DOI: 10.4274/MMJ.galenos.2024.47042
Medeni Med J 2025;40:12-17

Original Article

The Lateral Femoral Cutaneous Nerve is at High Risk During Direct Anterior Approach to the Hip Joint Due to Proximity and Anatomic Variations: A Cadaveric Study

Lateral Femoral Kutanöz Sinir, Yakınlık ve Anatomik Varyasyonlardan Dolayı Kalça Eklemine Direkt Anterior Yaklaşım Sırasında Yüksek Risk Altındadır: Bir Kadavra Çalışması

Dang Hoang GIANG[1], Thanh Xuan DAO[1], Du Gia HOANG[2]

[1]Hanoi Medical University Faculty of Medicine, Department of Surgical, Hanoi, Vietnam
[2]Bach Mai Hospital, Clinic of Orthopedic Trauma, Hanoi, Vietnam

ABSTRACT

Objective: In direct anterior approach (DAA) to the hip joint, the risk of lateral femoral cutaneous nerve (LFCN) injury is high. This study on cadavers aimed to identify variations in the anatomy and route of the LFCN and its relationship with the DAA.

Methods: The cross-sectional study was conducted on 15 adult formalin-embalmed cadavers [8 males and 7 female (15 paired hips)]. The anterior superior iliac spine, pubic tubercle, and fibular head were used as anatomical reference points.

Results: All 30 portals were inserted completely without damage or complications at the anatomical sites. The mean age standard deviation was 72.0 (16.8) range: 26-91 years old. Nineteen nerves crossed the incision. The branching pattern of the lateral cutaneous nerve of the thigh below the inguinal ligament is predominantly fan type (12 nerves, 40.0%), followed by sartorius type (11 nerves, 37.0%), with a lower percentage being posterior type (7 nerves, 23.3%). The average distance from the initial point to the location where the lateral cutaneous nerve of the thigh crosses the surgical incision was 35.3 (16.4-62.9) mm, with a range of 2.3-92.2 mm.

Conclusions: The risk of LFCN injury was 50%. Understanding variations in the anatomy and route of the LFCN and its proximity to the incision of the DAA to the hip joint may reduce the risk of injury.

Keywords: LFCN, DAA, injury, lateral femoral cutaneous nerve, direct anterior approach

ÖZ

Amaç: Kalça eklemine doğrudan anterior yaklaşımda (DAA), lateral femoral kutanöz sinir (LFCN) yaralanması riski yüksektir. Kadavralar üzerinde yapılan bu çalışma, LFCN'nin anatomisi ve rotasındaki varyasyonları ve DAA ile ilişkisini belirlemeyi amaçlamıştır.

Yöntemler: Bu kesitsel çalışma 15 erişkin formalinle mumyalanmış kadavra [8 erkek ve 7 kadın (15 çift kalça)] üzerinde yürütüldü. Anatomik referans noktaları olarak anterior superior iliyak diken, pubik tüberkül ve fibula başı kullanıldı.

Bulgular: Tüm 30 portal, anatomik bölgelerde hasar veya komplikasyon olmadan tamamen yerleştirildi. Ortalama yaş standart sapma 72,0 (16,8) idi (aralık: 26-91). On dokuz sinir kesiyi geçti. Uyluğun lateral kutanöz sinirinin inguinal ligamentin altında dallanma deseni baskın olarak fan tipidir (12 sinir, %40,0), bunu sartorius tipi (11 sinir, %37,0) takip eder ve daha düşük bir yüzde posterior tiptir (7 sinir, %23,3). Uyluğun lateral kutanöz sinirinin cerrahi kesiyi geçtiği yere başlangıç noktasından ortalama uzaklık 35,3 (16,4-62,9) mm, aralık ise 2,3-92,2 mm'dir.

Sonuçlar: LFCN yaralanma riski %50 idi. LFCN'nin anatomisindeki ve rotasındaki varyasyonları ve kalça eklemine DAA kesisine yakınlığını anlamak yaralanma riskini azaltabilir.

