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Case Report

The Supratrochlear Foramen in Iron Age Humerus Remains from Iran: A Paleoepidemiological Case Report

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Abstract

The supratrochlear foramen of the humerus (septal aperture) refers to the absence of the septum between the coronoid and olecranon fossae at the distal end of the humerus. Knowledge of this anatomical variation is important for anatomists, anthropologists, orthopedic surgeons, and radiologists in clinical practice. This study aimed to evaluate non-metric anatomical traits in skeletons discovered in an Iron Age cemetery in Tabriz. To date, multiple tombs have been uncovered beneath one meter of sterile soil, covered by a substantial layer of medieval building debris. Among the 40 adult skeletons found in this cemetery, no prior scientific data on burials in this area had been collected. This study documented the presence of a supratrochlear foramen in both humeri of a female skeleton from this Iron Age site in Tabriz (Iran). The bilateral incidence of this trait was 2.5%, which was lower than reported in previous anthropological studies. Notably, this is the first documented case in Iran comparable to European and white American populations. The closure of this foramen serves as a criterion of age estimation in sub-adult humans. Given existing reports on its clinical implications, greater attention should be paid to this diversity, particularly in Iran. The findings might prove valuable not only for anatomists and anthropologists but also for radiologists and orthopedic surgeons.

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Keywords ● Humerus ● Anthropology ● Age determination by skeleton ● Septal aperture

What's Known

- The humeral septal aperture is the absence of the septum between the coronoid-olecranon fossae at the distal end of the humerus.
- This anatomical variation might permit excessive elbow extension.

What's New

- The incidence of this variation was 2.5%, with a humeral angle of 79° in the evaluated skeleton.
- Greater attention should be given to this, in Iran, as it may hold significance for anatomists, anthropologists, and clinical practice.

Introduction

Non-metric traits in anthropology have a few centuries of history.[1] One of these variations is the septal or olecranon aperture, coronoid-olecranon, intercondylar, or supratrochlear foramen of the humerus. The floor of the olecranon fossa is always thin and may be partially deficient.[2] The slender bone sheet between the olecranon and coronoid fossae is consistently present until about age seven.[3] However, this bony septum occasionally becomes absorbed, resulting in the supratrochlear foramen (STF). Individuals with this anatomic variation might be able to overextend the elbow joint.[4] This foramen is important to orthopedics in the preoperative planning of nailing fractures of the distal humerus and to the radiologist for differentiating it from an osteolytic or cystic lesion.[2] This trait is also of significant interest

to anthropologists, who consider it important for understanding the connection between humans and lower animals. Additionally, bony defects that serve as stress risers might influence fracture patterns and impact treatment choices.[5]

The Iron Age (approximately 1800 to 500 BC) holds significant value as the foundational period of the Iranian plateau. By overcoming severe climatic conditions and prevailing over the nomadic populations, this area established the first bedrock of historic Iranian culture. From both historical and anthropological perspectives, Northwest Iran possesses a typically high value. This region preserves cultural artifacts from the Neolithic, Chalcolithic, Bronze, and Iron Ages, reflecting its rich and ancient history. One of these cultural developments was a shift in burial practices, with cemeteries being relocated to the suburbs of cities and villages.[6] Azerbaijan, one of Northwest Iran's historically significant regions, has been recognized as a center of urban life. Its origin trace back to the Tertiary geologic period, when the Paleocene and Miocene epochs provided favorable conditions for the emergence of a remarkably brilliant civilization.[7] Tabriz, the most prominent city in this region (latitude of 38° 4′ N and longitude of 46°18′ E; elevation 1348-1561 m above sea level), served as our study location. A previous study reported different incidences of this anatomical trait across anthropological and modern populations, including lower mammals.[3] However, to the best of our knowledge, no physical anthropological studies have been conducted for this specific period in Iran's northwestern region. In this way, the present research examined skeletons from this geographical area and historical period, with a particular focus on documenting humeral supratrochlear foramen (STF) variation. Understanding STF anatomy might be valuable for multiple disciplines: anthropologists studying human variation, radiologists interpreting imaging studies, and orthopedic surgeons planning supracondylar fracture treatments.

