

Supratrochlear Foramen; Morphological Correlation and Clinical Significance in Western Maharashtra Population

Pushpa Burute*, Suruchi Singhal*, Swathi Priyadarshini**

Abstract

Objectives: A bony septum separates the coronoid and olecranon fossae of humerus. At times, it is perforated, forming the supratrochlear foramen (STF) of the humerus. This study was intended to find out presence of STF and its correlation with humerus length and epicondylar breadth in western Maharashtra population. **Materials and methods:** The present study was done in the Department of Anatomy. Humeri were observed for presence or absence of STF. Humerus length and epicondylar breadth were measured by standard laboratory osteometric board and a Vernier Calliper respectively. **Results and conclusion:** Of a total of 113 bones that were taken for study, a foramen was observed in 30 bones, percentage prevalence 26.55%; 12/58 i.e. 20.69% on the right side and 18/55 i.e. 32.73% on left side. As prevalent in other studies for the same, it was found more commonly on the left side. A comparison of the dimensions of epicondylar breadth and humeral length in bones with STF and bones without STF was done using SPSS V16 software. Students T test and Chi Square test were applied. It was found that the Epicondylar Breadth was larger when the foramen was absent and Humeri with foramen present were shorter than those that had no foramina. This is the first of its kind of a study done for Western Maharashtra population.

Keywords: Epicondylar Breadth; Humerus Length; Supratrochlear Foramen.

Introduction

The humeri comprise of a shaft, upper end (head and two tuberosities) and lower end (Coronoid and olecranon fossae and the medial and lateral condyles with epicondyles). At the lower end anteriorly, the ulnar coronoid process articulates with the coronoid fossa and posteriorly the ulnar olecranon process articulates with the olecranon fossa to form the elbow joint. A bony septum separates the coronoid and olecranon fossae. This septum is occasionally perforated, forming the supratrochlear foramen (STF) of the humerus.

It has also been referred to as septal aperture, aperture in the coronoid-olecranon septum and

intercondyloid foramen [1-4].

Prevalence of foramen is more on left side and in gracile arms indicates mechanical stress as contributory factor. Many Indian studies on STF are on its prevalence only and no morphological correlation. This is the first of its kind of a study done with morphological correlation for Western Maharashtra population.

Anthropologists record it a non-metric skeletal variant, more frequently found in females [5].

Materials and Methods

The present study was done in the Department of Anatomy. A total of 113 adult dry humeri of both sides of unknown sex and free from any pathology were taken for study. The presence of supratrochlear foramen was noted. If the foramen was present, its shape was recorded and dimensions i.e. transverse diameter (TD) and vertical diameter (VD) measured using a Vernier Calliper.

Author's Affiliation: *Associate Professor, **Tutor, Department of Anatomy, BKL Walawalkar Rural Medical College, Sawarde, Dist- Ratnagiri Maharashtra, India.

Corresponding Author: Pushpa Burute, Associate Professor, Department of Anatomy, BKL Walawalkar Rural Medical College, Sawarde, Dist- Ratnagiri Maharashtra, India.
E-mail: pushpaburute60@gmail.com

The epicondylar breadth was measured using a Vernier Calliper.

The humeral length was measured using a standard laboratory osteometric board.

A comparison of the dimensions of epicondylar breadth and humeral length in bones with STF and bones without STF was done using SPSS V16 software. Students T test and Chi Square test were applied.

In bones where the foramen was absent, translucency and opacity of septum was visually measured using an illuminating X-Ray Board.

Results

A total of 113 bones were taken for study, 58 right sided and 55 left sided. A foramen was observed in 30 bones, percentage prevalence 26.55% (Figure 1).

The supratrochlear foramen was observed in 12/58 i.e. 20.69% on the right side and 18/55 i.e. 32.73% on left side.

The foramen was more prevalent on the left side.

The shape of the foramen was varied; transversely oval in 16 (53.33%), vertically oval in 1 (3.3%), round in 5 (16.66%) and triangular or irregular in 8 (26.66%).

The majority of the foramen were oval in shape.

The average Transverse Diameter (TD) was 6.3 mm and average Vertical Diameter (VD) was 4.3.

Largest size of the foramen was 10 X 6 mm. Largest TD observed was 10mm and largest VD 8mm.

Translucency of septum was seen in 19/46 = 41.3%

on right and 20/36 = 55.5% on left side (Figure 2).

The mean length of humerii with foramen present was 29.71 ± 2.43 cm. (Table 1).

The mean length of humerii with foramen absent was 30.81 ± 1.76 cm.

Humerii with foramen present were shorter than those that had no foramina. Difference observed is statistically significant (t-2.628, p value-0.01)

The average Epicondylar Breadth (EB) of humerii with foramen present was 5.92 ± 0.37 cm.

The average Epicondylar Breadth (EB) of humerii with foramen absent was 6.06 ± 0.36 cm. Difference observed is statistically not significant (t-1.733, p value-0.086)

The Epicondylar Breadth (EB) was larger when the foramen was absent for each population.