Anahtar kelimeler: LFCN, DAA, yaralanma, lateral femoral kutanöz sinir, direkt anterior yaklaşım

Address for Correspondence: T. X Dao, Hanoi Medical University Faculty of Medicine, Department of Surgical, Hanoi, Vietnam
E-mail: daoxuanthanh@hmu.edu.vn **ORCID ID:** orcid.org/0000-0002-2245-8202

Cite as: Giang DH, Dao TX, Hoang DG. The lateral femoral cutaneous nerve is at high risk during direct anterior approach to the hip joint due to proximity and anatomic variations: a cadaveric study. Medeni Med J. 2025;40:12-17

Received: 23 September 2024
Accepted: 23 December 2024
Epub: 5 February 2025
Published: 28 March 2025

INTRODUCTION

The direct anterior approach (DAA) for uncemented and cemented total hip arthroplasty, which involves a minimally invasive incision between the sartorius and tensor fascia latae muscles, has become increasingly beneficial for surgeons. It offers easier access to the hip joint, reduces intraoperative blood loss, and enhances control over the positioning of artificial joint components and leg length alignment[1,2]. Additionally, this technique helps lower the risk of postoperative complications, such as dislocation, leg length discrepancy, and sciatic nerve injury[1-3].

Although it resolves many shortcomings of the posterior approach, the standard DAA presents a significant risk of damaging the lateral femoral cutaneous nerve (LFCN), causing sensory issues in the anterolateral thigh and impacting the patient's postoperative quality of life[4,5]. Several applied anatomical studies have aimed to identify the ideal incision location for the DAA to prevent LFCN injury while maintaining easy access to the hip joint. This technique involves making a skin incision 2 cm below and lateral to the anterior superior iliac spine (ASIS), just above the belly of the tensor fasciae latae muscle[6,7].

Thus, this study aimed to describe the route of the LFCN and its proximity to the DAA for Vietnamese patients.

MATERIALS and METHODS

The study was conducted on 15 adult formalin-embalmed cadavers: 8 male and 7 female (15 paired hips). All the included adults were 18 years of age or older. The mean age (SD) was 72.0 (16.8) range 26-91 years old. The exclusion criteria consist of signs of trauma, tumors, congenital malformations, and previous surgeries around the hip joint that changed the anatomical structures in the pelvic and groin areas.

After obtaining the necessary research samples, we prepared protective gear, dissection instruments, anatomical markers, and an electronic Palmer caliper with a precision of 0.01 mm (ABSOLUTE Mitutoyo Series 500 digital caliper). The dissection was performed using the ASIS, pubic tubercle, and fibular head as anatomical reference points[2]. A 10 cm direct anterior incision was made starting below the ASIS. The incision was made 2 cm distal and 2 cm lateral from the ASIS, running parallel to the line between the ASIS and fibular head. The LFCN and its branches were dissected at the level of the inguinal ligament, along with related structures in the thigh area, comprising the inguinal ligament, the lateral border of the sartorius muscle, and the medial border of the tensor fasciae latae muscle.

The anatomical landmarks are identified as follows:

A: Center of the ASIS (Figure 1a-c).

B: The location where the lateral cutaneous nerve of the thigh crosses the inguinal ligament. If two branches existed, they were numbered sequentially from lateral to medial, such as B1, B2 (Figure 1a-c).

DD': Beginning and end points of direct anterior surgical incision (Figure 1a-c).

D1: A point along the surgical line DD' used to measure the shortest distance to the lateral cutaneous nerve of the thigh (Figure 1a-c).

C: Point at which the lateral cutaneous nerve of the thigh intersects the surgical line DD'. If multiple nerve branches intersect, label them as C1, C2, C3, etc. (Figure 1a-c).

Measurement Details:

The nerve's anatomical variations and branching patterns were documented.

The distance was measured from the midpoint of the ASIS to the LFCN where it ran across the inguinal ligament level (AB; Figure 1a-c).

