

# Prevalence, Morphology and Morphometry of the Supratrochlear Foramen of the Humerus: A Cross-sectional Study

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## ABSTRACT

**Introduction:** The Supratrochlear Foramen (STF) represents a significant anatomical variation located at the distal end of the humerus in humans. A thorough understanding of STF anatomy is advantageous for radiologists, orthopaedic surgeons, and anatomists alike.

**Aim:** To study the occurrence (presence or absence), morphology (like oval, round, irregular, and triangular shapes), and morphometric variations (vertical and transverse diameters) of the STF of the humerus in humans.

**Materials and Methods:** The present cross-sectional study was conducted for a duration of six months (May 2025 to October 2025) at the Department of Anatomy, Sawai Man Singh (SMS) Medical College in Jaipur, Rajasthan, India. The research involved dried human humeri of unspecified sex and age. The variables assessed included the occurrence of the STF, morphological shapes, vertical and transverse diameters, and septal translucency versus opacity. To determine the presence of the STF, 100 humeri were analysed, comprising 53 (53%)

from the right-side and 47 (47%) from the left-side. The shapes of the foramen (round, oval, irregular, triangular) were observed. Additionally, a digital vernier calliper was employed to measure the maximum vertical and transverse diameters of both sides.

**Results:** Out of the 100 humeri bones, 30/100 (30%) featured a foramen. Among these, 13/30 (43.33%) were situated on the right-side, while 17/30 (56.67%) were on the left. A total of thirty-three (33%) humeri exhibited translucency of the septum, whereas thirty-seven (37%) humeri possessed an opaque septum. The most common STF shape was round 11 (36.67%), followed by irregular shapes 9 (30%), oval shapes 8 (26.67%), and triangular shapes 2 (6.67%). The difference between right and left diameters was not statistically significant ( $p$ -value  $>0.05$ ).

**Conclusion:** Comprehending the STF in the distal humerus of humans is essential for radiologists to differentiate it from osteolytic or cystic lesions. It is also vital for orthopaedic specialists when addressing supracondylar fractures and performing intramedullary humeral nailing.

**Keywords:** Intramedullary nailing, Orthopaedic surgeons, Radiologists, Supracondylar fracture

## INTRODUCTION

The STF represents a significant anatomical variation located at the lower end of the human humerus. In the distal portion of this bone, the olecranon fossa and the coronoid fossa are typically separated by a thin plate of compact bone known as the supratrochlear septum, which is lined with a synovial membrane [1]. This septum can appear either translucent or opaque and may sometimes become perforated forming what is referred to as a STF. It is also known by other terms such as septal aperture, olecranon foramen, intercondylar foramen, epitrochlear foramen, and supratrochlear aperture. This foramen separates the lateral and medial epicondyles [2].

While foramina generally allow the passage of blood vessels and nerves, the STF does not usually transmit any significant structures. However, on rare occasions, the median nerve may pass through it, potentially causing symptoms like hand pain and weakness [3]. Research has highlighted the STF's shape and prevalence across different populations, revealing significant regional and ethnic diversity [4]. Comprehensive osteological data on the prevalence, morphology, and morphometry of the STF in the Rajasthan population remain limited [5]. With this background, the present study was conducted with the aim of studying the occurrence (presence or absence), morphology (like oval, round, irregular, and triangular shapes), and morphometric variations (vertical and transverse diameters) of the STF of the humerus in humans.

## MATERIALS AND METHODS

The present cross-sectional study was conducted in the Department of Anatomy, SMS Medical College and Hospital, Jaipur, Rajasthan, India from May 2025 to October 2025. As this osteological study

used dried human bones available in the Department of Anatomy and did not involve living participants or identifiable human material, Institutional Ethics Committee approval was not required under institutional policy.

**Sample size calculation:** Sample size was calculated assuming a 24.59% prevalence of STF in human humeri, based on the results of the seed article [6]. At the absolute allowable error of 10%, 74 human humeri are required as sample size, which is further enhanced and rounded off to 100 humeri as sample size. The humeri were randomly selected and classified according to side (right or left).

