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Original Research Paper

Anatomy

A UNIQUE DISORDER OF THE STERNUM : HONEYCOMB STERNA

Santosh Kumar* Tutor, Department of Anatomy, Shahid Nirmal Mahto Medical College, Dhanbad, Jharkhand, India 826005. *Corresponding Author

Makardhaj Prasad Department of Anatomy, Shahid Nirmal Mahto Medical College, Dhanbad, Jharkhand, India 826005.

ABSTRACT This article describes an uncommon example of a human sternal developmental anomaly in an anatomical specimen from the Department of Anatomy at Shahid Nirmal Mahto Medical College Dhanbad. The non-fusion of lateral ossification centres in the sternebrae caused the uncommonly recognized developmental anomaly, which results in a honeycomb-like appearance of the mesosternum. Sternal deficiencies are normally under diagnosed in the clinical literature due to the fact that many instances are asymptomatic. As a result, there is a gap in our modern understanding of the development and anatomical variations of the sternum. Although in the past, large-scale CT investigations have been conducted to explore the incidence of sternal developmental anomalies. A very rare work has been reported on sternal malformations. Most of the sternal abnormalities are clinically insignificant; a lack of awareness of these variants can lead to interpretation of radiological and pathological evidence. Hence, anatomical variants are asymptomatic which is vital in nature.

KEYWORDS : Sternum, Developmental abnormality, Variation, Unfused sternebrae, Accessory ossification centres

INTRODUCTION:

The adult sternum is divided into three parts that are linked by secondary cartilaginous joints: the manubrium (the first sternebrae), the mesosternum (or body, which includes the second to fifth sternebrae), and the xiphoid process (the sixth sternebrae). During the sixth week of intrauterine life, the sternum develops from a pair of longitudinal mesenchymal bands on either side of the anterior chest wall, which subsequently migrate medially to create the cartilaginous sternum. The fusion of these two parts, referred as the sternal bars, continues from the cranial to the caudal end of the sternum and is usually completed by the ninth week. The sternum typically has six ossification centres: one for the manubrium, four for the mesosternum, and one for the xiphoid process as shown in Figure 1. However, these numbers vary slightly. The mesosternum sternebrae usually have a single midline ossification centre.

A single midline ossification centre is seen in mesosternum sternebrae. While several points of ossification are not that rare, the phenomenon is known as bifurcated ossification centres [7, 17]. Sternoceles are typically equally spaced on both sides of the midline, but they may be positioned superiorly or inferiorly compared to each other. The sternebrae (which are formed from bifurcated ossification centres) first show bony discontinuity, asymmetrical shape, and changed edges. Until 4 years of age, distinct parts of the sternum begin to merge, and this may be seen throughout pregnancy up until about a year after birth. This is usually a growth segment and it is difficult to detect ossification patterns in adults [1,7]. Using radiography, Ashley [1] defined four patterns of sternal ossification, as follows:

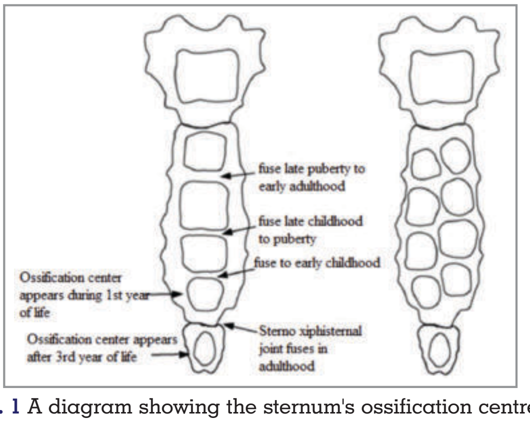

Fig. 1 A diagram showing the sternum's ossification centres. (Left) Sternum with a single ossification centre in the mesosternum and the age ranges at which the mesosternal sternebrae fuse. (Right) Segmented ossification centres in the mesosternum that usually combine to produce individual sternebrae around the age of 4.

