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Review Article
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Study of Supratrochlear Foramen of Humerus and Associated Clinical Significance: Comprehensive Review

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ABSTRACT

Introduction: the supratrochlear foramen, an opening in coronoid fossa, varies according to race, gender and side of hand. Supracondylar fractures are common specially in children for which intramedullary nailing is done. But since individuals with supratrochlear foramen have thin medullary cavity, if surgeon is unaware of this foramen, it causes postoperative complications. The aim of review is to highlight and bring out detailed information related supratrochlear foramen so as to avert clinical complications.

Review: the study was performed in the department of Anatomy using data bases such as Google scholar, research gate, pubmed, medline and Scielo. Various terms related to supratrochlear foramen were taken into account for exploring the literature. The literature was compiled, discussed and issues causing complications and how these complications can be rectified were brought out. Literature review exhibits that not only the morphometry, morphology of supratrochlear foramen varies but incidence of this foramen also varies.

Conclusion: the comprehension of information related to supratrochlear foramen is essential for orthopaedic surgeons for managing supracondylar fractures, for identifying races and species by anthropologists and anatomists for variations.

Keywords: Supratrochlear foramen; Supracondylar fracture; Race, Anthropologist, Anatomy, Variation, Gender, Morphology, Morphometry, Orthopedic surgeons.

Introduction

Supratrochlear foramen (STF) is an opening above trochlea of distal humerus connecting coronoid fossa with the olecranon fossa. The STF was observed firstly by Mekel in 1825 quoted by Kate and Dubey[1], 1970. Supratrochlear foramen is known by different names like olecranon aperture, intercondylar foramen, epitrochlear foramen, septal aperture and foramen olecrani[2-5]. Multiple causes such as mechanical and genetic factors are attributed to development of this foramen. Mechanical theory was proposed by Glanville which states that foramen results from damage caused by repetitive use of ulna and humerus during flexion and extension[6]. Genetic theory propounded by Chapman *et al*., 1996 expresses that T-Box genes is responsible for the formation of the supratrochlear foramen[7]. This genetic theory is affirmed by Hirsh, 1927 who is of the view that foramen is prearranged by the TBX gene and so complete foramen develops only after seven years in a child[8].

The incidence of STF is found to vary according to race, gender and side. The incidence of STF ranges between 0.3 % to 58 % in various ethnic groups[9-11]. The incidence of STF is observed to be highest in Arkansas-Indians and Africans[12] and low incidence of this foramen was found in Europeans and Americans[12]. So, the foramen exhibits ethnicity. The incidence of STF also reported to vary with gender as evidenced by two studies in which STF was detected more frequently in females as compare to males[13-14]. The occurrence of STF has been correlated with side of arm in few studies. It was found on higher side on left side[5, 15-19]. However, in one study its incidence was observed to be more on right side than left side[20]. The humerus with STF was found to have narrow intramedullary cavity[15]. In childerns, supracondylar fracture which is very frequent[20] which is managed by intramedullary nailing but there is increased chances of causing iatrogenic fracture during intramedullary nailing process in distal humerus by an orthopedic surgeon due to presence of STF. So, to prevent complications, antegrade nailing approach is advocated rather than retrograde nailing in patients with STF[18] as the presence of STF may influence the outcome of this procedure. The information on STF is important as it appears radiolucent in radiographs (Figure 1) and so may be misinterpreted as cystic or osteolytic lesions by radiologist during diagnosis[21]. To prevent unwanted complications due to misinterpretation or during surgical procedures involving pathologies of distal humerus, detailed knowledge of STF is essential. Hence the review was performed. Aim of this review is to highlight and compile the data elucidating variations related to STF and how these variations are responsible for causing pitfalls during surgical interventions and how these pitfalls can be averted.