If the lateral cutaneous nerve of the thigh intersects the surgical incision, the distance was measured from the start of the incision to the point where the nerve crossed the incision (DC, D'C; Figure 1a-c).

If the LFCN does not cross the incision, the shortest distance is measured from the incision line DD' to the LFCN incision line (DD'tk; Figure 1a-c).

Regarding the branching patterns of the LFCN below the inguinal ligament, we used Rudin's classification based on the size of the nerve branches, as well as the position of the branches relative to the lateral edge of the sartorius muscle and the medial edge of the tensor fascia latae muscle[5].

Statistical Analysis

The data were analyzed using SPSS version 22.0. Categorical variables are presented as counts and percentages, whereas quantitative variables are presented as mean ± standard deviation (SD) or median (interquartile range), based on whether the data follow a normal distribution. Differences between independent groups were assessed using the chi-square test and t-test or analysis of variance.

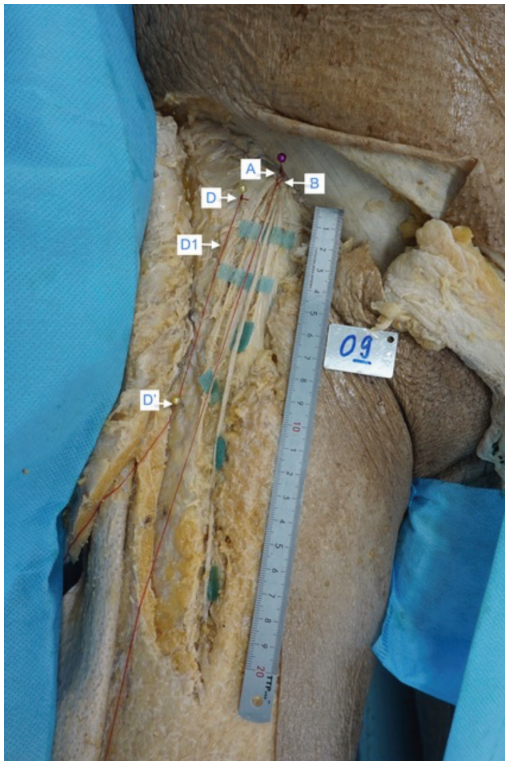

Figure 1a. Posterior type branch.

Figure 1b. Sartorius-type branch.

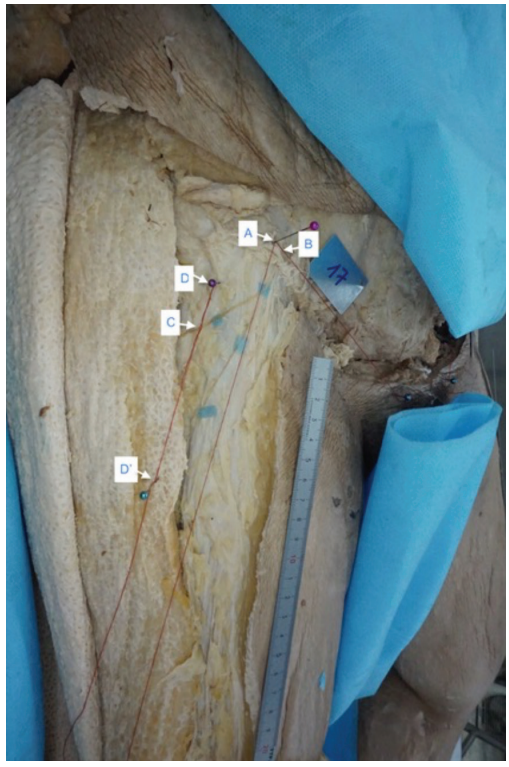

Figure 1c. Fan-type branch.

Ethical Committee Information

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Hanoi Medical University in Hanoi, Vietnam (reference number: 885/GCN-HDDDNCYSH-DHYHN, date: 27.03.2023).

Informed Consent: All local and international ethical guidelines and laws pertaining to the use of human cadaveric donors in anatomical research were followed.