**Inclusion criteria:** Fully ossified intact adult human humeri were included.

**Exclusion criteria:** Specimens showing visible signs of pathology, evidence of previous trauma, healed fractures, or gross anatomical deformities were excluded from the study.

## Study Procedure

The parameters studied included-

- Side distribution (right or left humerus).
- Presence and absence of the STF irrespective of age and sex.
- Prevalence of the STF in the study sample.
- Morphological shapes of the foramen (e.g. round, oval, irregular, triangular).
- Morphometric measurements (mean vertical and transverse diameters of the foramen in mm).
- Frequency of translucency and opacity of the septum, in case of absence of STF.

In humeri lacking a STF, the supratrochlear septum was observed on an illuminated X-ray view box. Light passed from the posterior to the anterior aspect of the bone. Septa that allowed visible transmission of light were recorded as translucent, while septa that showed no visible light transmission were recorded as opaque. All specimens were viewed under the same conditions to ensure consistency. Septal translucency was assessed by visual inspection not by objective radiographic or densitometric evaluation. So some observer subjectivity cannot be ruled out.

Measurements were designed to represent the maximum diameter in both the vertical and transverse planes rather than utilising arbitrary points, maximising anatomical consistency using a digital vernier calliper. A single observer performed all measurements, and the average of the three readings was used. To reduce intra-observer bias, we used a uniform measurement method.

## STATISTICAL ANALYSIS

Qualitative data was expressed as proportions and quantitative data as mean and standard deviation. Mann-Whitney U test was used to compare morphometric measurements between right and left-sides. A p-value less than 0.05 was considered statistically significant. Statistical Package for Social Sciences (SPSS) Version 28.0 was used to analyse the data.

## RESULTS

Of the 100 dried humeri, STF was present in 30 bones, more on the left than the right [Table/Fig-1].

| Side of humerus | Total no. of humeri | Presence of STF |
|-----------------|---------------------|-----------------|
| Right-sided     | 53                  | 13 (24.53%)     |
| Left-sided      | 47                  | 17 (36.17%)     |

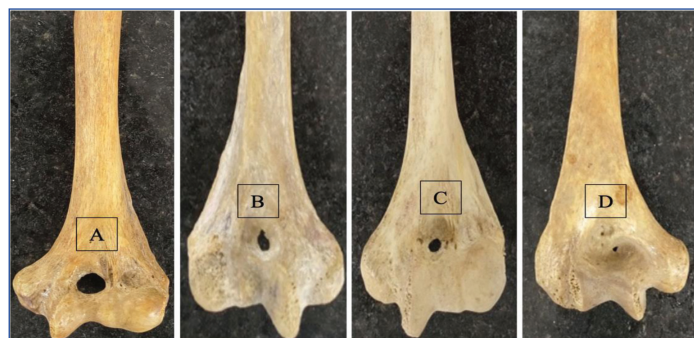
[Table/Fig-1]: Presence of STF irrespective of age and sex.

Most STF's were round 11 (36.67%), followed by irregular, oval, and triangular shapes [Table/Fig-2,3].

| Shape of STF | Right-sided | Left-sided | Total       | p-value* |
|--------------|-------------|------------|-------------|----------|
| Round        | 4           | 7          | 11 (36.67%) | 0.543    |
| Irregular    | 4           | 5          | 9 (30%)     |          |
| Oval         | 5           | 3          | 8 (26.67%)  |          |
| Triangular   | 0           | 2          | 2 (6.67%)   |          |

[Table/Fig-2]: Shape of STF in humeri.

\*Chi square test



[Table/Fig-3]: Photograph showing the various shapes of STF: (a) Round; (b) Irregular; (c) Oval; (d) Triangular.

Translucency of the septum was present in 33 bones, and opacity was observed in 37 bones out of the 100 humeri [Table/Fig-4,5].

| Types              | Right-sided | Left-sided | Total    | p-value* |
|--------------------|-------------|------------|----------|----------|
| Foramen            | 13          | 17         | 30 (30%) | 2.294    |
| Translucent septum | 17          | 16         | 33 (33%) | 0.203    |
| Opaque septum      | 23          | 14         | 37 (37%) | 0.964    |

[Table/Fig-4]: Frequency of STF in humerus, translucent septum and opacity.