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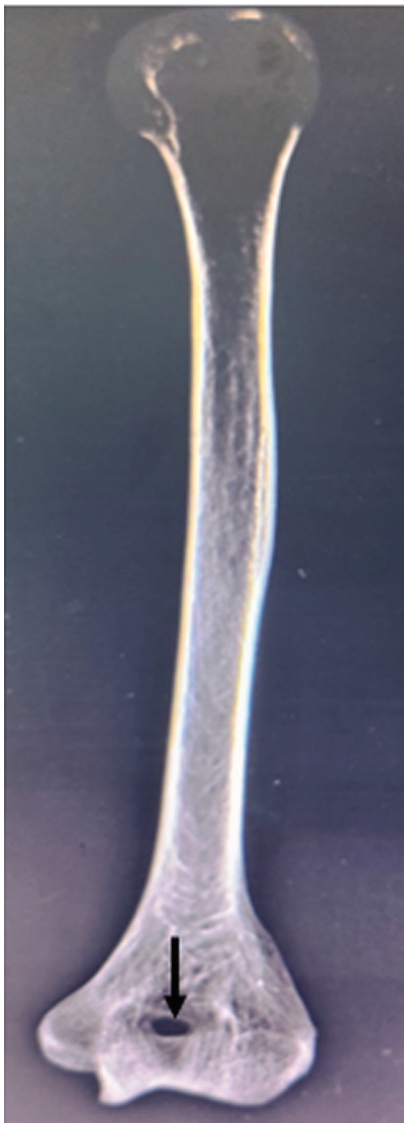

Figure 1. appearance of supratrochlear foramen in X-ray. Black arrow points to supratrochlear foramen.

So, the study was conducted in the department of anatomy, UP University of Medical Sciences Saifai Etawah. Literature survey was done using databases; Google scholar, research gate, pubmed, medline, scopus and Scielo. Only articles in English language were referred. Standard text books of Anatomy were also consulted. Various terms used for exploring literature are, "Supratrochlear foramen, incidence of supratrochlear foramen, clinical significance of supratrochlear foramen, Anatomy of Supratrochlear foramen, morphology of supratrochlear foramen and morphometry of supratrochlear foramen". The data was consolidated, issues arising due to presence of STF was brought out and how these issues can be minimised were also highlighted.

Review

The variations in the morphology and morphometry of STF is a known fact and is explicitly described in literature as elaborated in succeeding paragraphs.

Morphological forms of supratrochlear foramen:

The morphology of STF is in form of various shapes such as vertical oval, horizontal oval, round, triangular, rectangular, kidney shaped and sieve like (Figure 2-3). Oval shaped STF is most common type (Figure 2) followed by round type[9, 16, 19] and less common types (Figure 3) are rectangular, triangular, reniform and sieve type[16, 18-19]. However, round shape was found to be the most common variety by Diwan *et al*[14]., 2013.

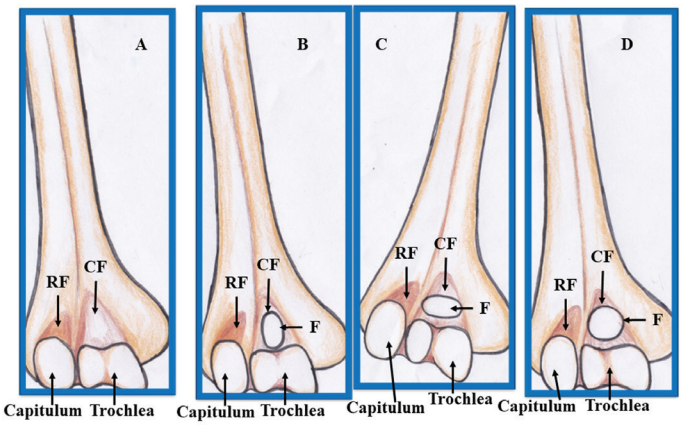

Figure 2. displaying common morphological forms of Supratrochlear foramen
A- Humerus with no supratrochlear foramen, B- Humerus with vertical oval supratrochlear foramen, C- Humerus with horizontal oval supratrochlear foramen, D- Humerus with circular supratrochlear foramen
RF- radial fossa, CF- coronoid fossa, F- supratrochlear foramen.

