International Journal of Medical Science in Clinical Research and Review
Online ISSN: 2581-8945
Available Online at https://ijmscrr.in/ Volume 7|Issue 06 (November-December) |2024 Page: 1225-1231
Original Research Paper

Impact of Age, Sex and Body Mass Index on Anatomical Variations of the Femoral Nerve in Relation to the Femoral Artery: Implications for Ultrasound-Guided Femoral Nerve Blocks - An observational study.

Authors:
Shaji Sainudeen[1], Dr. Kurian P Thomas Vaidyan[2], Suraj Jose[2], Aruna Godwin[2], Mujeeb Rahman2, Paridhi Mehta2, Altaf Hussein Sayedkazmi[2], Hany Fawzi W Greiss[1], Mansour Mohamed Yousef A Nadhari[1], Osama Sami Maki Alani[1]
[1]Consultant, Dept. of Anesthesia, Rashid Hospital, Dubai,UAE
[2]Specialist Senior Registrar, Rashid Hospital, Dubai, UAE
Corresponding Author:
Dr. Shaji Sainudeen, Consultant, Dept of Anesthesia, Rashid Hospital, Dubai UAE

Article Received: 01- October -2024, Revised: 21-October-2024, Accepted: 11-November-2024

ABSTRACT:

Background: Ultrasound-guided femoral nerve block is a commonly used technique for regional anesthesia. However, variations in the anatomical relationship between the femoral nerve and artery can complicate accurate nerve identification during the procedure. This study aimed to explore whether age, sex, or BMI influence the anatomical variation of the femoral nerve concerning the femoral artery. **Methods:** Conducted at a tertiary care emergency and trauma center from, this study enrolled 200 consecutive patients scheduled for femoral fracture fixation. After excluding five patients due to poor image quality, the final cohort comprised 195 individuals, with 128 males and 68 females. Ultrasound imaging was employed to measure the femoral nerve-artery (FN-FA) distance at the inguinal crease level with patients in the supine position. Subsequent data analysis examined correlations with age, sex, and BMI. **Results**: The findings revealed that age and sex significantly influenced the femoral nerve's position relative to the artery. Older patients tended to exhibit a greater distance between the nerve and artery, while males showed a closer proximity between the nerve and artery compared to females. Interestingly, BMI did not demonstrate a noticeable impact on this relationship. **Conclusion**: This study suggests that age-related changes in muscle and fascia, such as sarcopenia and variations in fascial thickness and elasticity, might contribute to the observed variations in nerve location. Understanding these factors holds promise for refining the accuracy and safety of ultrasound-guided femoral nerve blocks. The significance of tailoring approaches based on individual patient characteristics is underscored, potentially enhancing the procedure's precision and safety.

Keywords: Ultrasound guided regional block; Femoral nerve block; Regional anesthesia; Femoral nerve; Femoral artery; Sarcopenia.

INTRODUCTION:

Ultrasound-guided Femoral nerve block is considered a level one block and is one of the most accomplished superficial blocks [1,2]. Bomberg et al. described a primary failure rate of femoral nerve block at approximately 2.3% [2] and one of the contributing factor being the poor identification of the nerve and related structures [3]. The classic description of the ultrasound anatomy of the femoral nerve is that it lies in the groove between the psoas major and iliacus muscle immediately lateral/adjacent to the femoral artery deep to fascia iliaca [4]. However, studies have shown that the location of the femoral nerve in relation to the femoral artery is not as consistent as expected. It can be in direct contact with, beneath, or lateral to the artery at a varying distance [1,5-10].

This observational study aimed to analyze whether age, sex, or BMI had any influence on the change in anatomical variation of the femoral nerve with respect to the femoral artery.

METHODOLOGY:

This observational study was conducted at Rashid Hospital, Dubai, after obtaining approval from the Institutional Review Board and was retrospectively registered on clinicaltrials.gov (NCT06026150). Two

hundred consecutive patients above the age of 18 years scheduled for femoral fracture fixation were enrolled in the study after explaining the details and obtaining a written informed consent. Patients who refused to provide consent, those with any neurological illness that prevented them from providing valid consent, and those with local pathology in the inguinal region were excluded from the study. All scanning procedures were performed in a unified manner by the same anaesthesiologist for all patients. A high-frequency linear probe of 5-16 Hz (Sonosite X-Porte; Fujifilm Sonosite, Inc., Bothell, Wa98021, USA) was used for scanning and image capture.