\*Chi square test



[Table/Fig-5]: Photograph showing: (a) STF; (b) Translucent septum; (c) Opaque septum.

Differences in the transverse and vertical diameters of the right and left humeri were not statistically significant ( $p > 0.05$ ) [Table/Fig-6].

| Diameter of STF     | Right-side, n | Right-side (mm), Mean $\pm$ SD | Left-side, n | Left-side (mm), Mean $\pm$ SD | p-value* |
|---------------------|---------------|--------------------------------|--------------|-------------------------------|----------|
| Transverse diameter | 13            | 4.94 $\pm$ 2.793               | 17           | 5.05 $\pm$ 2.416              | 0.850    |
| Vertical diameter   | 13            | 3.37 $\pm$ 2.177               | 17           | 3.92 $\pm$ 1.832              | 0.305    |

[Table/Fig-6]: Transverse and vertical diameters of the right and left humeri.

\*Mann-Whitney U test.

## DISCUSSION

The current study found that the prevalence of the STF in the North Indian population is 30%, with a higher occurrence on the left-side i.e., 17/47 (36.17%) as compared to the right-side i.e., 13/53 (24.53%). The higher STF prevalence on the left-side was explained by handedness; the dominant right limb has more robust bones [7]. Comparative study of prevalence of STF between right and left-sides is shown in [Table/Fig-7] [4,6,8-11].

| Author name and year of study    | Prevalence (%) |       | Sample size |      | Frequency |      |
|----------------------------------|----------------|-------|-------------|------|-----------|------|
|                                  | Right          | Left  | Right       | Left | Right     | Left |
| Singhal S and Rao V (2007) [8]   | 27.9           | 28.05 | 68          | 82   | 19        | 23   |
| Nayak SR et al., (2009) [4]      | 44.51          | 26.81 | 164         | 220  | 73        | 59   |
| Paraskevas GK et al., (2010) [9] | 10             | 21.67 | 120         | 120  | 12        | 26   |
| Erdogmus S et al., (2014) [10]   | 4.82           | 16.87 | 83          | 83   | 4         | 14   |
| Mathew AJ et al., (2016) [6]     | 16.67          | 31.54 | 114         | 130  | 19        | 41   |
| Boonchan S et al., (2022) [11]   | 11.56          | 20.63 | 320         | 320  | 37        | 66   |
| Present study 2025               | 24.53          | 36.17 | 53          | 47   | 13        | 17   |

[Table/Fig-7]: Comparative study of prevalence of STF between right and left-sides [4,6,8-11].

Dang B et al., (2016) reported a 30% prevalence of STF in North Indians, aligning with the current study's findings [Table/Fig-8] [12-15].

| Author name and year of study    | Population    | Prevalence (%) |
|----------------------------------|---------------|----------------|
| Dang B et al., (2016) [12]       | North Indian  | 30             |
| Shivaleela C et al., (2016) [13] | South Indians | 26.7           |
| Sangeetha V et al., (2017) [14]  | North Indians | 30.5           |
| Bradshaw R et al., (2020) [15]   | Greeks        | 21.37          |
| Present study (2025)             | North Indian  | 30             |

[Table/Fig-8]: Prevalence of STF in various populations [12-15].

Only the four morphological categories identified in the present study (irregular, round, oval, and triangular) are presented for comparison;

therefore, the percentages for some previous studies may not total 100% because they do not include other morphological categories reported in those studies.

