

Innovations

Investigating Morphometric Patterns and Clinical Relevance of the Supratrochlear Foramen in the Humerus

S Dipak Raj¹, R Sujith², Dr Ashwini NS³,

¹ Undergraduate student, Sri Devaraj Urs Medical College, Sri Devaraj Urs Academy of Higher Education & Research, Kolar, India

² Undergraduate student, Sri Devaraj Urs Medical College, Sri Devaraj Urs Academy of Higher Education & Research, Kolar, India

³ Professor, Department of Anatomy, Sri Devaraj Urs Medical College, Sri Devaraj Urs Academy of Higher Education & Research, Kolar, India

Abstract:

The supratrochlear foramen (STF) is a perforation in the septum that separates the coronoid fossae and the olecranon, in the distal portion of the humerus. The supratrochlear foramen is present in some humans, with an incidence rate that varies greatly between populations. The study included 101 human humeri bones. However, there were only 33 bones with the Supratrochlear Foramen. The Transverse diameter, Vertical diameter of the foramen and the Distance from the Medial epicondyle, Distance from the Lateral epicondyle, Distance from lower trochlear margin, were noted with digital vernier calliper. The data was tabulated and analysed. The mean and standard deviation of Transverse diameter of STF on the right side was 7.19 ± 2.00 mm and 7.53 ± 2.5 mm on the left side were observed. The mean and standard deviation of vertical diameter of STF on the right side was 5.36 ± 1.33 mm and 4.83 ± 1.00 mm on the left side were observed. Nominal variations were observed when we compare with both the genders. The overall frequency of STF was 32.6%. These percentages fall within a medium to high range distribution when compared to other populations studied in previous research. The present provides new data to the literature on STF. Its significance lies in illuminating the frequency of this feature across various populations in closely situated geographical regions. Furthermore, researchers can employ this inaugural study as a foundation for clinical, radiological, and anatomical considerations pertaining to that specific anatomical area.

Key Words: Morphometric patterns, Supratrochlear foramen, Humerus anatomy, Clinical relevance, Anatomical variations

Introduction:

A thin bony septum separates the coronoid fossa and the olecranon fossa at the distal end of the humerus. (lamina) [1]. It is located just above the trochlea, which is one of the bony prominences at the lower end of the humerus. This septum is lined by the synovial membrane. The septum may be translucent or opaque. This septum may become perforated in some cases [1,2]. The perforated septum

has many alternate names, such as supratrochlear foramen, supratrochlear aperture, intercondylar foramen, epitrochlear foramen, or olecranon foramen.

The consideration of the humerus's medullary canal anatomy and the presence of a supratrochlear foramen (STF) are crucial to improving nail stabilization. Bones that contain an STF typically have a short and narrow medullary canal. The anatomy of the medullary canal and the presence of the supratrochlear foramen (STF) significantly influence the stabilization of the nail. When planning for retrograde intramedullary nailing, the presence of an STF should be considered to prevent iatrogenic fractures and improve the procedure's efficiency. [3]

The presence of a Supratrochlear foramen varies among global populations. Several shapes have been recognized, including oval, round, triangular, sieve-like, reniform, and irregular.

S. No	Author	Population	Prevalence %
1.	Koyun et al, [2011] ^[4]	Turkish	8.6
2.	Bashi et al, [2019] ^[5]	Turkey	20.37
3.	Sunday et al, [2014] ^[6]	Nigerian	27.7
4.	Chagas et al, [2016] ^[7]	Brazil	22.5
5.	Paraskevas et al, [2010] ^[8]	Greeks	11.7
6.	Bradshaw et al, [2019] ^[9]	Portuguese	16.18
7.	Nodu et al, [2012] ^[10]	South Africans	32.5
8.	Bokhari et al, [2018] ^[11]	Lahore	17
9.	Joshi et al, [2016] ^[12]	Western Indian	35.88
10.	Dang et al, [2016] ^[13]	North Indian	30
11.	Mayuri et al, [2013] ^[14]	North Indians	40.78
12.	Agarwal et al, [2018] ^[15]	North Indians	22.96
13.	Kumar et al, [2015] ^[2]	South Indian	26
14.	Mathew et al, [2016] ^[16]	Indians (Kerala)	24.59
15.	Veerapan et al, [2013] ^[17]	South Indians	19.17
16.	Present study	South Indians	32.6

[Table 1]: Table depicting the Prevalence of Supratrochlear foramen of the study group (n=101).

This study seeks to examine the occurrence, frequency, shape, and measurements of the supratrochlear foramen (STF) in the South Indian population. A thorough understanding of STF could be valuable for anthropologists studying evolutionary variances between humans and primates. Additionally, anatomists can benefit from this information in educational contexts, while orthopedic surgeons may find it useful in pre-operative procedures. Moreover, radiologists can utilize the findings for accurate interpretation.