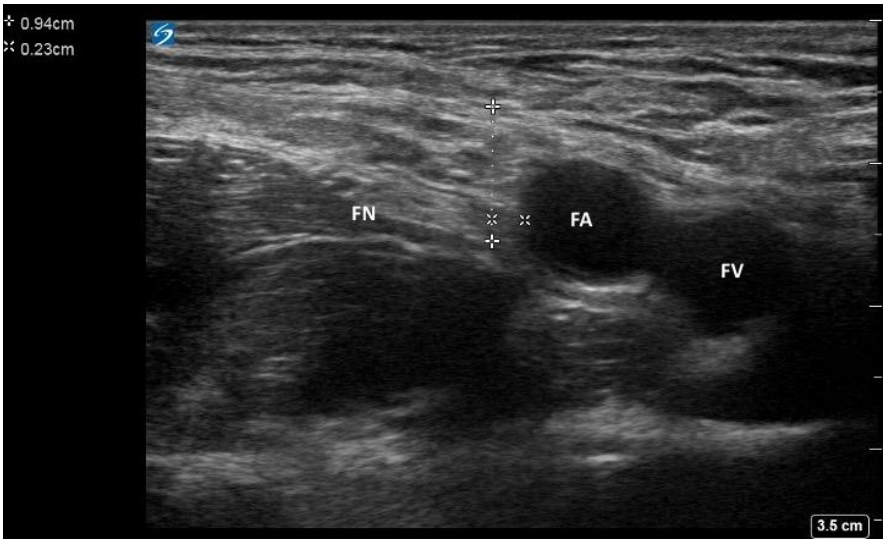
Upon ensuring patient privacy, the probe was placed on the inguinal crease with the pointer facing laterally, and the femoral artery was identified by its pulsation. A clear image of the artery and nerve was obtained by rocking and tilting the probe. The nerve was identified as a hyperechoic triangular/oval shadow lateral to the femoral artery. Images were saved according to the patient enrolment number. If the femoral artery branched at the level of the inguinal crease, scanning was performed more proximally to identify the point where the artery was single, and the measurements were taken at this point.

Patients in whom a clear image could not be obtained and in whom a single artery (a higher division of the femoral artery) could not be tracked, even at the level of the inguinal ligament, were excluded from the study. A second anaesthesiologist who was not involved in the scanning process performed further measurements.

Measurement: A vertical line is drawn from the medial end of the femoral nerve. Another horizontal line was drawn from the 9 o'clock position of the femoral artery perpendicular to the first line. The distance between the points where the two lines meet and the 9 o'clock position of the femoral artery was measured [Figure 1] and taken as the femoral nerve femoral artery [FN-FA] distance. In those patients in whom the femoral nerve lay beneath the artery, the distance was recorded as zero.

The data were analyzed with respect to age, sex, and BMI of the patients to determine whether these variables influenced the position of the femoral nerve in relation to the femoral artery. For further analysis of the influence of age, the enroled patients were divided into two groups: those aged less than or equal to 60 years and those older than 60 years.

Figure 1: Femoral nerve scan with measurement details.



FN- Femoral nerve, FA- Femoral artery, FV- Femoral vein

Statistical Analysis:

Statistical analyses were performed using IBM SPSS Statistics 20 for Windows (SPSS Inc., Chicago, IL, USA). Pearson's correlation was used to determine the correlation between age and BMI with the distance between the femoral artery and the nerve. Additionally, independent t-test is used to compare age and gender.

RESULTS:

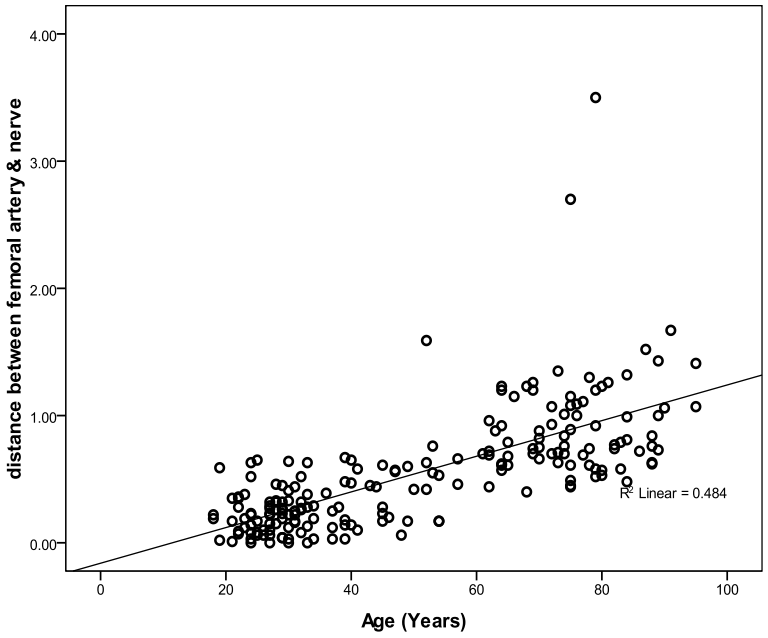
Patient allocation and demographics:

A total of 200 patients were initially included in this study. However, after enrolment, five patients were excluded due to poor image quality, resulting in a final cohort of 195 patients. Among these, 114 were $\leq$ 60 years of age, while the remaining 81 were older than 60 years. When considering gender distribution, 128 patients were identified as male, while 67 were female.

Age and femoral nerve location:

The correlation between age and FN-FA distance is depicted in figure 2. A positive correlation was observed between age and the distance between the femoral artery and nerve [correlation coefficient 0.696, p <0.001].

Figure 2: Relationship between age and Femoral nerve artery distance.



When the data were compared with respect to age [>60 years and ≤60 years], the nerve was closer to the artery in patients aged less than or equal to 60 years when compared to people above 60 years [Table 1].

Table 1: Comparison with respect to age

	≤ 60 yrs (n 114)	> 60 yrs (n 81)	p-value
Distance between femoral nerve and artery	0.289 ± 0.229	0.922 ± 0.454	<0.001

(Data is expressed as mean ± SD)

Sex and femoral nerve location:

A comparison between the distance of the femoral nerve to the artery in male and female population is shown in table 2. The nerve was significantly closer to the artery in males than in females [p value <0.001]

Table 2: Comparison between Femoral nerve-artery distance and gender.

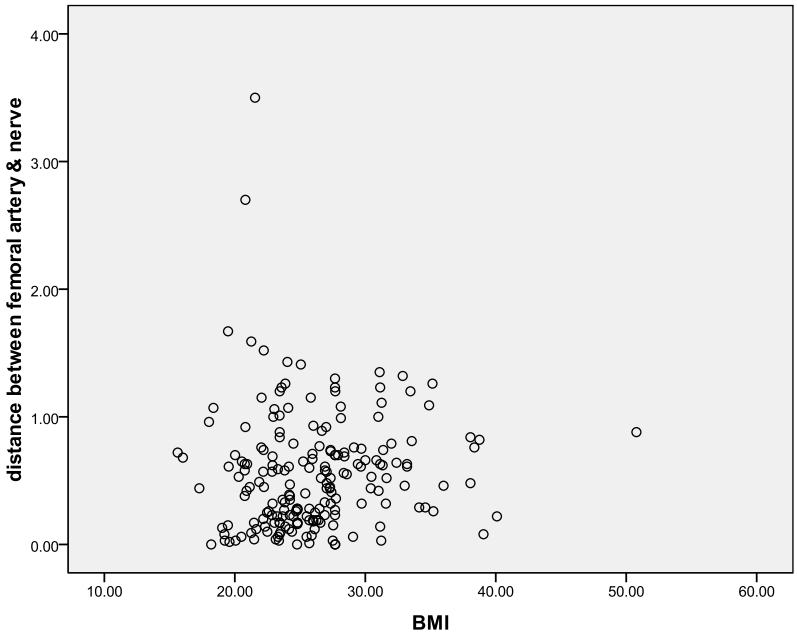
	Female (n 67)	Male (n 128)	P value
Distance between femoral artery & nerve	0.755 ± 0.434	0.446 ± 0.442	<0.001

(Data is expressed as mean ± SD)

BMI and femoral nerve location:

When the distance between the femoral nerve and the artery was correlated with BMI [Figure 3], no statistically significant correlation was found. [Correlation coefficient 0.058, p<0.420].

