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Cadaveric Exploration of the Anatomical Position of the Adductor Canal

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Abstract

Objective. This study aimed to precisely identify the location of the adductor canal to assist knee surgeons during procedures. **Materials and Methods.** We utilized twenty formalin-fixed cadavers to measure the length of the lower limb from the mid-inguinal point (MIP) to the base of the patella and divided the measured length into three parts: the proximal, middle, and distal. After dissecting the adductor canal, we measured the distance between the MIP and the proximal foramen and the distal foramen (adductor hiatus), the distance between the distal foramen and the base of the patella, and the length of the adductor canal. We also measured the location of the proximal and distal foramina concerning the upper and lower limits of the middle third of the thigh. **Results.** The mean lengths of the thigh and adductor canal were 39.59±3.6 cm and 15.24±2.26 cm, respectively. The average distances between the MIP and the proximal and distal foramina and between the distal foramen and the base of the patella were 14.39±1.98 cm, 29.56±2.22 cm, and 10.28±1.87 cm, respectively. In 75% of lower limbs, the proximal foramen was below the upper limit of the mid-third of the thigh, with an average distance of 1.74 cm, whereas in 85% of cases, the distal foramen was below the lower limit of the mid-third of the thigh, with an average distance of 3.3 cm. **Conclusion.** This study suggests that the ideal adductor canal block approach is within the middle third of the thigh.

Key Words: Adductor Canal Block ▪ Adductor Hiatus ▪ Mid-Inguinal Point ▪ Patella.

Introduction

For many years, postoperative analgesia after knee surgery has been achieved using peripheral nerve blocks, mostly femoral nerve blocks (FNB). However, the major problem with FNB was that it resulted in quadriceps weakness, necessitating the search for other nerve blocks. In the past few years, the adductor canal block (ACB) was first described as a purely sensory nerve block for knee surgeries and postoperative analgesia (1). In recent years, there has also been an increased acceptance of ultrasound-guided ACB during knee surgeries to enhance the delivery of anaesthetics (2). However, the procedure initially relied on surface landmarks to mark the location of the injection site (3). Although ultrasound guidance has several advantages, such technology is still lacking in many developing and underdeveloped countries due to cost and a lack of equipment and training. Hence, anaesthesiologists and clinicians in these regions still depend on the traditional surface landmark technique to perform the block. The rationale for ACB is that the saphenous nerve (sensory nerve) and a part of the obturator nerve pass through the adductor canal of the thigh, and therefore, injecting local anaesthetics in the canal blocks these nerves and provides analgesia. In some cases, a continuous ACB block of the saphenous and/or obturator nerves is essential for postoperative pain management in knee surgery (4). The advantage of ACB over FNB is that it preserves the strength of the quadriceps postoperatively, as reported in several studies (5, 6).

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The adductor canal, a musculoaponeurotic tunnel also known as Hunter's canal, is located in the middle of the thigh. It extends to the hiatus magnus (distal foramen), an aperture within the adductor magnus muscle from the apex of the femoral triangle (proximal foramen), also referred to as Scarpa's triangle. This canal is an important route through which neurovascular structures in the lower extremities pass, as it contains vital structures such as the nerve to the vastus medialis, saphenous nerve, femoral vein, and femoral artery. In several studies, ACB for postoperative analgesia has been performed at the mid-thigh level, roughly midway between the anterior superior iliac spine (ASIS) and the superior border of the patella (4, 7).

However, there is still much contention regarding the exact location of the ACB, as found in several studies. The use of ACB is primarily confined to orthopaedic centres with high patient volumes, where skilled anaesthesiologists proficient in regional anaesthesia are available. Nevertheless, in the absence of the aforementioned facility, ACB is still a challenging procedure in many centres. While there has been detailed research on the sonographic localisation of the adductor canal, there is limited information regarding cadaveric studies on the subject in the literature.

Hence, this study aimed to fill this gap by focusing on the precise identification of the adductor canal.

Materials and Methods

The present study was conducted at the Department of Anatomy, King George's Medical University, a major tertiary care centre in Northern India. Twenty formalin-fixed cadavers of both sexes (15 male and 5 female) were included in the study. Thigh length was measured from the mid-inguinal point (MIP) to the base of the patella with the cadaver in a supine position. The thigh was then divided into three segments. The upper and lower margins of the middle segment were marked (Figure 1). The inguinal ligament was identified, and a horizontal incision was made slightly below and parallel to it. Another vertical incision was made, starting from the pubic tubercle and extending down along the medial aspect of the thigh up to the medial aspect of the knee. The skin flap was then reflected laterally. The subcutaneous tissue was removed to expose the fascia lata. It was then incised and reflected laterally. The apex of the femoral triangle (proximal foramen) was identified and marked. The boundaries of the adductor canal were identified. The neurovascular bundle,

Figure 1. Length of the thigh from the mid-inguinal point (point a); To the base of the patella (point b).