Materials and Methods:

The study was done after approval from the Institutional Ethics Committee. The study included measurements on unpaired fully ossified dry adult bones. The study group was composed of 101 adult dry human humeri, all of which were sourced from the Department of Anatomy and the Department of Forensic Medicine at Sri Devaraj Urs Medical College, Kolar. These humeri were specifically chosen due to their known sex and side characteristics with the supratrochlear foramen (STF), after which ensuring a representative sample of 33 was finalised. To conduct our measurements and analyses, we employed a digital Vernier calliper with a precision of 0.01 mm.

Shape Of The Foramen	Right	Left
Round	4	4
Oval	8	14
Rectangle	-	2
Triangle	1	-
TOTAL (n= 33)	13	20

[Table 2]: Table depicting the supratrochlear foramen with different shapes of the study group (n=33).

Statistical analysis:

All the data was entered into Excel workbook sheets (Microsoft Office Excel; version 2007, Microsoft ® Corporation, US.) and analysed using SPSS (version 22.0; SPSS Inc., Chicago, IL). The data was analysed as follows. The dimensions were summarized as the mean and standard deviation and compared using paired t-test. A Two-tailed P values less than 0.05 were considered statistically significant and P values less than 0.001 were considered highly significant. Correlation coefficient used for assessing relationships between aspect ratio and anterior posterior of intercondylar area. All the results were expressed in mean ±SD.

Results:

The morphometric measurements of the supratrochlear foramen (STF) are summarized in [Table -2,3]

S.No	PARAMETERS	GENDER	MEAN ±SD	P value
1.	Distance from the Medial epicondyle	Male	24.51±3.31	0.275
		Female	23.41±2.66	
2.	Distance from the Lateral epicondyle	Male	24.85±2.42	0.278
		Female	26.48±4.38	

3.	Distance from lower trochlear margin	Male	13.61±1.63	0.752
		Female	14.1±1.66	
4.	Supratrochlear foramen - Transverse diameter	Male	7.45±1.87	0.422
		Female	7.19±2.52	
5.	Supratrochlear foramen - Vertical diameter	Male	5.32±1.31	0.465
		Female	4.97±1.13	

[Table -2]: Table depicting the Mean of all parameters of Humeri with the Gender (n=33)

S.No	PARAMETERS	SIDE	MEAN ±SD	P value
1.	Distance from the Medial epicondyle	Right	24.86±3.24	0.066
		Left	22.63±2.1	
2.	Distance from the Lateral epicondyle	Right	26.48±3.44	0.856
		Left	24.36±3.44	
3.	Distance from lower trochlear margin	Right	13.73±1.52	0.552
		Left	14.03±1.86	
4.	Supratrochlear foramen - Transverse diameter	Right	7.19±2.00	0.286
		Left	7.53±2.5	
5.	Supratrochlear foramen - Vertical diameter	Right	5.36±1.33	0.139
		Left	4.83±1.00	

[Table -3]: Table depicting the Mean of all parameters of Humeri with the Side (n=33)

Discussion:

The present study provides morphometric measurements of the supratrochlear foramen (STF) including both sexes for the same population in order to provide a better overview of the STF distribution and frequency among different populations in the region. The formation of STF is predominantly observed in females compared with males.

The prevalence of STF in the present study is about 32.6%. The STF prevalence in the human population varies from 0.3% to almost 60% worldwide [Table-1]. The supratrochlear foramen was absent in 67 dry humeri.

The mean and standard deviation of Transverse diameter of STF on the right side was 7.19±2.00 mm and 7.53±2.5mm on the left side were observed. Nominal variations were observed when we compare with both the genders.

The mean and standard deviation of vertical diameter of STF on the right side was 5.36 ± 1.33 mm and 4.83 ± 1.00 mm on the left side were observed. Nominal variations were observed when we compare with both the genders.

Whereas in the study conducted by Bashi et al, [2019]^[5] among Turkish population, the mean and standard deviation of Transverse diameter of STF on the right side was 6.55 ± 2.84 mm and 5.64 ± 1.96 mm on the left side, The mean and standard deviation of Vertical diameter of STF on the right side was 4.82 ± 1.33 mm and 4.86 ± 1.32 mm on the left side, reveals the larger anatomical size of the foramen among South Indians.

