International Journal of Anatomy and Research,
Int J Anat Res 2014, Vol 2(2):340-43. ISSN 2321- 4287

Case Report

XIPHOID FORAMEN AND ITS CLINICAL IMPLICATION

Santhosh kumar N [1], Bravian D [2], Anju Balaji More *[3].

[1, *3] Associate professor, [2] Post Graduate student.
Dept. of Anatomy, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Tamilnadu, India.

ABSTRACT

Background: In this case report, we want to present a case of pear shaped foramina at the xiphoid process of sternum.
The context and purpose: Variations and foramen in the xiphoid process of sternum are frequent. They are clinically important due to their proximity to heart, lungs, diaphragm, liver and stomach.
Results: The pear shaped foramina was present in the xiphoid process. It resembled the glenoid fossa of scapula in shape. The maximum length of the foramina was 1.6cm and breadth 1.4cm.
Conclusions, brief summary and potential implications: A sound knowledge of xiphoid process variations and anomalies is very important during sternal bone marrow aspiration, radiological reporting, acupuncture and assessing injuries during autopsy and post mortem examination.
KEYWORDS: Foramen, Sternum, Xiphoid process.

Address for Correspondence: Dr. Anju Balaji More, Associate professor, Dept. of Anatomy, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Tamilnadu, 629161, India. Phone: 09655953630. **E-Mail:** as.anju@yahoo.in

Access this Article online

Quick Response code

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 03 April 2014
Peer Review: 03 April 2014 Published (O):31 May 2014
Accepted: 22 April 2014 Published (P):30 June 2014

BACKGROUND

The Greek word 'xiphos' means straight sword. This tip of sternum somewhat resemble to it and so the name. But it can be broad, thin, pointed, bifid, perforated, curved, or even deviated laterally. The xiphoid process is formed by pair of mesenchymal condensation bands in the median plane anteriorly at the thoracic region. The primary centre of ossification for the xiphoid process appears after birth during childhood at around 3rd year of age. Initially the cartilage of xiphoid process (metasternum) unites with lower end of sternum (mesosternum) by symphysis, a fibrous immovable joint with lower end of sternum at age of 15 to 29 years. It is transformed to synostosis by the 40th year of life. The exact age is highly variable [1].

The xiphoid process gives attachment anteriorly to the linea alba fibres of rectus abdominis. Laterally, the aponeurosis of the three flat muscles of the anterior abdominal wall (external oblique, internal oblique, and transverses abdominis) takes origin. Posterior surface of the process gives attachment to the anterior and posterior costoxiphoid ligament, fibres from the diaphragm, and transverse thoracis. The innervation to these muscles and ligaments is from lower intercostal nerves. In addition anterior branch of the iliohypogastric and ilioinguinal nerves supply the external, internal oblique and transverse abdominis. Phrenic nerve ($C_{3, 4, 5}$) supply to the two fleshy slips of diaphragm arising from back of the xiphoid process in addition to the lower intercostal nerves [1, 2].

Variations in sternum and xiphoid process in particular have a wide array of presentation in

imaging and autopsy series. In living subjects, these variations are frequently detected incidentally on cross-sectional images in radiology, multiplanar and 3D reconstructed CT images, and MRI [3].

Knowledge of radiological appearances of these variations and anomalies is useful so as not to confuse those with pathological conditions. Awareness of a xiphoid foramen is important in bone marrow sampling, radiology (X - ray, CT, MRI, USG) reporting, pathology autopsy and forensic medicine post-mortem reporting and patoacupuncture practice [3, 4, 5].

MATERIALS AND METHODS

During routine undergraduate dissection, 2013-14 batch at Dept of Anatomy, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Tamilnadu the variation was noticed. A formalin-fixed male cadaver aged 60 years was dissected. The exact cause of death and medical history of the person is not known. As the source of cadaver is unclaimed body made available for the purpose of dissection under Anatomy Act.

The procedures followed were in accordance with ethical standards of handling of cadaver for learning and teaching.

OBSERVATIONS

The xiphoid process was cartilaginous without any ossification. There was symphysis type of joint with the lower end of body of sternum. It was not ossified in to a synostosis.

The total length of sternum was 18.5cm.

The length of sternum from sternal angle to the tip of xiphoid process was 14.5 cm.

Distance between sternal angle to the foramina was 13 cm. Length and breadth of manubrium was 4 and 4.4 cm respectively.

Length of the body of sternum was 12cm.

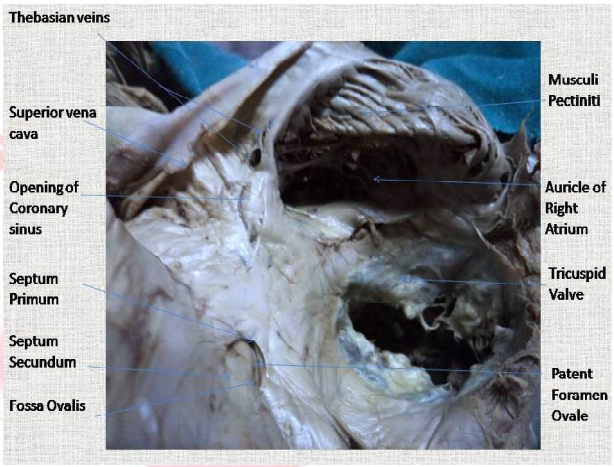
The xiphoid process length and breadth was 3 and 2.3 cm respectively.

The pear shaped foramina was present in the xiphoid process. It resembled the glenoid fossa of scapula in shape. The maximum length of the foramina was 1.6 and breadth 1.4cm. (Fig. 1)

The same cadaver had interatrial communication in the form of patent foramen ovale, Ostium secundum type. (Fig. 2)

Fig. 1: Foramina in Xiphoid process.