Case Presentation

In 1997, municipal road construction near Tabriz's Blue Mosque accidentally uncovered a cemetery. Subsequent scientific studies identified this as an important historical site dating to approximately 1800-1500 BC, characterized by gray pottery accompanying skeletal remains, a feature consistent with Iron Age burials.[8] There were 45 skeletons, including 40 adults. This paper reported on a physical variation, STF, which was observed in skeletons from this prehistoric archaeological site. All procedures for this research project were approved by the Ethics Committee of Shiraz University of Medical Sciences (Ethical code: IR.SUMS.REC.1393.S7084).

The humeral supratrochlear foramen was found bilaterally in only one skeleton (burial number MK-80-21). The individual was interred in an East-West orientation with the body positioned in an embryonic (squatting) posture. Morphological analysis of the mastoid process, mandible, and dental wear patterns (Lovejoy method) identified the remains as female, aged approximately 24-30 years at death.[9] Cranial anthropometric study revealed a mesocephalic skull. Both humeri exhibited STF (figure 1), with an incidence rate of 2.5% in the sample.

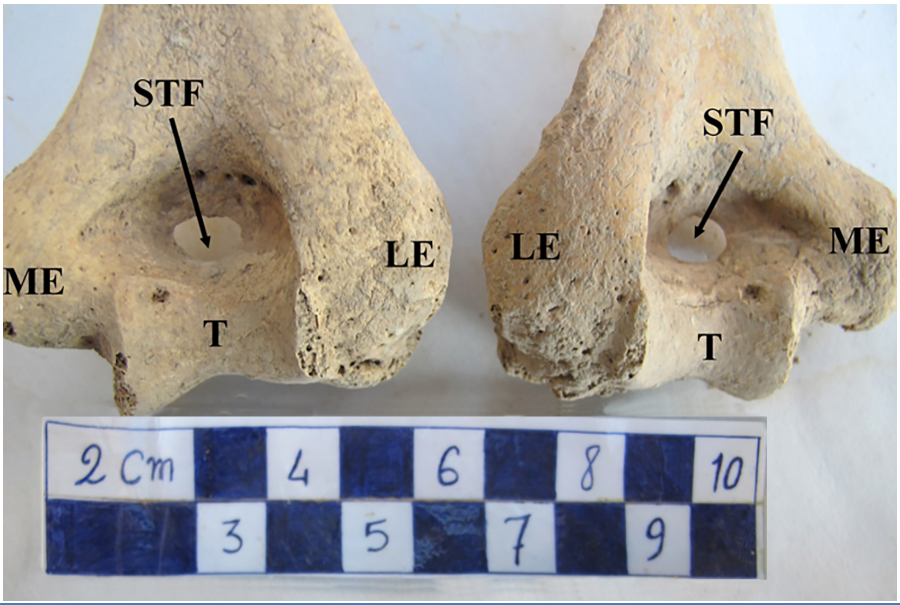

Figure 1: The supratrochlear foramen or septal apertures are observed in the photograph of the lower end of the right (R) and left (L) humerus (posterior view) from grave No. MK-80-21. LE: Lateral epicondyle; ME: Medial epicondyle; STF: Supratrochlear foramen; T: Trochlea

Table 1: Incidence of the humeral supratrochlear foramen in anthropological studies in different populations

Authors	Population	Incidence (%)
Hirsh 1927[3]	White American	4.7
Glanville 1967[4]	European	6
Mays 2008[15]	England	6.9
ÇİMEN et al, 2003[16]	Turkish	12
Glanville 1967[4]	African	47
Present study	Iranian	2.5

The oval foramina measured 5.5×10 mm (right) and 14.6×14.8 mm (left), respectively.

We additionally measured the condyle-diaphyseal angle (humeral angle), defined by the intersection of the trochlear tangent and the diaphysis axis, which was about 79° in this skeleton.