The difference in prevalence of foramen on the right and left side was insignificant using chi square test.

The chi-square statistic is 2.0977. The p-value is 0.147517. This result is not significant at $p < .05$.



Fig. 1: Humerus with supratrochlear foramen

Table 1: Statistical significance at 5% level of significance

	Present (Mean±SD)	Absent (Mean±SD)	t- value	DF	Sig(2-tailed) p-value	Significance
HL (cms)	29.71 (±2.43)	30.81 (±1.76)	2.628	111	0.01	Significant
EB(cms)	5.92 (±0.37)	6.06 (±0.36)	1.733	111	0.086	Non -significant

HL- humeral length, EB- epicondylar breadth

Table 2: Percentage prevalence of STF in different populations

Sr. No.	Population studied	Incidence%
1	Ainus (Akabori, 1934)	8.8
2	Japanese (Akabori, 1934)	18.1
3	Americans (Benfer & Mc kern, 1966)	6.9
4	Egyptians (Orztuk et al. 2000)	7.9
5	Eastern Indians (Chatterjee, 1968)	27.4
6	Central Indians (Kate & Dubey, 1970)	32
7	North Indians (Singh & Singh, 1972)	27.5
8	South Indians (Singhal & Rao, 2007)	22.20
9	Arkansas Indians (Nayak et al. 2009)	58
10	North Indians (RK Diwan et al. 2012)	24.1
11	Western Indians (Present study, 2016)	26.55



Fig. 2: Humerus with translucent septum



Fig. 3: Humerus with opaque septum

Discussion

Incidence of supratrochlear foramen in human populations shows a wide variation as evident from the present study and previous studies. The range is considerable; from very low in Greeks (less than 1%) to over 50% among Arkansas Indians [6] (Table 2).

Within the Indian population, considerable differences have been observed; a prevalence of 32% was found in Central India, whereas a lower prevalence was found among the South (28%), North (27.5%), and East Indian (27.4%) populations [7]. The highest recorded prevalence of 58% for Arkansas

Indians has been reported [6].

In the present study of Western Maharashtra region, the incidence is 26.55%. It matches the incidence found in South, North and East Indian population although there is a wide geographical and ethnical difference among the four population groups.

In all Indian studies, the prevalence of the foramen is more common on the left side and in females.

The size and shape of the foramen in various studies is also highly variable, although the most common shape for all populations and also in this study is the oval shape.

Despite the numerous studies on the foramen available, the function of the foramen and its possible aetiology when present are still topics of anatomical debate. It follows that due to its anatomical location, its presence and formation are related to the elbow joint.

The main movements at elbow are flexion and extension around a horizontal axis. The foramen lies on this axis. Hence mechanical stresses that involve the interaction between humerus and ulna lead to subtle changes in the bones at this site and probably lead to the formation of the foramen. Septal resorption, rather than deposition of bone is believed to be the causative agent as the foramen is absent in children [8,9].

On the other hand, possibility of it being a heritable feature cannot be ruled out as reflected in the observed population differences in its occurrence [8].

According to "Wolff's law", the mechanical strain applied to any bone influences its structure. This concept is termed 'bone functional adaptation' in recent literature [10]. Their review says that (i) organisms are able to adapt their structure to changing environmental conditions, and (ii) bone has the ability to respond to localized mechanical strain. High levels of strain result in increased bone deposition thereby reducing the strain. Conversely, low strain levels result in bone resorption, which in turn reverts to more strain.

We now discuss the application of Wolff's law in relation to the possible occurrence of the foramen.

The elbow is a link between the hand, the wrist, and the shoulder. Primarily, it helps in the positioning of the hand in space such as in reaching out to grab an object.

Animals such as pig, dog and hyena assume postures of extreme extension of forearms during feeding as they need to tear food morsels. This causes severe impact pressures on the elbow joint due to

which resorption of the bone and formation of the foramen happens.

Although in humans, these postures are not assumed, the formation of the foramen can still be explained. Anatomically, the left elbow exhibits a greater extension angle than the right; the foramen is more common on the left [11]. Also, women have a greater inward curvature of the angle of elbow and it has been universally proven that the foramen is more common in females. Although the majority of human population is right sided, as the humerus bears the weight of only the upper limb as compared to the femur that bears the weight of the whole body, it is subjected to relatively low strain levels. A possibility exist that the low strain levels result in bone resorption and subsequent foramen formation.

Our study has similar results. The incidence of foramen is more common on the left and hence we feel that mechanical stress is a major contributing factor to its formation. We do not have any similar study to compare with in Indian Populations.

In our study, the humeral length and epicondylar breadths were shorter in bone having the foramen as compared to bones without the foramen. These findings further bolster the mechanical theory. The prevalence of the foramen is greater on the generally more gracile arm (with smaller length of humerus and smaller epicondylar breadths) and on the left sided humerii [4,12,13].

Since sexual dimorphism contributes to length of long bones, a greater association between foramen and females is commonly observed [14].

It follows that robust bones are assumed to have a thicker and stronger olecranon septum that would withstand the stresses of humero-ulnar articulation and hence less prevalent on right side and in males.

