	9.8 ± 2.0	<0.01

Values are mean ± SD.
FN = femoral nerve, FA = femoral artery, inguinal ligament = a ligamentous stretch between the anterior-superior iliac spine and medial pubic tubercle, inguinal crease = a skin fold distal to the inguinal ligament and parallel to it, medially intersecting the junction of the scrotal (labial) fold with the thigh.

needle-femoral nerve contacts of the other three insertions were not significantly different by pair-wise comparisons. There were no needle-femoral nerve contacts when the needle was inserted at the inguinal crease (20 mm lateral to the femoral artery). In all cadaver legs, the femoral nerve was medial to this insertion point.

The femoral nerve was more superficial (closer to the fascia lata) at the level of the inguinal crease than at the level of the inguinal ligament (6.8 ± 2.7 vs 26.4 ± 7.0 mm; $P < 0.01$) (Table 2). The femoral nerve was also significantly wider (14.0 ± 2.0 vs 9.8 ± 2.0 mm; $P < 0.01$) at the inguinal crease than at the inguinal ligament level. It should be noted that the femoral artery-femoral nerve relationship was more consistent at the inguinal crease than at the inguinal ligament. At the inguinal crease level, the femoral nerve was immediately adjacent to the femoral artery. Indeed, in 70.6% of the cases, the femoral nerve was partially covered by the femoral artery. In contrast, at the level of the inguinal ligament, the femoral artery partially covered the nerve in only 11.7% of cases and the distance between the two structures varied from 0.0 to 13.0 mm (median 8.5).

Discussion

The preferred site of insertion in femoral nerve block varies widely. Moore (8) suggested an insertion site at 2.5 cm below the inguinal ligament and just lateral to the femoral artery. In another common technique, the needle is inserted at the lateral border of the femoral artery, but at the inguinal ligament level (9). Our results suggest that the femoral nerve is most consistently localized when the needle is inserted at the inguinal crease level and immediately lateral to the femoral artery. Based on anatomical measurements, this is mainly because of the intimate and predictable femoral nerve-femoral artery relationship, as well as the greater width of the femoral nerve at this level. These anatomical characteristics, along with the superficial position of the femoral nerve at the inguinal crease level, should facilitate performance of femoral nerve block in patients, with fewer attempts required to localize the femoral nerve. In patients, however, the use of a nerve stimulator may substantially facilitate identification of the femoral nerve at other sites.

It is important to note that some of the branches of the femoral nerve to the sartorius muscle and neighboring skin start departing the main trunk of the nerve as the nerve emerges under the inguinal ligament. However, the bulk of the femoral nerve remains enveloped by the epineural sheath at the inguinal crease level.

The limitation of the study was the possibility that the anatomy of embalmed cadavers was somewhat distorted. Specifically, the blood vessels did not contain blood, and were partially collapsed. However, the embalming process typically affects veins more than arteries because of the thicker and more rigid arterial vessel wall, and the diameter of the arteries should be affected similarly at both the inguinal ligament and inguinal crease levels. Additionally, the mere finding of the catheter tip-nerve contact in our cadaveric study is no guarantee of a successful blockade in patients. However, our preliminary data of a follow-up clinical study testing the ease of performing femoral nerve block through the approach at the inguinal crease level are in agreement with the anatomical results. In this study, a needle connected to a low-output nerve stimulator was inserted at the inguinal crease level, immediately lateral to the femoral artery and directed in the sagital plane at 60 degrees cephalad. In 100 consecutive patients, this technique resulted in identification of the femoral nerve (rhythmic movement of the patella) on one or two attempts in more than 90% of patients (11). Injection of 30 milliliters of local anesthetic after the quadriceps muscle twitch was obtained at 0.4 milliampere or less resulted in a 100% success rate (inability to extend the leg in the knee joint and insensitivity to touch in the anterior thigh and medial leg below the knee).

In summary, insertion of the needle at the inguinal crease level and immediately to the lateral border of the femoral artery in adult cadavers resulted in a high frequency of needle-femoral nerve contacts. Additional advantages of approaching the femoral nerve at this location are the greater width and superficial location of femoral nerve, which both should facilitate localization of the femoral nerve.

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