

Sexual Dimorphism with the Shape of Hyoid Bone

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Abstract

Background: Hyoid bone is of considerable forensic interest owing to its susceptibility to fracture during manual strangulation, hanging and other forms of neck compression. In road traffic accidents it may get injured leading to significant airway concerns. A hyoid bone's shape may influence its susceptibility to fracture and hyoid fractures are frequently confused with normal variations in both clinical and forensic medico-legal cases. Aim our study was to establish a method of sex differentiation by the shape of hyoid bone there by helping the forensic expert to come to a conclusion.

Materials and Methods: The study was conducted in the department of anatomy on 60 hyoid bones obtained from medico legal postmortems conducted in the department of forensic medicine, Government medical college Mysore.

Results: It is observed that the most common shape of hyoid is 'U' in male's and deviated type in female's. Least common types are 'V' shape in male's and boat shape in females.

Conclusion: The present study was conducted to know the relationship of the sex with the shape of the hyoid bone . The presence of a fractured hyoid bone is of great importance in cases involving badly decomposed bodies and skeletal remains lacking soft tissue evidence of neck injury. The present study was conducted to help forensic experts while diagnosing hyoid fractures and determination of sex from the skeletal remains.

Keywords: hyoid bone; shape; Fracture; sex determination; Forensic expert.

Introduction

Hyoid bone is a 'U' shaped bone suspended from the tips of the styloid process by stylohyoid ligaments.¹ It lies at the level of the 2nd to 3rd cervical vertebrae and approximately at the level of lower margin of the lower jaw when the head is held in natural position.²

It has a body, 2 greater and 2 lesser horns or cornuae. Body is irregular, elongated and quadrilateral having anterior surface which is convex, faces antero - superiorly and posterior surface which is smooth, concave faces postero - inferiorly. Greater cornuae project backwards from the body and each cornua laterally ends in a tubercle. Lesser cornuae are 2 small conical projections at the junction of the body and greater cornuae.²

Ossification: All elements originate in the cartilaginous tissue of the pharyngeal (also known as branchial) arches. By a generally accepted concept of origin, the lesser horn's and superior part of the body above the horizontal ridge are derived from the 2nd, so called hyoid arch. While the rest of the body and greater horns differentiates from 3rd pharyngeal arch.³

Determination of the sex of the skeletal remains of an individual from an examination of a single bone, except hip bone is considered to be a most impossible task.⁴

Studies have been done on establishing sex from femur, sternum, clavicle, radius, ulna, scapula and other bones.^{5,6,7}

The hyoid bone is a rather neglected structure of the human skeleton which has not been given sufficient attention.⁸

After going through the literature regarding the shapes of human hyoid bone, it is noticed that the work is limited to western population till 1988. The present study was conducted to know the relationship of the sex with the shape of the hyoid bone.

Materials and Methods

The material for the present study include 60 specimens (male: female, 30:30) of hyoid bones collected from the cadavers during autopsies (2013 to 2016) at Government medical college, Mysore. All specimens were aged between 19 to 80. The damaged hyoid bones mainly of hanging and strangulation cases were excluded from the study. The specimens were stored in 10% formaldehyde solution.

In these specimens laryngeal cartilages, thyroid gland, infrahyoid muscles and thyro hyoid membranes were dissected. First infrahyoid

muscles and thyrohyoid membrane were cut following from the down to 1 cm of hyoid bone, then muscular and ligamentous structures of bone were removed. During dissection care was taken to preserve the lesser cornua of hyoid bone and then each bone was completely dried in air. Later each hyoid bone was numbered, shape of each bone was recognized and tabulated.

Hyoid bones were classified according to their shape in to following 5 types as shown in figure 1, as done by Harjeet and Jit I 1996⁹ as follows.

1. Hyperbolic ('U' shaped) - figure 2
2. Parabolic ('V' shaped) - figure 3
3. Boat shape - figure 4
4. Horse shoe type - figure 5
5. Deviated type - figure 6

Results

Modern text books of anatomy do not provide adequate information about various shapes of hyoid bone which are important in identifying sex of the hyoid bone.