RESULTS

Data from all 30 specimens were collected. No damage or complications occurred at the anatomical sites. Of the total of 30 hips, 63.3% showed intersection through the surgical incision, including 3 branching patterns in the lateral cutaneous nerve of the thigh (Figure 2). The branching pattern of the lateral cutaneous nerve of the thigh below the inguinal ligament was predominantly fan type (12 nerves, 40.0%), followed by sartorius type (11 nerves, 37.0%) and posterior type (7 nerves, 23.3%).

The lateral cutaneous nerve of the thigh can branch in 3 ways: as a posterior-type branch, a sartorius-type branch, or a fan-type branch (Figure 1a-c).

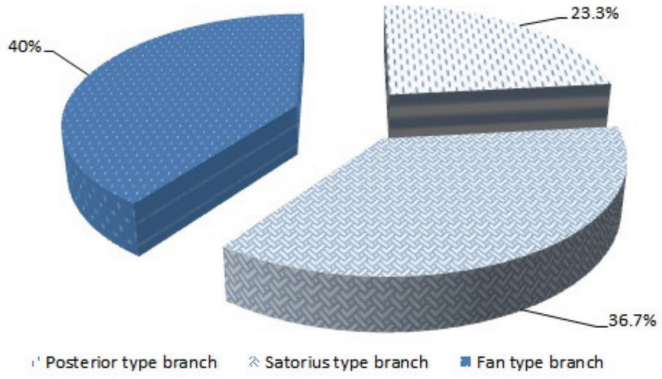

Figure 2. Prevalence of branching patterns in the LFCN below the inguinal ligament (n=30).

LFCN: Lateral femoral cutaneous nerve

Table 1 shows the thigh area origin characteristics and mean distance from the ASIS to the LFCN.

Most of the lateral cutaneous nerves of the thigh intersecting the surgical incision belonged to the fan-type group (66.7%), followed by posterior-type branches (26.7%), with only one case being the sartorius type (Table 2).

The mean distance from the initial point to the location where the lateral cutaneous nerve of the thigh crossed the surgical incision was 35.3 (16.4-62.9) mm, with a range of 2.3-92.2 mm (Table 3).

Table 4 presents the differences in mean distances of LFCN to ASIS along the inguinal ligament between male and female. However, there was no statistically significant difference in this relation.

Table 1. Features of the thigh's lateral cutaneous nerve at the inguinal ligament location (n=30).

Features	**n (%)**
Characteristics of patients entering the thigh region, n (%)	
Below the anterior superior iliac spine	15 (50.0)
Through the anterior superior iliac spine	13 (43.3)
Upper superior iliac spine	2 (6.7)
Distance from the anterior superior iliac spine to the LFCN (mm)	**Mean ± SD**
Mean ± SD	18.6±15.2
Median (IQR), min-max	12.5 (8.4-22.3), 5.5-54.3

LFCN: Lateral femoral cutaneous nerve, IQR: Interquartile range, SD: Standard deviation, IQR: Interquartile range

DISCUSSION

In the 30 cadavers dissected, we found only 2 nerves exiting the pelvis lateral to the ASIS, whereas 28 (93.3%) entered the thigh at the ASIS (of which 15 were directly below the ASIS and 13 were through the ASIS). Regarding the distance from the ASIS to the nerve, we recorded 2 cases (cadavers number 21 and 25) in which the nerve entered the thigh lateral to the ASIS. The distances from the ASIS were 49.9 mm and 7.7 mm, respectively.

According to this classification, the fan- and sartorius-type patterns accounted for the majority, accounting for 77% (40.0% and 37.0%, respectively). The posterior type pattern was the least common (23.3%).