Figure 3: BMI and Femoral Nerve – Artery correlation.



DISCUSSION:

Ultrasound-guided femoral nerve block is considered a basic block because of its superficial anatomy and low complication rate [1,2]. Despite this, identifying femoral nerve is challenging, particularly for beginners, and must rely on the identification of the surrounding structures [3]. Cadaveric and ultrasound studies have revealed that variations in the anatomical relationship between the femoral nerve to the femoral artery are not uncommon [1,5-10], making nerve identification even more difficult. In this study, we analysed the impact of age, sex, and BMI on this variation in the anatomical relationship between artery and nerve.

From our study, it was concluded that age and sex, but not BMI had an impact on the location of the nerve to the artery. A positive correlation was observed between the age and location of the nerve to the artery. In the male population, the nerve lay closer to the artery, irrespective of age, while BMI had no impact on this relationship.

Although the classical description of the infra inguinal anatomy of the femoral nerve states that the nerve lies immediately lateral to the artery in the groove formed by the iliacus and psoas muscles [1,5,6,7,10,11], this may not hold true in most cases. According to Vloka et al., a consistent relationship between the artery and nerve occurs more at the inguinal crease than at the inguinal ligament, and in 70.6% of cases at the crease level, the nerve was found to be partially covered by the artery [6]. The findings of a cadaveric study conducted by Orebaugh were consistent with the findings of Vloka [11]. On the other hand, Gruber et al. reported that only in 15% of cases, the nerve was in direct contact or underneath the artery, while in 62.5%, the nerve was within 0.5cm proximity and in the remaining 17.5%, it was more than 0.5cm lateral to the artery [7]. These varying observations confirm the inconsistent relationship between the nerve and the artery, although other factors influencing this variability were not considered in these studies.

Yoshimura et al [12] demonstrated a positive correlation between age and the relationship between femoral nerve and artery but could not establish any correlation with sex. However, they excluded patients with BMI >30, citing the reason that the inguinal crease in an obese patient is at a distance from that of a normal patient which may affect the measurement. Additionally, none of their patients had lower extremity injury or received a femoral nerve block. In our study, we did not exclude patients based on BMI and all of our patients had femoral fractures. Mehmood et al. [13] showed that the distance between the femoral nerve and artery is altered at the mid-inguinal ligament but not at the level of the inguinal crease in patients with femoral fractures, irrespective of the type of fracture. In our study, scanning was performed where the artery was single and most of the time it was found at the level of inguinal crease.

Age-related changes in the muscles and fascia may account for this alteration in the anatomy of the femoral nerve and artery. Since Rosenberg's description of the term "sarcopenia" in 1989, referring to an age-related decrease in muscle mass and strength [14], extensive research has been conducted in this field. There is no consensus on the age at which this change initiates. According to Lexell et al. [15], the process commences in the fourth decade of life, and by the age of 80, there is an estimated reduction in 30-50% in muscle mass and

strength. Additionally, Takahashi et al. [16] demonstrated that the decline in muscle mass varies among different muscle groups. For instance, in the psoas, it commences in the twenties and reaches its maximum decline between 60 and 70, while in the quadriceps, the decline starts much later, in the 50s. Alongside sarcopenia, fascial elasticity diminishes with age, and the thickness varies in different areas. The fascia covering the back muscles thickens with ageing, while it decreases in the lower limb [17]. Furthermore, Myosteatosis (skeletal muscle fat infiltration) of the thigh occurs with ageing [18]. As age advances, atrophied muscle tissues are partially replaced by adipose tissue, and the remaining muscle tissue also contains increased fat [19].

Sarcopenia, decreased thickness, and elasticity of the fascia, and increased inter- and intramuscular adipose tissue may be the reasons for this age-related change in the position of the femoral nerve. The femoral artery is considered to be a fixed structure because of its deep fascial attachment [20], while the femoral nerve is attached to the surrounding fascia, especially in the posteromedial part where it is densely attached to the iliopectineal arch [21]. In young patients, owing to the muscle mass, the femoral nerve is pushed against the relatively fixed femoral artery. As age advances, due to the decrease in muscle volume and myosteatosis combined with less elastic fascia, there may be less tension in the anterior compartment of the thigh, leading the nerve, which is attached to the fascia, to move away from the relatively stationary femoral artery.