The present study shows that 'U' shaped hyoid bone is more common (33.33%) in adult males followed by Horse shoe shaped type (30%) and

U Type	V Type	Boat Type	Horse Shoe Type	Deviated Type
It is a half circle Anteriorly; the greater cornua are almost straight	It is triangular in shape and resembles 'V', body is bent upon itself with convexity forward	It resembles a boat, the two greater cornua deviate from each other as if opened out	It is half circle anteriorly the greater cornua faces each other	One greater cornua deviates more than the other making the Cornua asymmetrical

Table 1: Various shapes of Hyoid bone in males and females with their percentage.

Shape of hyoid bone	Male	Female	Total
'U' shape	10 (33.33%)	5(16.66%)	15(25%)
'V' shape	2(6.66%)	6(20%)	8(13.33%)
'B' shape	5(16.66%)	4(13.33%)	9(15%)
'H' shape	9(30%)	6(20%)	15(25%)
'D' shape	4(13.33%)	9(30%)	13(21.66%)
Total	30	30	60

Table 2: Comparison of Shape of Hyoid bone of present study with previous studies. (in %).

Name of authors	'V' shape			'U' shape			'B' shape			'H' shape			'D' type		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
Papadopoulos et al (1989) ¹⁰	5.3	5.3	5.4	1.54	21.1	18.3	2.11	3.16	26.4	10.5	31.6	21.1	17.1	10.5	13.8
Harjeeth and Jit et al (1996) ⁹	33.5	18	25.8	20.5	33	26.8	14	19	11.5	10.1	12	11.1	22	18	20
Mahima Srivastava (2016) ⁵	36	20	28	14	34	24	10	8	9	14	16	15	26	22	24
Sayed Sadia Sameera (2016) ⁴	36.36	20.58	31	13.6	35.29	21	10.6	8.8	10	13.63	14.70	14	25.75	20.58	24
Present study 2019	6.66	20	13.33	33.33	16.66	25	16.66	13.33	15	30	20	25	13.33	30	21.66



Fig. 1: Different shapes of hyoid bone.



Fig. 2: 'U' Hyperbolic shape.



Fig. 3: 'V' Parabolic shape.



Fig. 4: 'B' - Boat shape.



Fig. 5: 'H' - Horse shoe shape.



Fig. 6: 'D' - Deviated type.

least common is 'V' shaped type (6.66%) as shown in table 1.

In females, deviated type of hyoid bone is more common followed by 'V' shape (20%), Horse shoe shape (20%) and least common type is boat shape (13.33%) as shown in (Table 1).

Discussion

Modern sex determination techniques originated in traditional physical anthropology, even today initial assessment of sex is based on visual gauge of the width of the pubic bone and the subpubic angle or greater sciatic notch. However, since the pelvis

is not always available, intact or 100% diagnostic, more options were needed.¹¹

The standards from classical studies like those of Pearson and Bell 1919¹² on the femur, Borovansky [1936] on the skull and washburns 1948¹³ ischio-pubic index are still being used with success. Accuracy rate in identification of sex from an entire skeleton is highest when compared to the accuracy rate from individual bone. Even with human pelvis alone and skull alone sex can be determined with 95% and 92% accuracy only.¹⁴

The incidence of 'U' shape in males it is more than all other studies.^{4,5,9,10} In females it is least in the present study compared to all other studies.^{4,5,9,10}

The incidence of 'B' shape is more in both sexes when compared with all other studies^{4,5,9,10} except in females it is less than incidence given by Harjeet and Jit I (1996).⁹

The incidence of 'H' shape is more in both the sexes when compared with other studies.^{4,5,9,10} except in females it is less than incidence noted by Papadopoulos (1989).¹⁰

The incidence of deviated type is less when compared with other studies.^{4,5,9,10} (Table 2).

in males and it is more when compared with other studies^{4,5,9,10} among females.

