Defining the Location of the Adductor Canal Using Ultrasound

Wan Yi Wong, MMed, MBBS, * Siska Bjørn, MS, † Jennie Maria Christin Strid, MD, † Jens Børglum, MD, PhD, ‡ and Thomas Fichtner Bendtsen, MD, PhD†

Background and Objectives: The precise location of the adductor canal (AC) in the thigh is a matter of debate among anesthesiologists. The location of the AC has become a subject of increasing interest owing to the advent of ultrasound-guided adductor canal block (ACB) for postoperative analgesia after total knee arthroplasty.

Methods: Twenty-two volunteers were examined using ultrasound. The proximal end of the adductor canal was identified where the medial border of the sartorius muscle intersects the medial border of the adductor longus muscle. The distal end of the adductor canal is the adductor hiatus, which was also visualized ultrasonographically.

Results: The mean distance from the anterior superior iliac spine to the midpoint of the thigh was 22.9 cm (range, 20.3–24.9 cm). The mean distance from the anterior superior iliac spine to the proximal end of the adductor canal was 27.4 cm (range, 24.0–31.4 cm). Consequently, the mean distance from the midpoint of the thigh to the proximal end of the adductor canal was 4.6 cm (range, 2.3–7.0 cm).

Conclusions: In all volunteers, the midpoint of the thigh was proximal to the beginning of the adductor canal, suggesting that an injection performed at this level is in fact a femoral triangle block.

† Department of Anesthesiology, Intensive Care and Pain Medicine, Tan Tock Seng Hospital, Singapore; † Department of Anesthesiology and Intensive Care Medicine, Aarhus University Hospital, Aarhus, Denmark; and ‡ Department of Anesthesiology and Intensive Care Medicine, Zealand University Hospital, University of Copenhagen, Copenhagen, Denmark. Accepted for publication October 12, 2016.

Address correspondence to: Thomas Fichtner Bendtsen, MD, PhD, Department of Anesthesiology, Aarhus University Hospital, Norrebrogade 44, DK-8000 Aarhus, Denmark (e-mail: tfb@dadlnet.dk).

The authors declare no conflict of interest.

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for effective analgesia after a total knee arthroplasty; and an injection specifically delivered into the AC will likely not anesthetize the medial vastus nerve.17

To the best of our knowledge, no reports or studies have illustrated the correlation between the surface landmarks and ultrasonographic identification of the proximal and distal ends of the AC. This is relevant for the regional anesthesiologist to ensure the accurate placement of a nerve block. Therefore, the aim of this study was to examine and identify the exact location of the AC with ultrasound guidance in relation to the midpoint of the thigh, defined as the midpoint between the ASIS and the base of patella.

METHODS

Twenty-two volunteers with American Society of Anesthesiologists (ASA) physical status I were recruited during a randomized, controlled, clinical trial prospectively approved by the regional ethics committee (MJ: 1-10-72-368-15). The Danish Ethics Committee approved that the additional data sampling for the present separate study did not require additional prior approval. Written, informed consent and demographic data were obtained from all subjects.

The lower limb that was not part of the concurrent clinical trial was chosen for measurements for the purpose of this study. The subjects’ thighs were exposed from the ASIS to the patella in the supine position. The distance from the ASIS to the base of patella was measured, and the midpoint of the thigh was marked as the half-distance between the ASIS and the base of patella (Fig. 2). The ultrasound probe (Sonosite X-Porte 5–2 MHz; FUJIFILM SonoSite Inc, Bothell, Washington) was then placed medially and proximally just below the inguinal crease, and the entire trajectory of the femoral artery was scanned systematically. The femoral artery was first identified inside the FT, with the sartorius muscle anteromedially, the vastus medialis muscle anterolaterally, and the adductor longus posteromedially (Fig. 1A and Fig. 2). The probe was slid distally along the trajectory of the femoral artery until the medial border of the sartorius muscle intersected the medial border of the adductor longus muscle, which is defined as the apex of the FT (Fig. 1B). The AC begins right at the apex of the FT, and this reference point is easy to identify with ultrasound.4,18 This point was marked on all subjects (Fig. 1B and Fig. 2). The femoral artery was traced further distally until it diverged from the sartorius muscle between the medial vastus and adductor magnus muscles and exited through the adductor hiatus into the popliteal fossa (Fig. 1C). The adductor hiatus is the distal end of the AC, and it was marked on the thigh (Fig. 2).