The authors categorised STF shapes as irregular, round, oval, and triangular and compared them with previous literature, as shown in [Table/Fig-9] [12,13,16-21]. The present study shows that the round shape of the STF is more common than the oval shape, which differs from several previous studies in which the oval shape was more predominant. This discrepancy may reflect population-specific genetic and developmental variation that influences distal humerus morphology.

| Author name and year of study          | Irregular | Round | Oval  | Tri-angular |
|----------------------------------------|-----------|-------|-------|-------------|
| Dang B et al., (2016) [12]             | -         | 60    | 40    | -           |
| Shivaleela C et al., (2016) [13]       | 10.53     | 47.37 | 42.11 | -           |
| Savitha V and Dakshayani K (2016) [16] | -         | 35.71 | 28    | 7.14        |
| Jagdish P et al., (2017) [17]          | -         | 63.33 | 36.66 | -           |
| Bokhari NQH et al., (2018) [18]        | 14.7      | 14.7  | 54.88 | 2.94        |
| Deshmukh VR et al., (2018) [19]        | -         | 50    | 45    | -           |
| Rao KV et al., (2018) [20]             | 5.88      | 11.76 | 76.47 | -           |
| Bahsi I (2019) [21]                    | -         | 61.93 | 32.36 | -           |
| Present study (2025)                   | 30        | 36.67 | 26.67 | 6.67        |

**[Table/Fig-9]:** Comparative study of prevalence of various shapes of STF in percentage (%) [12,13,16-21].

In the current study, the vertical and transverse diameters of the STF were larger on the left-side than on the right. Some earlier research indicated that the right-side had a larger vertical diameter and the left had a larger transverse diameter, and vice versa, as illustrated in [Table/Fig-10] [4,12,13,19,22-24].

| Author name and year of study    | Vertical diameter of STF |            | Transverse diameter of STF |            |
|----------------------------------|--------------------------|------------|----------------------------|------------|
|                                  | Right                    | Left       | Right                      | Left       |
| Nayak SR et al., (2009) [4]      | 3.81±0.97                | 4.85±1.64  | 5.99±1.47                  | 6.55±2.47  |
| Patel SV et al., (2013) [22]     | 4.77±1.15                | 4.90±1.68  | 7.31±1.77                  | 7.03±1.49  |
| Arunkumar K et al., (2015) [23]  | 3.90±1.32                | 3.84±1.20  | 5.67±1.71                  | 5.39±1.57  |
| Dang B et al., (2016) [12]       | 3.79±0.68                | 3.94±1.40  | 5.14±1.165                 | 5.21±2.13  |
| Ramamurthi K (2016) [24]         | 4.3±1.6                  | 4.9±1.5    | 5.3±2.2                    | 6.8±2.3    |
| Shivaleela C et al., (2016) [13] | 3.88±2.39                | 3.68±3.53  | 4.50±3.18                  | 3.32±3.22  |
| Deshmukh VR et al., (2018) [19]  | 4.2±3.1                  | 4.3±1.7    | 5.3±2.7                    | 6.7±2.3    |
| Present study (2025)             | 3.37±2.177               | 3.92±1.832 | 4.94±2.793                 | 5.05±2.416 |

**[Table/Fig-10]:** Comparative study of vertical and transverse diameter of STF (in mm) (mean±SD) [4,12,13,19,22-24].

The clinical significance of the STF in humeral intramedullary nailing is important. Knowledge of this anatomical variation can enhance the safety of orthopaedic procedures and lead to better surgical results.

## Limitation(s)

One of the limitations of the present study is that the age and sex of the dried humeri were unknown. Therefore, sex- and age-specific variation analysis of the supratrochlear foramen could not be performed, which limits the generalisability of the findings to the general population. A study for a specific Rajasthani community may not be fully powered by a sample size anchored to a different demographic baseline since anatomical variances

and bone morphometrics are strongly influenced by sexual dimorphism, age-related remodelling, and regional genetic or environmental factors. Therefore, a sample of 100 specimens might not adequately reflect the underlying variance or minute morphometric subtleties specific to this regional cohort without demographic stratification.

## CONCLUSION(S)

The STF is a significant anatomical variant located at the distal end of the humerus. Awareness of the STF's presence is crucial for orthopaedic surgeons when planning surgeries for supracondylar fractures. On X-rays, the STF appears as a radiolucent area, resembling an osteolytic or cystic lesion, so understanding its presence can help radiologists avoid misinterpreting X-rays.

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