The Distance from the Medial epicondyle, Distance from the Lateral epicondyle, are compared in the table 4

Author	Distance from the Medial epicondyle		Distance from the Lateral epicondyle	
	Left	Right	Left	Right
Bahsi et al (2019) ^[5]	24.73±3.04	25.00±3.07	26.91±1.97	26.19±2.64
Bokhari et al (2018) ^[11]	25.3+ 0.24	21.7+ 0.45	26.2+ 2.8	27.4+ 3.0
Joshi et al (2016) ^[12]	25.2±3.2	24.7±3.3	25.7±2.7	24.7±1.9
Mathew et al (2016) ^[16]	24.39±3.15	24.91±2.93	26.92±2.46	27.2±2.95
Sunday et al, (2014) ^[16]	25.82 ± 2.75	26.30 ± 2.07	-	-
Present Study	22.63±2.1	24.86±3.24	24.36±3.44	26.48±3.44

[Table -4]: Table comparing the Mean of parameters of Humeri with the Side with previous literatures (n=33)

The mean and standard deviation of the Distance from lower trochlear margin on the right side was 5.36 ± 1.33 mm and 4.83 ± 1.00 mm on the left side were observed. Nominal variations were observed when we compare with both the genders.

Apart from its evolutionary and developmental significance, the supratrochlear foramen holds additional importance in the surgical context. The presence of this bony opening, functioning as a stress riser, can significantly influence fracture patterns and guide appropriate management strategies. Moreover, it may elevate the risk of a fracture in the affected arm due to a relatively minor force.

The supratrochlear foramen, serving as a stress riser, tends to propagate fractures proximally, causing a separation between the two columns. Consequently, the periosteum, capsule, and ligaments around the elbow remain intact, preserving the stability of the fracture despite articular displacement.^[20] For this reason, Kuhn and associates ^[21] suggested that this unique fracture pattern, with its usual characteristics, deserves special consideration, and should be added as a separate type of single column fracture to the existing classification systems for fractures of the distal part of the humerus.

Conclusion:

Supracondylar humerus fractures are the most common pediatric elbow fracture, accounting for 3.3% of all pediatric fractures [18] and 60% of pediatric elbow fractures.[19] From a biomechanical perspective, the humerus's supracondylar region is susceptible to injury due to the thin layer of bone located between the medial and lateral columns.

This study contributes novel data to the research literature on STF, enhancing our comprehension of its population frequency and distribution. Through comparisons with previously reported frequencies, this research advances our understanding of human skeletal variations.

The supratrochlear foramen (STF) at the distal end of the humerus is a skeletal variation that holds substantial relevance across multiple disciplines. In academic anatomy, awareness of this variation provides valuable insights into the diversity of the human skeletal structure. Orthopedic surgeons benefit from this knowledge in preoperative planning for supracondylar fractures and in selecting the most suitable intramedullary nails. Radiologists interpreting lower humerus radiographs and CT scans find the understanding of the STF helpful in distinguishing it from osteolytic or cystic lesions. Medicolegal forensic experts can utilize the STF as a dependable tool to establish connections between humans and primates.

This increased knowledge is particularly crucial for anthropologists striving for positive identifications, especially when encountering rare variations that enhance discriminative capabilities.

References

1. Öztürk A, Kutlu C, Bayraktar B, Ari Z, Sahinoglu K. *The supratrochlear foramen in the humerus: anatomical study. Ist Tip Fak Mecmuasi 2000; 63: 72-6.*
2. Kumar U, Sukumar C, Sirisha V, Rajesh V, Murali Krishna S, Kalpana T. *Morphologic and Morphometric Study of Supra Trochlear Foramen of Dried Human Humeri Of Telangana Region. Int J Cur Res Rev 2015; 7: 95-8.*
3. Chhabra PK, Yadav S, Jangir RK, Mehta R, Anand M. *The Impact of Supratrochlear Foramen on Humeri's Medullary Canal Diameter and Its Surgical Implications. Cureus. 2023 Aug 21;15(8):e43864.*
4. Koyun N, Aydinlioglu A, Gumrukcuoglu FN. *Aperture in coronoid-olecranon septum: A radiological evaluation. Indian J Orthop. 45:392- 95 (2011).*
5. Ilhan Bahsi. *An Anatomic Study of the Supratrochlear Foramen of the Humerus and Review of the Literature. Eur J Ther; 25(4): 295-303 (2019).*
6. Sunday OO, Olusegun OS, Oluwabunmi BM. *The Supratrochlear Foramen of the Humerus: Implications for Intramedullary nailing in the distal humerus. Journal of Biology, Agriculture, and Healthcare. 4(7): 2224-32 (2014).*
7. Chagas Carlos AA, Gabriel gutfiten-Schlesinger, Túlio FO Leite, Lucas AS Pires, Julio G. Silva. *Anatomical and Radiological Aspects of the Supratrochlear Foramen in Brazilians. Journal of Clinical and Diagnostic Research., 10(9): AC10-AC13 (2016).*
8. George K. Paraskevas, Basileios Papaziogas, Alexandros Tzaveas, George GiaglisC, Panagiotis Kitsoulis, Konstantino, Natsis. *The supratrochlear foramen of the humerus and its relation to the medullary canal: A potential surgical application. Med Sci Monit, 16(4): BR119-123 (2010).*
9. Bradshaw R, Constantine Eliopoulos , Matteo Borrini. *Septal Aperture of the Humerus: Etiology and Frequency Rates in Two European Populations. The anatomical record. 303(7):1821-1830 (2019).*
10. Ndou R, Smith P, Gemmell R, et al: *The supratrochlear foramen of the humerus in a South African dry bone sample. Clin Anat, 26(7): 870–74 (2013).*