Type I: Midline ossification centres are present in all three sternebrae of the mesosternum, which originates from cranial to caudal in this order. Due to this vertical doubling of ossification centres, there may be many of these sclerotic sternebrae orientated along the midline, but they remain aligned vertically. There may be one or two ossification centres for the fourth sternebra of the mesosternum.

In type II, the first sternebra on the mesosternum (some instances), the second (all cases), and the third (some cases) contain a single, midline ossification centre, whereas the fourth (some cases) may have two. Deeplocated on the midline or craniocaudally displaced.

Type III: The ossification centres in the first three metacarpal segments (i.e. the second, third, and fourth metacarpal segments) of the mesosternum are doubled. For the fourth metacarpal segment, either one, double, or no ossification centres may be present.

Type IV: A single ossification centre exists for the first mesosternal sternebra, whereas two ossification centres exist for the second and third mesosternal sternebra. In spite of the considerable diversity in sternal morphology being widely described, both aberrant development and partial fusion of the sternum are unusual findings in archaeology and anthropology. Though fusion of the sternebrae is usually complete by the age of 25, non-fusion of the sternebrae of the mesosternum has been observed in older people [8].

MATERIALS AND PROCEDURES:

The sternum of an adult person was examined from the Department of Anatomy, SNMC, Dhanbad. Although the sternum's origin is unclear, it is believed to have been part of a anatomical collection. Macroscopic examination was the main evaluation framework for evaluating the sternum's morphology. Using Ashley's criteria [1], the pattern of sternal fusion was categorised as one of four kinds based on these findings.

RESULTS:

The sternum, shown in Figure 2, was composed of a manubrium and mesosternum comprised of six segments with different degrees of fusion, as well as an ossified xiphoid process and costal cartilage. While the manubrium and the first sternebra of the mesosternum were fused sternebrae, the third and fourth sternebrae were composed of two unfused ossification centres, and the fifth sternebra appears to have originally consisted of three ossification centres that had nearly completely fused into a single section.

According to Ashley's classifications, this pattern of ossification is compatible with Type II. The sternal segments had a hazy hexagonal form, but were longer along the superior–inferior axis and were less consistent in shape and size. Caudocranially, the degree of fusion increased, as is usual for Homo sapiens [6].

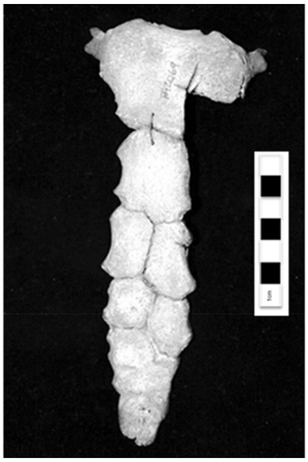

Fig. 2 shows an unfused accessory ossification centre found in the mesosternum (medial sternum) of a human being. anterior view of an adult human sternum with the manubrium, mesosternum, and ossified xiphoid process located on the superior lateral sides of the manubrium as well as ossified costal cartilage, found on the superior lateral portions of the manubrium

DISCUSSION:

When it comes to clinical settings, sternal abnormalities are underdiagnosed. Clinically apparent instances are usually diagnosed at or soon after birth, whereas asymptomatic sternal abnormalities are more frequently found accidentally later in life [14]. As a consequence, large-scale radiography and Computed Tomography (CT) imaging investigations have provided the bulk of our knowledge about the prevalence and variety of sternal anomalies [17, 18]. There are many morphological variants and developmental disorders affecting the bones of the sternum, which have been described in these reviews [5, 18]. When Yekeler and colleagues [18] examined the morphology and frequency of sternal variation and abnormalities in 1000 individuals (582 men, 418 women; ages 20–92 years, with a mean of 54 years), they discovered that the sternal variation and abnormalities were more common in males than in women. A number of previously documented sternal abnormalities, such as sterna clefts, fissures, tubercles, and fusion patterns, were found to be more common than previously thought [18], as were several more unusual cases, such as an individual with a trifurcate xiphoid process and an individual who had three foramina in their xiphoid. However, none of these prior, comprehensive clinical studies have found any people who had developmental anomalies that are comparable to those described in this paper. Knox [8] provided a short description of the closest case that could be located in the literature (see Fig. 3) while remarking on the apparent regularity with which this developmental anomaly is observed in specimens of Pongo [12, 15]. Each of the second, third, and fourth mesosternal sternebrae has been divided into two segments, resulting in a structure that resembles the sternum of an adult male human.