Our results are consistent with the cadaver dissection studies conducted by Thaler (2020, n=44), and Phruetthiphat (2021, n=30). However, all authors observed a higher prevalence of the sartorius type pattern, with proportions of 60% (Phruetthiphat), and 70.5% (Thaler), whereas, in our study, the sartorius type pattern was found in only 37% of cases[6,7]. The difference may be due to variations in the assessment of the nerve branch sizes and the morphology of the two groups because both branches run anteriorly along the lateral border of the sartorius muscle, making it difficult to distinguish between the two patterns[8,9]. This challenge was also reported by Sugano et al.[10] (n=64) during the dissection of 64 lateral cutaneous nerves of the thigh,

Table 2. Features of the lateral cutaneous nerve of the thigh that intersect the direct anterior surgical incision.

Features	**n (%)**
Large and small branches	
Large branch	3 (20.0)
Small branch	11 (73.3)
Both	1 (6.7)
Amount of cutting branches	
1 branch	2 (13.3)
2 branches	5 (33.3)
3 branches	7 (46.7)
4 branches	1 (6.7)
Branching patterns	
Posterior type	4 (26.6)
Sartorius type	1 (6.7)
Fan type	10 (66.7)
Cutting position	
1/3 above	7 (46.7)
1/3 middle	4 (26.7)
1/3 under	4 (26.7)

where the author suggested combining the sartorius and fan-shaped patterns into a single anterior branch pattern (63%). This pattern closely corresponds with our findings when combining the sartorius and fan type groups[10].

The fan-type pattern was most frequently intersected by the DAA (10 nerves, 66.7%), followed by the posterior type branch and fan-type branch with 4 nerves (26.7%) and 1 nerve (6.7%) respectively, with 10 out of 12 (82.3%) fan-type lateral cutaneous nerves of the thigh being cut. Our findings are consistent with those of many other studies, which also suggest that because of the numerous small branches innervating the entire anterolateral thigh, intersection by the DAA is unavoidable[5,6,10].

A study in Japan, considered the largest dissection study with 64 cadavers, conducted by Sugano et al.[10], reported that the DAA intersected 42% of the posterior type branch, which is similar to our result of 4 out of 7 (57.1%). However, the anterior branch patterns (sartorius and fan-type) did not intersect in any of the patients. This discrepancy may be due to differences in the classification of the LFCN into branches.

In the 15 lateral cutaneous nerves of the thigh not intersected by the DAA, the sartorius branch was the most common, accounting for 10 out of 15 (66.7%), followed by the posterior type branch with 3 out of 15 (20.0%) and 2 out of 15 (13.3%) for the other branches. Most of the sartorius-type branches did not intersect, with 10 out of 11 (90.9%) remaining intact. These results are consistent with the findings of most previous studies[6,7]. According to the data from our measurements, starting the incision 3 cm distal and 4 cm posterior to the ASIS and extending the incision toward the fibular head decreased the risk of LFCN injury by 20%.

Table 3. Distance from the initial point to the location where the lateral cutaneous nerve of the thigh crosses the surgical incision.

Distance (mm)	Mean±SD	Min.-max.
DC1 (n=15)	19.9±13.7	2.3-49.5
DC2 (n=13)	43.3±22.4	5.8-80.7
DC3 (n=8)	70.0±22.0	18.9-92.9
DC4 (n=1)	38.6	-
Median DC (IQR)	35.3 (16.4-62.9)	2.3-92.2

IQR: Interquartile range, Min.-max.: Minimum-maximum, SD: Standard deviation

Table 4. Mean distances between LFCN and ASIS along the inguinal ligament.

Gender	Side	Mean distance (mm)	Standard deviation	Min-max	p-value
Female	Left	21.1	22.0	5.5-46.3	0.98
	Right	21.5	14.6	10.4-38.0	
Male	Left	21.2	19.5	6.7-54.3	0.65
	Right	14.4	7.1	8.4-22.3	

LFCN: Lateral femoral cutaneous nerve, ASIS: Anterior superior iliac spine

The closest distance from the incision to the nerve is 9.9±5.8 mm, with this position being on average 41.4±36 mm from the starting point of the incision. The nerve was very close to the incision, particularly within the upper and middle thirds of the incision. Therefore, during dissection, it is important to thoroughly separate the deep fatty layers and to avoid placing retractor instruments in these areas to prevent nerve compression throughout the surgical procedure[3,11].