The distance from the ASIS to the base of patella and the distance from the ASIS to the midpoint of the thigh were measured in all subjects. The distances from the ASIS to the proximal and distal ends of the AC were also measured (Fig. 2). From these measurements, the distance from the midpoint of the thigh to the beginning of the AC as well as the length of the AC was calculated. Data were analyzed using Stata 13.1 (StataCorp LP, College Station, Texas). Normality of distribution of continuous variables was assessed with Q-Q plots. Continuous normally distributed variables are presented as mean and range, continuous non-normally distributed variables are presented as medians and interquartile range, and categorical variables are presented as count (%%).

RESULTS

Thirteen male and 9 female healthy volunteers were included in this study (Table 1). The proximal and distal ends of the AC were ultrasonographically identifiable in all subjects. Table 2 displays the measurements of the length and midpoint of the thigh, the proximal end and length of the AC, and the distance from the midpoint of the thigh to the proximal end of the AC.
The proximal end of the AC was distal to the midpoint of the thigh in all 22 subjects (Table 2).

**DISCUSSION**

In this study, the proximal end of the AC was located distal to the midpoint of the thigh, defined as half the distance between the ASIS and base of patella, in all of the 22 subjects.

A recent cadaver study by Anagnostopoulou et al²⁰ showed similar results. The proximal end of the AC defined as the "superior foramen of the adductor canal" was distal to the midpoint of the thigh in 13 of the 17 dissected specimens.²° The mean distance from the midpoint of the thigh to the superior foramen of the AC was 6.5 cm (range, 1.8–10.0 cm) compared to 4.6 cm (range, 2.3–7.0 cm) in our study.²⁰ Tubbs et al¹³ also performed a dissection study in 16 specimens and reported a mean distance from the ASIS to the proximal border of the VAM of 28.0 cm (range, 20.0–32.0 cm). The AC is roofed by the VAM in its entire length, and hence the proximal border of the VAM marks the beginning of the AC. Consequently, the results from the cadaver study correspond very well with the results seen in the present study, where the mean distance from the ASIS to the ultrasonographically identified proximal end of the AC was 27.4 cm (range, 24.0–31.4 cm).

We recognize that ultrasonography is a different technique for identification of the proximal and distal ends of the AC compared to cadaver dissection, and this technical difference may produce slightly different results despite the easy ultrasonographic recognition of the AC. This difference in methods may explain the four specimens in the study by Anagnostopoulou et al, where the beginning of the AC was proximal to the midpoint of the thigh.²⁰

**TABLE 1. Demographics**

<table>
<thead>
<tr>
<th>n = 22</th>
<th>Age, y</th>
<th>23 [22–24]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, male</td>
<td>13 (59%)</td>
<td></td>
</tr>
<tr>
<td>Weight, kg</td>
<td>73 (54–93)</td>
<td></td>
</tr>
<tr>
<td>Height, cm</td>
<td>177.3 (157–195)</td>
<td></td>
</tr>
</tbody>
</table>

Continuous non-normal variables are presented as median [IQR]. Categorical variables are presented as count (%). Continuous normal variables are presented as mean (range).