Fig. 2: Interior of Right Atrium showing Patent Foramen Ovale.



DISCUSSION

The incidence of xiphod foramen reported by Yekeler et al. in their study conducted at Istambul, Turkey by assessing MDCT images of 1000 consecutive patients is 27.4% and double ended xiphoid process in 27.2% [6]. In the study by Shivakumar G et al, study was conducted on 86 dry sterni. The incidence of xiphoid foramen was 3.5% and that of bifid xiphoid process was 4.6%. 7% had elongated where as 5.8% were broad and thin xiphoid processes [7]. Of the 80 cadavers studied by El-Busaid et al; Xiphoid foramen was noted in 2.5% of cases, bifurcated in 10 cases (5M, 5F) (12.5%), and duplicated in 6 cases (4 M, 2 F) (7.5%) of cases [8].

After studying 2016 roentgenograms at North Carolina, Moore MK et al have noted that sternal foramina are more common in Blacks than in Whites. They have not acknowledged any sex predilection in these foramina. Even though clinical significance of these foramina is taken lightly they see a potential forensic value in individual identification [9].

Akin et al have anatomically evaluated xiphoid process in 64- Row MDCT in Turkish population

using data from 500 consecutive patients. They have stated single xiphoid foramen in 34.2% and 9% with two or more foramen. They have come across shape variations like ventrally deviated, both ventrally and dorsally curved (resembling hook), reverse 'S' shape and double and triple xiphoid endings. Ossification was completed in 50.8% and sternoxiphoidal fusion present in 42.8% of cases only [10].

Study on 343 postmortem sternum samples collected from autopsy cases by Singh J and Pathak RK at Chandigarh, India have found significant sex and age differentiation. Xiphisternum was generally absent in females and younger subjects. [11] Xie YZ et al studied the xiphoid processes of 41 dissected cadavers and their radiographs. They also re-evaluated 902 patient's MDCT records to discover that Xiphoid process's pointed, oval, forked, hook, ventrally and dorsally deviated and S- shape. They have portrayed four patterns of xiphoid foramen.

1. Pattern L: a large foramen with a diameter of more than 5 mm (55.51 %);

2. Pattern S: a small foramen with a diameter of no more than 5 mm (28.49 %);

3. Pattern LS: a mixture of one large and small foramina (6.80 %); and

4. Pattern SS: two or more small foramina (9.19 %)[12]

In our case the foramen belongs to pattern L. (Fig.1)

A sound knowledge of xiphoid process variations and anomalies is very important for medical practitioners. Fatal cardiac tamponade can result from a congenital foramen ignored during acupuncture [13-15]. Possibility of low thickness of sternal body should be considered during the sternal puncture. Cases of fatal death following sternal bone marrow biopsy have been reported in the literature. They involved law-suit againt the performing doctors [16, 17]. Foramina in sternum have been misinterpreted as acquired lesions by gunshot wounds during post-mortem [5]. Imaging appearances of the sternal variation and anomalies, need to be kept in mind while labelling pathological conditions, as traumatic fissures or fracture and/or osteolytic lesions in cross-sectional imaging of the sternum. Cortical irregularity, expansion and soft tissue mass are helpful to differentiate.

Acupuncturists if unaware of congenital sternal foramina; may land up with complications due to serious heart and/or lung injury by needle insertion. The area has a number of commonly used acupuncture point [6]. Oblique or transverse needling is preferred over perpendicular if patient is known to have congenital sternal foramen [18].

Xiphodynia is an uncommon syndrome with symptoms of refered pain from xiphisternal joint. It involves upper abdominal pain, chest pain, sometimes throat and arm symptoms[19]. According to Maigne JY et al the mean xiphosternal angle in asymptomatic subjects was 172 ± 15°. It was 105°, 135°, and 120°respectively in three cases of xiphodynia [20].

As an individual bone, sternum is not very useful tool for sex determination. Range of values of the length, width and thickness of its various parts overlaps and are practically co-extensive. According to the Hyrtl's law the ratio between the length of the manubrium and that of the mesosternum is more than 1:2 in case of women and less in men. Since means of various indices are statistically insignificant (P>0.05), individually they are not useful for the purpose. With the help of Multivariate discriminant analysis technique the success to correctly assign the sex varies from 82% for female and 89% for male sterni [21, 22].

Review of lateral chest radiographs of 118 children below 2 years of age, revealed that all the 11 subjects had delayed ossification of mesosternum accompanied with congenital heart disease. This correlation was absent in control group [23]. It shows an unnamed syndrome complex where these two entities coexist. It is attention-grabbing in this case that the cadaver showed congenital cardiac anomaly in the form of patent foramen ovale, secundum type (Fig.2) [24].

CONCLUSION

Xiphoid process variations are asymptomatic and common. Thus, a sound knowledge of them and anomalies is very important for doctors (medical practitioners, radiologists) and acupuncturists to

have thorough knowledge about sternal anomalies for better diagnosis and treatment.

List of Abbreviations:

CT: Computerised Tomography
MRI: Magnetic Resonance Imaging
MDCT: Multiplanar and 3D reconstructed Computerised Tomography
3D: Three Dimensional
USG: Ultra Sono Graphy

Acknowledgement:

We would like to thank our Institution for the support; Dr. Velluswamy and Dr. Kunjumon PC for guidance and Mr. Ganeshan for back-up.

Conflicts of Interests: None

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How to cite this article:
Santhosh kumar N, Bravian D, Anju Balaji More. XIPHOID FORAMEN AND ITS CLINICAL IMPLICATION: A CASE REPORT. Int J Anat Res 2014;2(2):340-43.