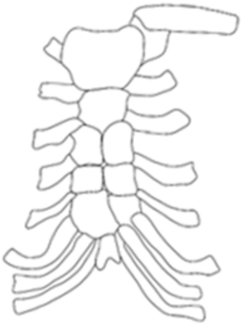

Fig. 3 Sternum of an adult male human, illustration adapted from line drawing in Knox ([8]:293)

The manubrium and mesosternum have been shown to have accessory ossification centres in CT examinations of growing sterna in clinical settings [1, 7], which is consistent with previous findings. Among 49 people with developing sternum, a review found that 20 percent of the patients had bifurcated or auxiliary ossification centres [10]. They develop as a consequence of endochondral ossification and are most often seen in the mesosternum [1]. They are also known as auxiliary ossification centres. While accessory ossification centres are usually symmetrical, it has been shown that they may grow in an irregular way in cases of asymmetry in the costal joints [1, 2]. As previously stated, an examination of ossification patterns revealed four distinct kinds of ossification. Approximately 60–67 percent of documented instances had one ossification centre in the manubrium, one in each of the first two sternebrae, and two in each of the remaining sternebrae (Type II), with one ossification centre in each of the other sternebrae [1, 2]. Prior to the formation of the mesosternebral column, the accessory ossification centres fuse together. This process is considered complete at the age of 13 years; nevertheless, evidence of the accessory ossification centres may still be seen on radiographic imaging [10]. A variety of developmental anomalies in the sternum that result in non-fusion have been documented in the published literature, with sternal foraminal foramina and sternal clefts being particularly well-covered [13, 16, 18]. As a consequence of inadequate fusion of a pair of sternebrae [4, 13, 16, 18], sternal foramina are a reasonably frequent developmental anomaly that has been documented to occur at a frequency ranging between 4.3 and 6.7 percent [4, 13, 16, 18]. In accordance with earlier findings, the sternal bones grow from cartilaginous precursors that develop in craniocaudal succession from the fifth month of pregnancy until soon after delivery [1, 3, 7]. Sternal anomalies such as sternal fissures and foramina [3] are the consequence of a failure in this developmental process taking place. Additionally, although non-fusion of the sternebrae and non-fusion of the mesosternum have both been recorded in juveniles, there have been no known instances of non-fusion of these extra segments beyond 5 years of age, which is a rather frequent occurrence among children. Therefore, this study describes a developmental anomaly that has not before been documented.

It is critical to have a clinical understanding of the sternum's growth, maturation, variation, and abnormalities in instances of probable chest and sternum injuries, as well as while performing surgical operations [2, 11].

CONCLUSION:

This report describes a person with a developmental sterna anomaly from the Department of Anatomy SNMMC, Dhanbad. Due to the non-fusion of the sternal ossification centres, the person exhibited a honeycomb-like look. This developmental anomaly has not been documented in the anthropological literature or in the many clinical studies of sternal disease and morphology. Due to the scarcity of previously published cases of similar sternal abnormalities in the clinical literature, it is unlikely that the defect described in this report would manifest clinically significant symptoms; however, lack of awareness of these variants can result in misinterpretation of radiological and pathological findings, and in rare instances, fatality during surgical procedures. Because the sternum is often utilised as a surgical entry, especially during cardiac surgery, it is critical to have a greater understanding of anatomical and developmental differences. Due to a lack of contextual data, discussing the frequency of this sternal anomaly or drawing particular conclusions is challenging. It is conceivable that other hominoid tribes have a higher prevalence of this honeycomb-like look, but this can only be verified by reexamining anthropological and natural history collections.

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Ethical Approval :

No ethical approval was required as the study was based on cadaver in the department of Anatomy and Forensic Medicine, Shahid Nirmal Mahto Medical College, Dhanbad, Jharkhand 826005

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