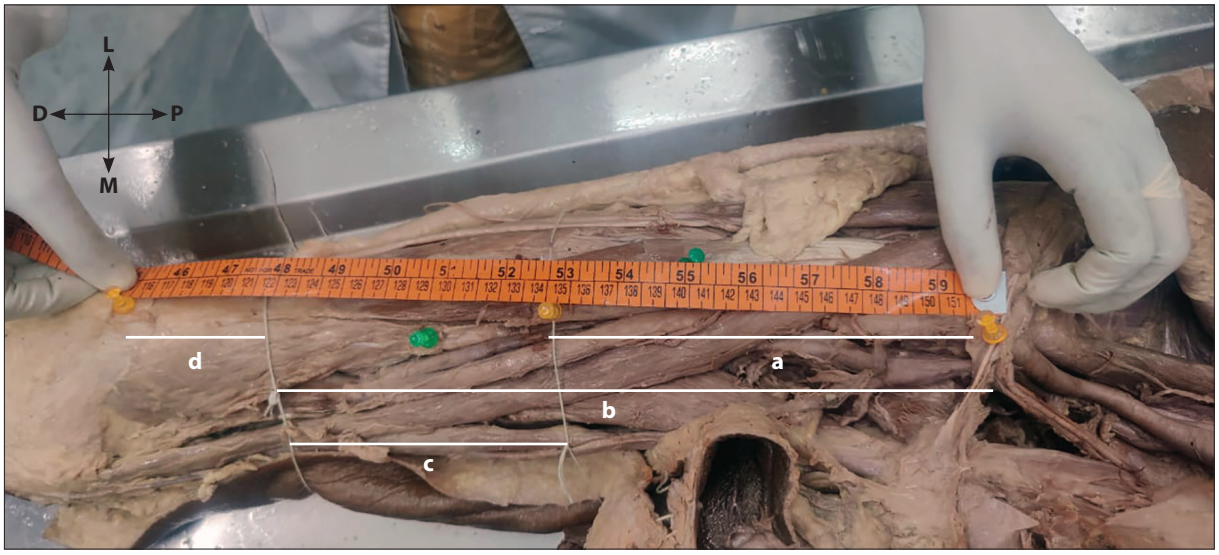

Figure 2. a - distance of the proximal foramen; b - distance of the distal foramen; c - length of the adductor canal; d - distance of the distal foramen from the base of the patella.

which typically includes the femoral artery, femoral vein, and saphenous nerve, was identified. The femoral artery was traced by a blunt dissection up to the adductor hiatus (distal foramen). The following measurements were made (Figure 2):

1) The Length of the thigh from the MIP to the base of the patella;
2) The distance of the proximal foramen from the MIP;
3) The distance of the distal foramen (from the summit of the hiatus) from the MIP, as well as from the base of the patella;
4) The length of the inguinal canal from the proximal foramen to the distal foramen.

Ethics Statement

The Institutional Ethics Committee of King George's Medical University, Lucknow, India, granted ethical approval for this study (Ref No: 131st ECMIIA/P18 dated 9 July 2024).

Statistical Analysis

The data were entered into Microsoft Excel and analysed using SPSS software version 26 (IBM Corp., Armonk, NY). Descriptive statistics, including the mean, standard deviation, and percentage distribution, were calculated for all measured parameters. An independent-sample *t*-test was used to compare the measurements between the right and left lower limbs. A P-value of <0.05 was considered statistically significant.

Results

The mean lengths of the thigh and adductor canal were 39.59±3.6 cm and 15.24±2.26 cm, respectively. The difference in the lengths of the thigh and adductor canal between the right and left sides was not statistically significant. The average distance between the MIP and the proximal and distal foramina was 14.39±1.98 cm and 29.56±2.22 cm, respectively. The mean distance between the distal foramen and the base of the patella was 10.28±1.87 cm. No statistically significant differences were observed in the above parameters between the right and left sides (Table 1).