Discussion

This study focused on the supratrochlear foramen, a feature often overlooked in orthopedic literature. Its occurrence among Iron Age Iranians was lower than reported in previous anthropological studies. Several variations can be found in the lower end of the humerus. One of these variations is the STF. This foramen or aperture is not congenital. However, it is rarely created through absorption of the septum between the olecranon and coronoid fossae, typically occurring after the age of seven.[10]

The reported incidence of this foramen in different anatomical studies ranged between 0.3%-58 %, with predominance on the left side.[11] However, anthropological studies reported frequencies between 4.7% to 47% (table 1), varying across different racial groups and geographical regions. This foramen was reported more frequently in females and on the left side.[12] Comparative studies indicated higher prevalence among African and Arab populations than other populations. Furthermore, studies demonstrated greater elbow joint laxity in African Americans and Indians than in Europeans.[2] These observations suggested a potential association between the supratrochlear foramen and joint hypermobility, possibly related to weaker muscles.[13] While some researchers consider this trait potentially symptomatic, possibly requiring surgical intervention,[14] further investigations, particularly medical imaging studies of individuals with hypermobility, are warranted.

In the present study, this trait was observed bilaterally in only one adult female. To the best of our knowledge, no previous studies have reported the incidence of this foramen in Iranian populations. The findings showed partial comparability with white American, European, and England populations (table 1). The incidence of this trait among Iranians during this specific period and location appears relatively low. However, additional studies are required to evaluate this trait across different regions and periods in Iran.

Previous studies reported that the shape of the STF typically exhibited an oval shape in most dried bone specimens (not anthropological samples), with transverse diameters ranging from 5.26 to 7.4 mm and vertical diameters varying between 2.7 to 4.8 mm.[11, 17] However, Mays reported these dimensions in an anthropological study in England from 0.5-21 mm (transverse) and 1-20 (vertical).[15] The STF dimensions in the present study were comparable to those of anthropological findings.

Previous studies reported condyle-diaphyseal angles ranging from 77° to 87°, with the maximum angle (87°) observed in Neanderthal specimens. The angle measured in the present study (79°) was within the range reported for other European populations. These findings suggested that while the trochlea maintained a horizontal orientation in Neanderthals, it exhibited a relatively oblique axis in modern humans.[3]

Darwin recognized this foramen as a variable character in humans that demonstrated their close relationship to lower mammals. He stated its occasional occurrence in several anthropoids and apes, including in full-grown gorillas, and orangutans while observing its absence in infant gibbons.[3] Some studies suggested that STF might represent a hereditary phylogenetic trait associated with evolutionary significance.[12] In some animals, particularly carnivores, the STF consistently appeared as a humeral feature.[18] Primates exhibit notable variations in this trait, with distinct patterns of foramen disappearance observed between Catyrhinin and Platyrhinin primates. Changes in the appearance and disappearance of the variations in primates depend on the biogeographic and stratigraphic conditions. Notable examples include two primates from the Upper Eocene epoch (Sanorzine stage) and the lower Oligocene epoch (Bartonian Stage) that have been found in the Egyptian Fayum region. Morphological stability of the humerus bone was obvious in

the Catopithecus, and STF was found in these species.[19] In fact, these studies demonstrated the atavistic nature of this feature in the superior primates.[1, 18, 20]

While the appearance and development of this foramen remain unclear, the trauma theory appears unlikely given its higher prevalence in females. Mechanical energy explanations are similarly improbable due to their predominant occurrence in the left humerus.[21] However, it might partially be attributed to the penetrance of one gene.[1]

Conclusion

The elbow joint exhibits numerous anatomical variations, and understanding them is essential for comprehensive anatomical knowledge. This study focused on the study of the supratrochlear foramen, a feature frequently overlooked in orthopedic literature. The findings of the present study indicated a lower incidence of this trait among Iron Age Iranian populations than previous anthropological reports. However, the humeral angle was less than Neanderthals, and it closely matched European population measurements. Given the clinical significance of this trait, increased attention should be paid to this anatomical diversity, particularly in Iranian populations. The knowledge gained in this regard could provide valuable insights for anatomists, anthropologists, radiologists, and orthopedic surgeons.

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Authors' Contribution

M.R.N: Contributed to the study's conception and design; supervised the project and acquired funding; reviewed the final version. J.R: Contributed to the study's conception and design; material preparation, data collection, and analysis; writing the first draft of the manuscript; and reviewing the final version. Both authors have read and approved the final manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of Interest: None declared.

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