The incidence of 'V' shape in males, it is almost same as that of Papadopoulos (1989)¹⁰ and it is less than other studies^{4,5,9} where as in females it is almost same as that of other studies^{4,5,9} and it is more than that of Papadopoulos (1989).¹⁰

Newer investigative modalities have brought in to light the role of spatial inter - relationships of the hyoid to its neighbouring structures. Thus highlighting the anatomic basis of various clinical procedures. Hyoid suspension is a procedure designed to stabilize the airway behind the back of the tongue to correct obstructive sleep apnea. The hyoid bone is pulled forward in front of voice box either in conjunction with genioglossus for tongue advancement or isolated procedures.¹⁵

Conclusion

After studying different shapes of hyoid bone it is concluded that in males 'U' shape and in females 'D' shape of hyoid bone were the leading types. However the study of hyoid bone alone will be inadequate in sex determination and needs to be considered along with the measurements of other bones of the same individual for more accuracy.

A hyoid bone's shape may influence its susceptibility to fracture and hyoid fracture is frequently confused with normal variation in both clinical and forensic applications. The present study was conducted to help forensic experts while diagnosing hyoid fractures and determination of sex from the skeletal remains.

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The Supratrochlear Foramen of Adult Humerus and its Clinical Considerations

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Abstract

Background: Supratrochlear foramen (STF) is located on the bony septum that separates the olecranon fossa from the coronoid fossa, at the lower end of the humerus. The knowledge of the presence of STF in a humerus may be important for preoperative planning for treatment of supracondylar fracture. The presence of STF may also result in erroneous interpretation of radiographs.

Materials and methods: The STF was studied in detail in 300 (175 right side and 125 left side) human dried humeri of unknown sex and age. The topographical anatomy of the STF was studied in detail, morphometric measurements were taken, and the specimens were photographed.

Results: Out of the 300 bones studied, 140 cases (46.6%) showed the presence of STF. The STF was oval, round, and triangular in shape in 128, 7, and 5 cases, respectively. The mean length of the transverse diameter for supratrochlear foramen was 6.60 mm and 5.9 mm on the left and right sides, respectively. The mean length of the vertical diameter for STF was 4.80 mm and 3.80 mm on the left and right sides, respectively. Most of the bones that had no STF showed a translucency of septum, in 54.4% of the bones.

Conclusions: The results of our study show that STF is more common on the right side, with the oval shape being more common. The respective sides did not exhibit any statistical significant differences. Presence of STF may be important for anthropological, clinical, and academic purpose.

Keywords: Humerus; intramedullary humeral nailing; supratrochlear foramen; Translucent septum.

Introduction

Olecranon and the coronoid fossa of humerus are separated by a thin plate of bone, which may become perforated in some cases to give rise to a foramen known as supratrochlear foramen.¹ Supratrochlear foramen was first described by Meckel (1825).² Since then, it has been described in various animals like dogs, hyenas, cattle, and other primates.^{3,4} Morphologically in humans thin plate of bone present until the age of seven years, after which the bony septum occasionally becomes absorbed to form the STF.⁵ Individuals with this anatomic variation may be able to overextend the elbow joint.⁶ In intramedullary fixation of the humerus is commonly used in traumatic injuries and pathological fractures.⁷ The Proper anatomical knowledge of the humerus is important in preoperative planning in the presence of variations in the distal end of the humerus.⁸ The presence of supratrochlear foramen is also important for radiologists and orthopaedicians for proper interpretation of x-rays as they appear radiolucent and may be mistaken for cystic or osteolytic lesions.⁸ Our study aims to highlight STF incidence, different shapes and clinical importance, which

may be beneficial for anthropologists, orthopaedic surgeons, and radiologists in day-to-day clinical practice.

Materials and Methods

A total of 300 (125 right side and 175 left side) human dried humeri free of any pathological changes and of unknown sex of Indian origin, were studied in Department of Anatomy, Kannur Medical College, Anajakandy, India for various parameters such as; presence or absence of a STF; Shape (oval, round, and triangular); transverse and vertical diameters of the STF and its distance from the tip of the medial epicondyle were measured using a vernier caliper.

Statistical analysis: Data were expressed in Mean±Standard deviation (SD). The Side differences of transverse and vertical diameter of the STF were compared using the unpaired Student's t test; the level of significance was set at $P < 0.05$ (Table 3). All statistical tests were performed using GraphPad Prism version 5.0 for Windows (GraphPad Software, San Diego, CA).