Study Limitations

The research was conducted after the end of the coronavirus disease-2019 pandemic period, and we encountered significant difficulties with administrative processes and in selecting suitable cadavers for the study. Additionally, because the study involved cadaver dissection, we could not assess factors related to treatment outcomes or the demographic characteristics of patients. At cadaver insertion, we did not measure the weight or height.

CONCLUSION

The anatomical features of the LFCN were mainly the fan-shaped and sartorius types. Understanding the distance between the nerve and direct anterior incision can help surgeons reduce the risk of complications during total hip arthroplasty.

Ethics

Ethics Committee Approval: The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Hanoi Medical University in Hanoi, Vietnam (reference number: 885/GCN-HDDDNCYSH-DHYHN, date: 27.03.2023).

Informed Consent: All local and international ethical guidelines and laws pertaining to the use of human cadaveric donors in anatomical research were followed.

Footnotes

Author Contributions

Surgical and Medical Practices: D.H.G., T.X.D., D.G.H., Concept: D.H.G., T.X.D., D.G.H., Design: D.H.G., T.X.D.,

D.G.H., Data Collection and/or Processing: D.H.G., T.X.D., D.G.H., Analysis and/or Interpretation: D.H.G., T.X.D., D.G.H., Literature Search: D.H.G., T.X.D., D.G.H., Writing: D.H.G., T.X.D., D.G.H.

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

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Haynes JA, Hopper RH Jr, Ho H, et al. Direct anterior approach for primary total hip arthroplasty lowers the risk of dislocation compared to the posterior approach: a single institution experience. J Arthroplasty. 2022;37:495-500.
2. Curtin BM, Edwards PK, Odum S, et al. Anterior capsulectomy versus repair in direct anterior total hip arthroplasty. Eur J Orthop Surg Traumatol. 2023;33:3649-54.
3. Mangla N, Wadhwa S, Mishra S, et al. Cadaveric study of variations in the course of lateral femoral cutaneous nerve: insight to prevent injury. Medeni Med J. 2023;38:172-9.
4. Dahm F, Aichmair A, Dominkus M, et al. Incidence of lateral femoral cutaneous nerve lesions after direct anterior approach primary total hip arthroplasty - a literature review. Orthop Traumatol Surg Res. 2021;107:102956.
5. Rudin D, Manestar M, Ullrich O, et al. The anatomical course of the lateral femoral cutaneous nerve with special attention to the anterior approach to the hip joint. J Bone Joint Surg Am. 2016;98:561-7.
6. Phruetthiphat OA, Sangthumprateep V, Trakulngernthai S, et al. Functional outcome and complication following THA through modified direct anterior approach correlated to cadaveric study: are there any differences in Asian hip? J Orthop Surg Res. 2021;16:513.
7. Thaler M, Dammerer D, Hechenberger F, et al. The anatomical course of the lateral femoral cutaneous nerve in relation to various skin incisions used for primary and revision total hip arthroplasty with the direct anterior approach. J Arthroplasty. 2021;36:368-73.
8. Grothaus MC, Holt M, Mekhail AO, et al. Lateral femoral cutaneous nerve: an anatomic study. Clin Orthop Relat Res. 2005;437:164-8.
9. Ukai T, Suyama K, Hayashi S, et al. The anatomical features of the lateral femoral cutaneous nerve with total hip arthroplasty: a comparative study of direct anterior and anterolateral supine approaches. BMC Musculoskelet Disord. 2022;23:267.
10. Sugano M, Nakamura J, Hagiwara S, et al. Anatomical course of the lateral femoral cutaneous nerve with special reference to the direct anterior approach to total hip arthroplasty. Mod Rheumatol. 2020;30:752-7.
11. Sariali E, Leonard P, Mamoudy P. Dislocation after total hip arthroplasty using Hueter anterior approach. J Arthroplasty. 2008;23:266-72.