Kirchengast et al., in the study investigating the effect of age and sex differences on lean body mass and sarcopenia, observed a higher rate in women aged less than 70 years than in males (31% to 18.2%) [22]. Furthermore, men had relatively higher muscle mass than women. [23], explaining why the nerve is closer to the artery in men than in females.

Compared to the studies by Schafhalter-Zoppoth and Hsu, a correlation between BMI and the femoral artery-nerve relationship could not be established in this study either [24,25]. Furthermore, recent studies have questioned the usefulness of BMI in assessing the health status of the elderly, as ageing affects the ratio of muscle to fat, in comparison to the younger population [26,27]. A lower BMI is observed in the elderly because of their reduced lean body mass. We believe that the use of BMI as a metric in this study was erroneous.

CONCLUSION:

This study investigated the impact of age, sex, and BMI on the anatomical relationship between the femoral nerve and the artery during ultrasound-guided femoral nerve blocks. Age and sex were found to significantly influence the nerve's location relative to the artery, with older patients having a greater distance between them. In males, the nerve was closer to the artery than in females. These complex variations in the femoral nerve anatomy make identification challenging, especially for beginners. Age-related changes in the muscle and fascia, such as sarcopenia, decreased fascial thickness and elasticity, and increased intramuscular adipose tissue, likely contribute to these alterations . This study provides valuable insights to enhance the accuracy and safety of these blocks, emphasizing the need to tailor approaches based on patient characteristics.

Conflict of interest: The authors have declared that no competing interests exist.

REFERENCES:

1. Szucs S, Morau D, Iohom G. Femoral nerve blockade. *Med Ultrason.*2010; 12(2):139-144.
2. Bomberg H, Huth A, Wagenpfeil S, et al. Psoas Versus Femoral Blocks: A Registry Analysis of Risks and Benefits. *Reg Anesth Pain Med.* 2017;42(6):719-724. doi:10.1097/AAP.0000000000000643
3. Smistad E, Iversen DH, Leidig L, Lervik Bakeng JB, Johansen KF, Lindseth F. Automatic Segmentation and Probe Guidance for Real-Time Assistance of Ultrasound-Guided Femoral Nerve Blocks. *Ultrasound Med Biol.* 2017;43(1):218-226. doi:10.1016/j.ultrasmedbio.2016.08.036
4. Hadzic A. Femoral nerve block. In Hadzic A (editor) *Hadzics's peripheral nerve blocks and anatomy for ultrasound guided regional anesthesia*, 2nd edn. New York:McGraw-Hill; 2012 pp 267-279.
5. Vloka JD, Hadzić A, Drobnik L, Ernest A, Reiss W, Thys DM. Anatomical landmarks for femoral nerve block: a comparison of four needle insertion sites. *Anesth Analg.* 1999;89(6):1467-1470. doi:10.1097/00000539-199912000-00028