Results

Out of the 300 bones studied, 140 cases (46.6%) showed the presence of STF. In 69 (49.2%) cases on the left side and in 71 (50.7%) cases on the right side, a STF was present. The STF was oval (128), round (7), and triangular (5) in shape (Fig. 1, Table 2). The mean length of the transverse diameter for supratrochlear foramen was 6.60 mm and 5.9 mm on the left and right sides, respectively. The mean length of the vertical diameter for STF was 4.80 mm



Fig. 1: Photograph showing various shapes of supratrochlear foramen (STF). A: triangular STF; B: round STF; C: Transparent STF; D: Oval STF.

and 3.80 mm on the left and right sides, respectively (Table 3). The differences between the sides were not significant (Table 1). The incidence of STF was slight higher on the right side (50.7%) as compared to the left side (49.2). Most of the bones that had no STF showed a translucency of septum, in 54.4% of the bones (Table 1).

Table 1: Frequency of Supratrochlear foramen and Translucent septum.

Sl. No.	Types	Total	Percentage (%)
1	Translucent septum	160	54.4
2	STF	140	46.6

Table 2: Different shapes of foraminae and their prevalence.

Sl no	Shapes	Total	Percentage (%)
1	Oval	128	91.4
2	Round	7	5
3	Triangular	5	3.5

Table 3: Different measurements in supratrochlear foramen. Data are shown as mean ±standard deviation & range).

	Right side		Left side	
	Mean±SD	Range	Mean±SD	Range
Transverse diameter for supratrochlear foramen (mm)	5.9 ±2.1	3.2-8.5	6.6 ±1.47	2.2-10.1
Vertical diameter for supratrochlear foramen (mm)	4.80±2.3	2-7.5	3.8±0.99	2.2-5.6

Differences between the sides were not significant ($P > 0.05$, unpaired Student's t test).

Table 4: Incidence of supratrochlear foramen in various human races.

Serial no.	Author	Population studied	Incidence (%)
1.	Trotter M 1935	White Americans	4.3
2.	Ndou R et al 2013	African Negroes	21.7
3.	Akabori, 1934	Ainus	8.8
4.	Akabori, 1934	Japanese	18.1
5.	Nayak SR 2009	Indians	34.4
6.	Hirsh, 1927 (quoted by Morton and Crysler)	Arkansas Indians	58
7.	Present study	South Indians	46.6

Discussion

The supratrochlear foramen (STF) was first described by Meckel in 1825.² The STF is of great interest to anthropologists, who claim it as important in establishing relationships between humans

and lower animals,² According to Hrdlicka, the perforation is very frequent in primates other than man.⁹ Apart from its evolutionary significance STF has much clinical and surgical importance in the recent times.¹⁰ There is a wide variation in the rate of the STF occurrence in various human populations. Studies on STF in different populations showed an incidence of 58% in Arkansas Indians⁹, African Negroes (21.7%), South Africans (32.5%)¹¹, in White Americans (4.3%)¹², in American Negroes (18.4%)¹², 18.1% in Japanese¹³, 17.5% in Chinese.¹⁴ 6.1% in Netherlands¹⁵ (Table 4). The incidence of STF in the Indian population ranges from 28% to 34.4%.¹⁶ In the present study, majority of STF were oval (91.4%) followed by it was round shape (5%). Veerappan et al.¹⁶ observed oval shape in 42.85%, round shape in 37.71%, triangular shape in 14.28% and sieve like in 7.14% in their study. A study had defined the STF to be ovoid in shape with the long axis transversal (6.3/3.7 mm).¹⁷ Another study reported that STF, Transverse diameter were left side (6.55 mm) and right side (5.99 mm) and vertical diameter left (4.85 mm) and right (3.81 mm) side respectively.⁸ In our study transverse diameter for supratrochlear foramen was 6.60 mm and 5.9 mm and mean length of the vertical diameter for STF was 4.80 mm and 3.80 mm on the left and right sides.

Limitations

Dry humeri of unknown gender and age were considered in the study. The effect of the ulnar morphometry and its bearing on the formation of STF could not be ascertained.

Conclusion

The results of our study showed 46.6% STF incidence in the south Indian population, with the left side predominant. By its high incidence it is important to the orthopaedician in the preoperative planning at distal humerus and to the radiologist for differentiating it from other pathological or morphometric variations.

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