In 75% of lower limbs, the proximal foramen was below the upper limit of the mid-third of the thigh, with an average distance of 1.74 cm, and in 20% of lower limbs, it was above the upper limit of the mid-third of the thigh, with an average distance of 0.83 cm. In 2 cases, the proximal foramen was almost at the level of the upper limit of the middle third of the thigh (Figure 3). In 97.5% of

Table 1. Paired Samples Statistics

Paired samples		Mean±3.70	Mean change	% mean change	t value	P-value
Pair 1	Length of thigh (right)	39.57±3.70	-0.04	-0.10	-0.556	0.585
	Length of thigh (left)	39.61±3.66				
Pair 2	Distance of the proximal foramen from the mid-inguinal point (right)	14.39±2.02	0	0	0	1.000
	Distance of the proximal foramen (left)	14.39±2.10				
Pair 3	Distance of the distal foramen from the mid-inguinal point (right)	29.32±2.77	-0.49	-1.67	-1.397	0.179
	Distance of the distal foramen from the mid-inguinal point (left)	29.81±2.50				
Pair 4	Length of the adductor canal (right)	15.07±2.40	-0.35	-2.32	-1.080	0.294
	Length of the adductor canal (left)	15.42±2.29				
Pair 5	Distance of the distal foramen from the base (right)	10.48±1.85	0.39	3.72	1.302	0.208
	Distance of the distal foramen from the base (left)	10.09±2.01				

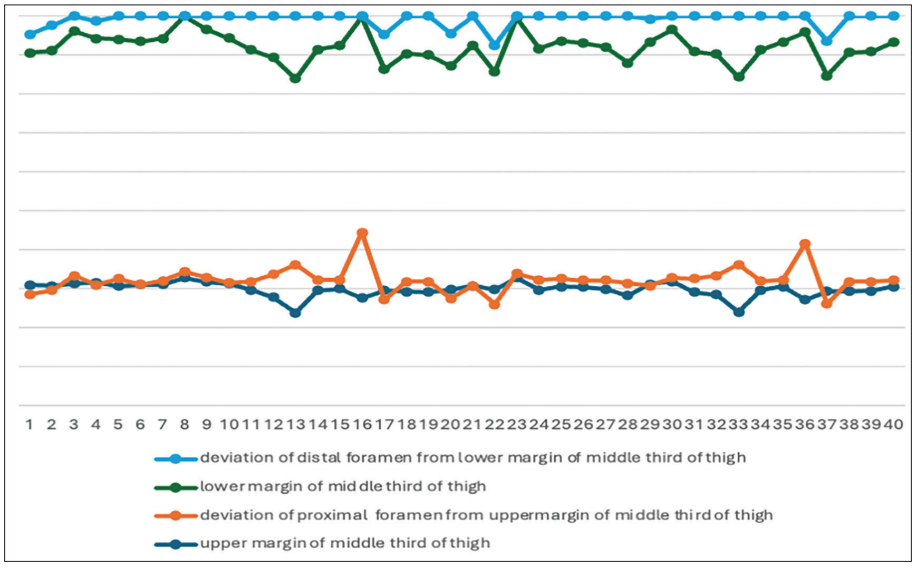

Figure 3. Plot diagram showing the deviation of the proximal and distal foramina in relation to the middle third of the thigh.

cases, the distal foramen was below the lower limit of the mid-third of the thigh, with a mean distance of 3.3 cm, whereas in 1 limb (2.5%), the distal foramen was above the lower limit of the mid-third of the thigh at 0.2 cm (Figure 3).

Discussion

This cadaveric study uniquely employed the mid-inguinal point as a reference for measurements. It revealed a mean adductor canal length of 15.24±2.26 cm and provided precise data on the anatomical position of the proximal and distal foramina relative to the middle third of the thigh. The proximal foramen was located below the upper limit of the middle third in 75% of cases, whereas the distal foramen was located below the lower limit in 97.5% of cases. No statistically significant differences were observed between the right and left sides. In a comparative analysis of the dimensions of the thigh and the adductor canal, discrepancies in the findings were observed across

different studies. In an ultrasonographic study in 2016 involving 22 volunteers, the authors reported an average thigh length of 45.7 cm, an average length of the adductor canal of 11.5 cm, and an average distance of the proximal foramen from the ASIS of 27.4 cm (8). In a cadaveric study in 2019 involving 40 limbs, the average measurements were slightly shorter, with males having a mean thigh length of 44.2 cm, a mean adductor canal length of 10.5 cm, and females having a mean of 42 cm and 8.5 cm, respectively. The mean distance of the proximal foramen from the ASIS was 25 cm and 24 cm in males and females, respectively (9). The ASIS was used as the reference point in both studies (8, 9).