No anatomical structure is known to pass through the foramen as yet and in life the foramen is covered by a membrane, it still has much clinical significance [6].

In bones with the foramen, the medullary canal has been found to be shorter and narrower than normal [7,15,16]. This may have implications in orthopaedic surgery, when a nail or rod is inserted into the medullary cavity (intramedullary fixation) in order to stabilize a diaphyseal fracture site. Knowledge of the dimensions of the humerus and the medullary cavity are therefore important for choosing the nail or rod of appropriate length and diameter to avoid secondary fractures during the surgical procedure.

As the incidence of the foramen in Indian

population varies from 27% to 58%, it is inferred that for all surgical procedures of the humerii and elbow joint, the presence or absence of the foramen should become a part of the preliminary investigations for work up.

It is recommended for radiologists to be aware of the occurrence of the aperture to help avoid misinterpretation of radiographs as it may be interpreted as an osteolytic lesion [17]. The foramen is a weak link in the elbow joint, as it is a deficiency in the bone (good size foramen have been observed). Hence, its presence may also lead to low energy fractures of the distal aspect of the humerus.

On the other hand, it also adds to the range of motion at elbow as studies reveal that individuals with the foramen have the potential to hyperextend at the elbow joint [8]. The clinical assessment of the condition of a joint often requires Range of Motion (ROM) measurements [18]. When the foramen is present, the ROM tends to be greater compared to when it is absent [8]. This might be of use for subsequent rehabilitation management and assessment of disability following injuries to the elbow joint.

It can be concluded that the supratrochlear foramen has anthropological, morphological and surgical importance and should be looked for in studies pertaining to the elbow joint.

References

1. Akabori E. Septal apertures in the humerus in Japanese, Ainu and Koreans. *Am J Phys Anthropol.* 1934; 8: 395-400.
2. Sahajpal DT, Pichora D. Septal aperture: an anatomic variant predisposing to bilateral low-energy fractures of the distal humerus. *Can J Surg.* 2006; 49: 363-364.
3. Koyun N, Aydinlioglu A, Gumrukcuoglu FN. Aperture in coronoid-olecranon septum: A radiological evaluation. *Indian J Orthop.* 2011; 45: 392-395.
4. Krishnamurthy A, Yelicharla A, Takkalapalli A, Munishamappa V, Bovindala B, Chandramohan M. Supratrochlear foramen of humerus – A morphometric study. *Int J Biol Med Res.* 2011; 2: 829-831.
5. White TD, Black MT, Folkens PA. *Human Osteology*, 3rd ed. San Diego: Elsevier Academic Press; 2012.
6. Nayak SR, Das S, Krishnamurthy A, Prabhu LV, Potu BK. Supratrochlear foramen of the humerus: An anatomico-radiological study with clinical implications. *Ups J Med Sci.* 2009; 114: 90-94.
7. Singhal S, Rao V. Supratrochlear foramen of the humerus. *Anat Sci Int.* 2007; 82: 105-107.

8. Glanville EV. Perforation of the coronoid-olecranon septum. Humero-ulnar relationships in Netherlands and African populations. *Am J Phys Anthropol.* 1967; 26: 85-92.
 9. Mays S. Septal aperture of the humerus in a mediaeval human skeletal population. *Am J Phys Anthropol.* 2008; 136: 432-440.
 10. Ruff C, Holt B, Trinkaus E. Who's afraid of the big bad Wolff?: "Wolff's law" and bone functional adaptation. *Am J Phys Anthropol.* 2006; 129: 484-498.
 11. Gunal I, Kose N, Erdogan O, Gokturk E, Seber S. 1996. Normal range of motion of the joints of the upper extremity in male subjects, with special reference to side. *J Bone Joint Surg Am.* 78: 1401-1404.
 12. Mahajan A. Supratrochlear foramen: Study of humerus in North Indians. *Professional Med J.* 2011; 18: 128-132.
 13. Ndou R, Smith P, Gemell R, Mohatla O. The supratrochlear foramen of the humerus in a South African dry bone sample. *Clin Anat.* 2013; 26: 870-874.
 14. 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: 247-252.
 15. Akpınar F, Aydinlioglu A, Tosun N, Dogan A, Tuncay I, Unal O. A morphometric study on the humerus for intramedullary fixation. *Tohoku J Exp Med.* 2003; 199: 35-42.
 16. Sunday O, Olusegun O, Oluwabunmi B. The supratrochlear foramen of the humerus: implications for intramedullary nailing in distal humerus. *J Bio, Agri Healthcare.* 2014; 4: 136-139.
 17. De Wilde V, De Maeseneer M, Lenchik L, Van Roy P, Beckman P, Osteaux M. Normal osseous variants presenting as cystic or lucent areas on radiography and CT imaging: A pictorial overview. *Eur J Radiol.* 2004; 51: 77-84.
 18. Vasen AP, Lacey SH, Keith MW, Shaffer JW. Functional range of motion of the elbow. *J Hand Surg Am.* 1995; 20: 288-292.
-