11. Bokhari, Nida Qasim Hayat , Qamar Ashfaq Ahmad , Maria Noman , Mahjabeen Muneera , Raafea Tafweez Kuraishi. *The Supratrochlear Foramen of Humerus: A Human Anatomic Study*. *PJ H S*, 12(3): 980-82 (2018).
12. Joshi MM, Kishve PS, Wabale RN. *A morphometric study of supratrochlear foramen of the humerus in western indian dry bone sample*. *Int J Anat Res*; 4: 2609-13 (2016).
13. Dang Bhumica , Vivek S. Malik , Priyanka Parmar. *Supratrochlear Foramen: Incidence, Importance and Clinical Implications in North Indian Population*. *Int J Intg Med Sci*, 3(4):265- 69 (2016).
14. Mayuri J, Aparna T, Pradeep P, Smita M. *Anatomical study of supratrochlear foramen of humerus*. *J Res Med Dent Sci*, 1: 33-5 (2017).
15. Agrawal D, Sujatha GB, Rani VS, Chinara PK. *A Study of Supratrochlear Foramen and Their Members.*; 7(2):154 (2018).
16. Asha Joselet Mathew, Geetha Sulochana Gopidas, Tintu Thottiyil Sukumaran. *A Study of the Supratrochlear Foramen of the Humerus: Anatomical and Clinical Perspective*. *Journal of Clinical and Diagnostic Research*, Vol-10(2): AC05-AC08 (2016).
17. Veerappan V, Thotakura B, Aruna S, Kannan G, Narayanan GKB. *Study of intercondylar foramen of humerus - clinical and radiological aspect*. *IOSR-JNHS*; 2: 24-7 (2013).
18. Landin L.A.: *Fracture patterns in children: analysis of 8,682 fractures with special reference to incidence, etiology and secular changes in a Swedish urban population, 1950-1979*. *Acta Orthop Scand Suppl* 1983; 202: pp. 1-109.
19. Landin L., Danielsson L.: *Elbow fractures in children: an epidemiological analysis of 589 cases*. *Acta Orthop Scand* 1986; 57: pp. 309-312.
20. Sahajpal DT, Pichora D: *Septal aperture: an anatomic variant predisposing to bilateral low-energy fractures of the distal humerus*. *Can J Surg*, 2006; 49: 363–64 19.
21. Kuhn JE, Lois DS, Loder RT: *Divergent single-column fractures of the distal part of the humerus*. *J Bone Joint Surg (Am)*, 1995; 77: 538–42 20. Brumback RJ: *The rationales of interlocking nailing of the femur, tibia and humerus*. *Clin Orthop*, 1996; 324: 292–320.
22. Benfer RA, McKern TW. *The correlation of bone robusticity with the perforation of the coronoid-olecranon septum in the humerus of man*. *Am J Phys Anthropol* 1966; 24: 247-52.
23. Glanville EV. *Perforation of the coronoid-olecranon septum humero-ulnar relationships in Netherlands and African populations*. *Am J Phys Anthropol* 1967; 26: 85-92.
24. Trotter M. *Septal apertures in the humerus of American whites and negroes*. *Am J Phys Anthropol* 1934; 19: 213-27.
25. Myszka A, Trzeciński D. *Septal aperture and osteoarthritis-the same or independent origins?* *Adv Anthropol* 2015; 5: 116-21.
26. Dang B, Malik VS, Parmar P. *Supratrochlear foramen: incidence, importance and clinical implications in North-Indian Population*. *Int J Intg Med Sci* 2016; 3: 265-9.
27. Brauer CA, Lee BM, Bae DS, Waters PM, Kocher MS. *A systematic review of medial and lateral entry pinning versus lateral entry pinning for supracondylar fractures of the humerus*. *J Pediatr Orthop*. 27:1816 (2007).
28. Susan Stranding, *Gray's Anatomy: The Anatomical basis of clinical practice*, Elsevier, London, UK, 40 the edition.