However, our study had a notable deviation from the previous results, in which the mean length of the thigh measured using the MIP was 39.59±3.6 cm, which is lower than that in earlier studies. The MIP was used for thigh length in this study since the MIP and the base of the patella present in the same vertical plane.

Furthermore, the average length of the adductor canal was found to be longer, 15.24±2.4 cm. The average distance of the proximal foramen from the MIP was 14.39±2.02 cm. The author measured the mean distance of the distal foramen from the patella base as 9 cm and 9.5 cm in males and females, respectively, compared to 10.28±1.87 cm in the present study (9). A study conducted in 2016 stated that the anatomical location of the proximal foramen of the adductor canal is located caudal to the midpoint of the thigh, with an average distance of approximately 4.6 cm. Meanwhile, another study found that the proximal foramen is located caudal to the midpoint of the thigh at a mean distance of 4.5 cm in 90% of cases (8, 9). A cadaveric study with a sample size of 17 showed that in 13 specimens, the proximal foramen of the adductor canal was located distally to the midpoint of the thigh at an average distance of 6.5 cm (10).

In contrast, the present study showed that in 75% of lower limbs, the proximal foramen was located below the upper boundary of the mid-third of the thigh at an average distance of 1.74 cm. Meanwhile, the distal foramen is located below the lower boundary of the mid-third of the thigh, with an average distance of 3.3 cm. These variations highlight the importance of understanding individual anatomical variations and emphasize the need to consider multiple sources of evidence when interpreting findings related to adductor canal anatomy.

Limitations of the Study

The sample size and characteristics of the participants may not be representative of the general population. Individual anatomy, height, body habitus, and musculoskeletal differences were not considered. Further research with larger, more heterogeneous samples and possibly the use of imaging and procedural guidance may address some of these limitations and provide more information on the best way to perform ACB.

Future Scope

While the present study provides a detailed surface-based anatomical localization of the adductor canal and its foramina, future studies can build upon this dataset to explore the internal anatomy in greater detail. Specifically, cross-sectional anatomical studies at key levels of the thigh are recommended to assess the depth and spatial arrangement of the femoral artery, vein, saphenous nerve, and nerve to the vastus medialis. Such data will be valuable for refining blind adductor canal block techniques, especially in settings where ultrasound guidance is not available. Additionally, integrating depth measurements, simulated needle trajectories, and safety margins will help translate anatomical insights into safer clinical practice.

Conclusion

The precise placement of the injection is crucial when administering the drug in ACB for optimal anaesthetic effect. The observations made in this study indicate that the proximal foramen of the adductor canal is located distal to the upper border of the middle third of the thigh, and the

distal foramen lies distally to the inferior border of the same region. These findings emphasise the importance of aiming at the distal portion of the mid-third of the thigh while performing ACB. Therefore, the focus should be on this area to avoid accidental injection placement at the midpoint, which may result in an undesirable femoral block. Therefore, by directing attention to the distal end of the middle third of the thigh, anaesthesiologists can refine the precision and effectiveness of ACB procedures to improve patient comfort and results.

What Is Already Known on This Topic:

Patients experienced better quadriceps strength and earlier mobility following adductor canal blocks compared to femoral nerve blocks. No significant complications have been reported when the adductor canal is correctly located and local anaesthetic is administered. Although the technique of the adductor canal block, its anatomy, and its application in knee anaesthesia are well described, it is important to pay attention to the exact localisation of the adductor canal to perform the block and avoid complications. Some earlier studies have also described the anatomical relationships and landmarks of the adductor canal; however, variations still exist. Although the general anatomy is well understood, it is essential to investigate the exact landmarks in more detail.

What This Study Adds:

This study provides the mean distances of the proximal and distal openings of the adductor canal from the mid-inguinal point, a recognisable bony marker, which helps define the canal location more precisely. The study also assessed the reliability of the proximal and distal openings that could be identified within the boundaries of the middle third of the thigh using the MIP landmark, which helped validate the usefulness of the landmark. The study also provided information on the normal range and inter-individual variability, which will be useful in guiding injection techniques.

Authors' Contributions: Conception and design: HS and RS; Acquisition, analysis and interpretation of data: HS, NUS and PS; Drafting the article: HS and RS; Revising it critically for important intellectual content: HS and RS; Approved final version of the manuscript: HS, RS and NK.

Presentation and Awards: Presented at the 12th International Conference of the Society of Clinical Anatomists at the D.Y. Patil Medical College and Hospital, Pune, India.

Conflict of Interest: The authors declare that they have no conflict of interest.

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