6. Gruber H, Peer S, Kovacs P, Marth R, Bodner G. The ultrasonographic appearance of the femoral nerve and cases of iatrogenic impairment. *J Ultrasound Med.* 2003;22(2):163-172. doi:10.7863/jum.2003.22.2.163
7. Schafhalter-Zoppoth I, Moriggl B. Aspects of femoral nerve block. *Reg Anesth Pain Med.* 2006;31(1):92-93. doi:10.1016/j.rapm.2005.10.001
8. Muhly WT, Orebaugh SL. Ultrasound evaluation of the anatomy of the vessels in relation to the femoral nerve at the femoral crease. *Surg Radiol Anat.* 2011;33(6):491-4. doi: 10.1007/s00276-010-0755-9.
9. Gray AT, Collins AB, Schafhalter-Zoppoth I. An introduction to femoral nerve and associated lumbar plexus nerve blocks under ultrasonic guidance. *Tech Reg Anesth Pain Manag.* 2004; 8(4): 155-163. doi.org/10.1053/j.trap.2004.10.004
10. Baker MD, Gullett JP. Ultrasound-Guided Femoral Nerve Blocks. *Pediatr Emerg Care.* 2015;31(12):864-871. doi:10.1097/PEC.0000000000000634
11. Orebaugh SL. The femoral nerve and its relationship to the lateral circumflex femoral artery. Anesth Analg. 2006 Jun;102(6):1859-62. doi: 10.1213/01.ane.0000217210.44764.0e.
12. Yoshimura M, Nakanishi T, Sakamoto S, Toriumi T. Age is a predictive factor in the femoral nerve positioning: an anatomical ultrasound study. *J Anesth*. 2018; 32(5):777-780. doi: 10.1007/s00540-018-2544-2.
13. Mehmood S, Coleman M, Egan M, Crotty J, Harmon D. Study of the anatomical position of the femoral nerve by magnetic resonance imaging in patients with fractured neck of femur: relevance to femoral nerve block. *J Clin Anesth.* 2010; 22(2):122-5. doi: 10.1016/j.jclinane.2009.05.007
14. Irwin H Rosenberg, Summary comments, *The American Journal of Clinical Nutrition.*1989;50 (5):1231–1233. doi.org/10.1093/ajcn/50.5.1231
15. Lexell J, Taylor CC, Sjöström M. What is the cause of the ageing atrophy? Total number, size and proportion of different fiber types studied in whole vastus lateralis muscle from 15- to 83-year-old men. *J Neurol Sci.* 1988;84(2-3):275-94. doi: 10.1016/0022-510x(88)90132-3.
16. Takahashi K, Takahashi HE, Nakadaira H, Yamamoto M. Different changes of quantity due to aging in the psoas major and quadriceps femoris muscles in women. *J Musculoskelet Neuronal Interact*. 2006;6(2):201-5
17. Wilke J, Kalo K, Niederer D, Vogt L, Banzer W. Gathering Hints for Myofascial Force Transmission Under In Vivo Conditions: Are Remote Exercise Effects Age Dependent? *J Sport Rehabil.* 2019 Sep 1;28(7):758-763. doi: 10.1123/jsr.2018-0184.
18. Buch A, Carmeli E, Boker LK et al. Muscle function and fat content in relation to sarcopenia, obesity and frailty of old age--An overview. *Exp Gerontol.* 2016;76:25-32. doi: 10.1016/j.exger.2016.01.008.
19. Engelke K, Ghasemikaram M, Chaudry O et al. The effect of ageing on fat infiltration of thigh and paraspinal muscles in men. *Aging Clin Exp Res.* 2022; 34(9):2089-2098. doi: 10.1007/s40520-022-02149-1.
20. Tijani Y, Burgaud M, Hamel A, Raux M, Nasr B, Gouëffic Y. The Common Femoral Artery Is a

Fixed Arterial Segment. *Ann Vasc Surg.* 2021;73:51-54.
doi: 10.1016/j.avsg.2020.10.049

21. Paraskeuopoulos T, Anagnostopoulou S, Saranteas T. Anatomical basis of the various spread patterns around the femoral nerve in the inguinal region. *Eur J Anaesthesiol*. 2015;32(5):368-9. doi: 10.1097/EJA.0000000000000228.
22. Kirchengast S, Huber J. Gender and age differences in lean soft tissue mass and sarcopenia among healthy elderly. *Anthropol Anz.* 2009;67(2):139-51. doi: 10.1127/0003-5548/2009/0018.
23. Okabe T, Suzuki M, Goto H et al. Sex Differences in Age-Related Physical Changes among Community-Dwelling Adults. *J Clin Med.* 2021;10(20):4800.
doi: 10.3390/jcm10204800
24. Schafhalter-Zoppoth I, Moriggl B. Aspects of femoral nerve block. *Reg Anesth Pain Med.* 2006;31(1):92-3; author reply 93. doi: 10.1016/j.rapm.2005.10.001.
25. Hsu HT, Lu IC, Chang YL et al. Lateral rotation of the lower extremity increases the distance between the femoral nerve and femoral artery: an ultrasonographic study. *Kaohsiung J Med Sci.* 2007;23(12):618-23. doi: 10.1016/S1607-551X(08)70060-3
26. Oreopoulos A, Ezekowitz JA, McAlister FA et al. Association between direct measures of body composition and prognostic factors in chronic heart failure. *Mayo Clin Proc.* 2010;85(7):609-17. doi: 10.4065/mcp.2010.0103.
27. Srikanthan P, Karlamangla AS. Muscle mass index as a predictor of longevity in older adults. *Am J Med.* 2014 Jun;127(6):547-53.
doi: 10.1016/j.amjmed.2014.02.007.