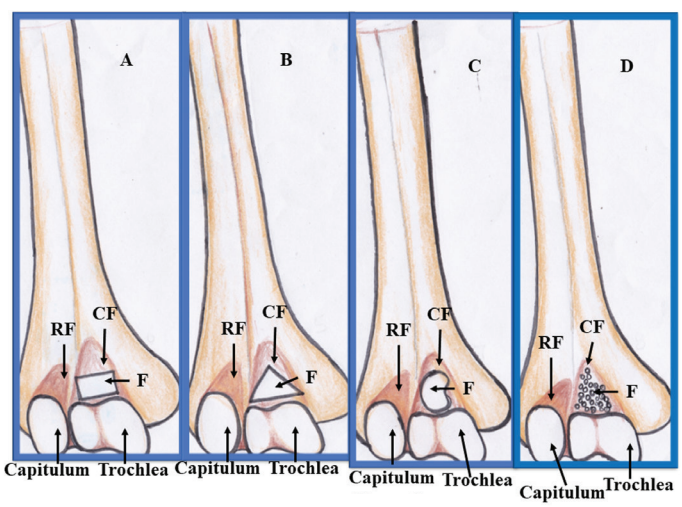

Figure 3. displaying less common morphological forms of Supratrochlear foramen
A- Humerus with rectangular supratrochlear foramen, B- Humerus with triangular supratrochlear foramen, C- Humerus with reniform supratrochlear foramen, D- Humerus with sieve type supratrochlear foramen
RF- radial fossa, CF- coronoid fossa, F- supratrochlear foramen.

Morphometric variations of the supratrochlear foramen:

The mean transverse diameter of STF ranges between 4.88 ± 1.63- 7.53±1.28 mm and 5.24 ± 1.76- 8.30 ± 1.07mm on left side and right side respectively and mean vertical diameter ranges between 3.37 ± 1.25- 5.35±1.60mm and 3.81 ± 0.97 - 4.09±1.13mm on left and right sides respectively[18, 20, 22-23]. No major variations in the diameters of the STF is observed.

Besides, morphological and morphometric variations, the STF also manifests ethnic variations.

The incidence of STF in Greek population is reported to be 1% and highest frequency of 58% in Arkansas Indians[16]. The incidence of this foramen is 6.9%in American, 7.9 % in Egyptians and 18.8% in Japanese[3, 21, 24]. This extensive deviations in various ethnic groups can be explained by genetic theory as STF is stated to be inherited trait[10]. Thus, incidence of STF can throw light on the ethnic group to which unknown skeleton belongs.

The STF was also found to vary according to gender and side of hand which is vividly described in following paragraphs.

Variations according to gender:

As gender is concerned the foramen was detected on higher side in females as compared to males[15-16, 19]. It was observed that joints in females exhibits higher degree of mobility as compared to males[13]. In addition to this, in females, elbow angle has more inward curvature[19]. These factors are responsible for higher incidences of STF in females. Thus, the STF can be useful in identifying female skeleton.

Variations according to side of hand:

In majority of studies the frequency of the STF was found more on left side of hand as compared to right side[5, 15-19]. This was explained on the basis of handedness as right-hand bones are suggested to be stronger than left hand bones. In addition to this left hand is found to have substantial joint motion and joint mobility as compared to right hand which may be cause of high incidence of STF on left side of hand[19]. Contrary to this one study report higher prevalence of the STF on right side[20]. The STF can be used in identifying the side of hand.

Evolutionary history:

The STF is observed in dogs, horse, and hyena in same form as in human beings. Charles Darwin suggested this foramen as one of characteristic which link evolution of human beings to lower animals. This is further affirmed by the fact that ancient primitive people have higher incidence of this foramen as compared to modern man. Thus, STF can be used by anthropologists for identifying specimens[11].

Conclusion

The STF exhibits racial, morphometric, morphological, gender and handedness variations. As ethnicity is concerned highest incidence is observed in Arkansas Indian and low frequency in Europeans and Americans. The STF also displays great variation in various shapes and dimensions. In addition to this, the foramen is found to be on higher side on left hand side and in females. The foramen appears as radiolucent in radiographs and can be mistaken for cystic or osteolytic lesions by radiologist. Since bones with STF has thin medullary cavity, management of supracondylar fractures by intramedullary nailing should be carried out via antegrade route rather than retrograde nailing approach to minimise postoperative complications. Thus, detailed knowledge about the STF is essential to identify the races, species and differentiating females and males skeletons by anthropologists, also important to avoid misinterpretation of radiographs by radiologists. In addition, information is of utmost useful to orthopedic surgeons in managing the supracondylar fractures. In patients with STF, the antegrade nailing approach should be preferred as compared with retrograde route for treating supracondylar fractures.

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Mini Curriculum and Author's Contribution

1. Rajani Singh: MS. Contribution: Scientific and intellectual participation, data acquisition and interpretation, manuscript righting, review and final approval

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