**TABLE 2. Measurements of the Location of the Adductor Canal**

<table>
<thead>
<tr>
<th>n = 22</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of thigh, cm</td>
<td>45.7</td>
<td>40.5–49.8</td>
</tr>
<tr>
<td>Midpoint of thigh, cm</td>
<td>22.9</td>
<td>20.3–24.9</td>
</tr>
<tr>
<td>Proximal end of AC, cm</td>
<td>27.4</td>
<td>24.0–31.4</td>
</tr>
<tr>
<td>Midpoint of thigh to proximal end of AC, cm</td>
<td>4.6</td>
<td>2.3–7.0</td>
</tr>
<tr>
<td>Length of AC, cm</td>
<td>11.5</td>
<td>8.9–14.5</td>
</tr>
</tbody>
</table>

Length of thigh, the distance from ASIS to the base of patella; midpoint of thigh, half the distance from ASIS to the base of patella; proximal end of the AC, the distance from ASIS to start of AC; length of AC, the distance from proximal end of AC to the distal end of AC (adductor hiatus).
Nonetheless, we can conclude from these cadaver studies as well as from the present study that the midpoint of the thigh is at the level of the FT, and hence, the proximal end of the AC is distal to the midpoint of the thigh in most human beings.

Ultrasound is a useful clinical tool to identify the apex of the FT and the location of the AC. The point where the medial border of the sartorius muscle intersects the medial border of the adductor longus muscle marks the beginning of the AC, which is clearly seen in most human beings using ultrasound (Fig. 1B). The distal end of the AC is identified by the femoral vessels exiting at the adductor hiatus to become the popliteal vessels between the tendons of the adductor magnus muscle (Fig. 1C). The ultrasonographic visualization of the VAM with the characteristic double contour was also visible in most of the subjects (Fig. 3). This can be used as an additional ultrasonographic confirmation of the location of the AC. We recognize most regional anesthesiologists use ultrasound to guide needle insertion from the skin to the target nerve. However, many use surface landmarks rather than ultrasound to identify the level of injection. The most commonly applied surface landmark used to identify the location of the AC is the midpoint between ASIS and base of patella, which is proved to be a biased proxy marker of the AC by our results.

The FT and the AC were easily recognized in all our subjects, and we deem ultrasound to be more accurate than the use of surface landmarks to identify the actual location of the AC. We recognize most regional anesthesiologists use ultrasound to guide needle insertion from the skin to the target nerve. However, many use surface landmarks rather than ultrasound to identify the level of injection. The most commonly applied surface landmark used to identify the location of the AC is the midpoint between ASIS and base of patella, which is proved to be a biased proxy marker of the AC by our results.

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An injection at the midthigh level produces an effective block of the femoral nerve branches that innervate the anteromedial part of the knee. Based on our observations, this is mainly an FT injection (Fig. 1A and Fig. 2). Consequently, “ACB” is a misnomer for midthigh blocks that are actually in the FT. It could be speculated that a true ACB may not produce the same effective analgesia after total knee arthroplasty if the medial vastus nerve is an important contributor to knee innervation. In addition, an injection of a small volume of local anesthetic into the distal part of the true AC can be speculated to spread into the popliteal fossa and anesthetize the posterior branch of the obturator nerve and the popliteal plexus, which provide intra-articular innervation of the knee. An injection of a large volume of local anesthetic into the FT at the midthigh level may spread proximally and anesthetize the quadriceps’ motor branches of the femoral nerve, whereas a large volume injected into the true adductor canal may spread via the popliteal fossa to the sciatic nerve. Paralysis of the quadriceps femoris and the muscles of the leg would impede ability to ambulate and increase the risk of fall.

The need for a clinical trial comparing the effects of an FT block with a true ACB remains.

CONCLUSIONS

In this study of 22 volunteers, the proximal end of the AC was consistently distal to the midpoint of the thigh. Consequently, an injection at the midpoint between ASIS and the base of patella is in fact an FT block, whereas true ACB requires a more distal approach. Furthermore, the proximal and distal ends of the AC are easily identified using ultrasound, which is a more reliable method to identify the exact location of the AC compared to surface landmarks and measurements.

REFERENCES


