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Sternal foramina and variant xiphoid morphology in a Kenyan population

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Sternal foramina may pose a great hazard during sternal puncture, due to inadvertent cardiac or great vessel injury. They can also be misinterpreted as osteolytic lesions in cross-sectional imaging of the sternum. On the other hand, variant xiphoid morphology such as bifid, duplicated, or trifurcated may be mistaken for fractures during imaging. The distribution of these anomalies differs between populations, but data from Africans is scarcely reported. This study therefore aimed to investigate the distribution and frequency of sternal foramina and variant xiphoid morphology in a Kenyan population. Eighty formalin-fixed adult sterna (42 males [M], 38 females [F]) of age range 18–45 years were studied during dissection at the Department of Human Anatomy, University of Nairobi. Soft tissues were removed from the macerated sterna by blunt dissection and foramina recorded in the manubrium, body, and xiphoid process. The xiphisternal ending was classified as single, bifurcated (2 xiphoid processes with a common stem), or duplicated (2 xiphoid processes with separate stems). Results were analysed using SPSS version 17.0. Foramina were present in 11 specimens (13.8%): 7 M, 4 F. The highest frequency was in the sternal body (n = 9), where they predominantly occurred at the 5th intercostal segment. Xiphoid foramina were present in 2 specimens (both males) (2.5%), while manubrial foramen was not encountered. The xiphisternum ended as a single process in 64 cases (34 M, 30 F) (80%). It bifurcated in 10 cases (5 M, 5 F) (12.5%), and duplicated in 6 cases (4 M, 2 F) (7.5%). There were no cases of trifurcation. Sternal foramina in Kenyans vary in distribution and show higher frequency than in other populations. These variations may complicate sternal puncture, and due caution is recommended. The variant xiphisternal morphology may raise alarm for xiphoid fractures and may therefore be considered a differential. (Folia Morphol 2012; 71, 1: 19–22)

Key words: sternal foramina, xiphoid morphology, sternal puncture, sternal imaging

INTRODUCTION

Sternal foramina may pose a great hazard during sternal biopsy, due to inadvertent pericardial or great vessel puncture [13]. Fatality incidences following this procedure have been widely reported [2, 5, 6]. The foramina may also be misinterpreted as osteolytic lesions or bullet wounds of the anterior chest wall during cross-sectional imaging of the sternum [11].

The xiphoid process, on the other hand, is the most variable part of the sternum [12]. It is usually elongated and pointed, but it can be bifid, duplicated, deflected, or trifurcated [14]. These variable morphologies are important during imaging and physical examination, as they can be misinterpreted as xiphoid fractures or hard lumps resembling epigastric masses [8]. Awareness of them is important especially in young

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clinicians, so they do not necessitate surgical intervention. The distribution of these anomalies differs between populations, but data from Africa is scarcely reported. This study therefore aimed to determine the frequency and distribution of sternal foramina and variant xiphoid morphology in a Kenyan population.

MATERIAL AND METHODS

A total of 80 adult sterna (42 males, 38 females) of age range 18 to 45 years were studied. These were obtained during dissection at the Department of Human Anatomy, University of Nairobi. All specimens were of Black African ethnicity. Harvesting of the specimens was done by cutting bilaterally and longitudinally through costal cartilages and removing the sternum. Broken, incomplete, and deformed sterna and those with unfused manubriosternal symphysis were excluded. The specimens were macerated in 10% formalin for two months and soft tissues removed by blunt dissection. Extra care was taken to avoid artificial perforation of the sternum. Specimens were then inspected for foramina in the manubrium, body, and xiphoid process. The xiphoid ending was categorised as single, bifurcated (2 xiphoid processes with a common stem) or duplicated (2 xiphoid processes with separate stems).

Results were analysed using SPSS version 17.0, Chicago, Illinois. General descriptive statistics were applied to derive means and standard deviations. Representative sterna were photographed using a Fujifilm A235 digital camera with a resolution of 12.2 megapixels.

RESULTS

A total of 82 specimens were available, but two were excluded due to broken xiphoid process. In all cases the sternum comprised the manubrium, body, and xiphisternum.

Foramina

These were present in the body and xiphoid process in varying frequencies. Overall, they occurred in 11 specimens (7 males, 4 females) (13.8%). Manubrial foramina were not encountered.

Foramina in the sternal body

The highest frequency of foramina was in the sternal body (n = 9; 11.2%). The most common site was the 5th intercostal segment (77.8%) (Fig. 1). However, foramina were not encountered in the second or third intercostal segments.

Xiphoid foramina

These were present in 2 specimens (both males) (2.5%) (Fig. 2). In one specimen there were double foramina in the xiphoid process (Fig. 3).

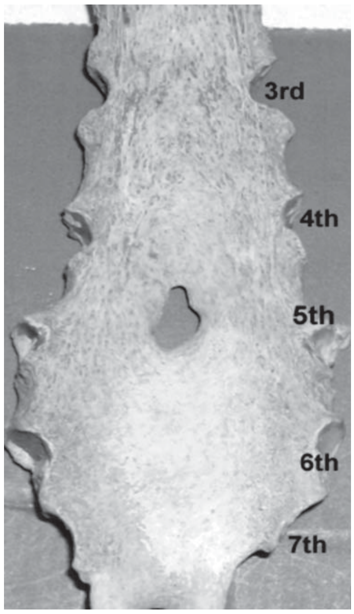

Figure 1. Macrograph showing a foramen in the sternal body. Note the foramen at the level of the fifth costal notch.

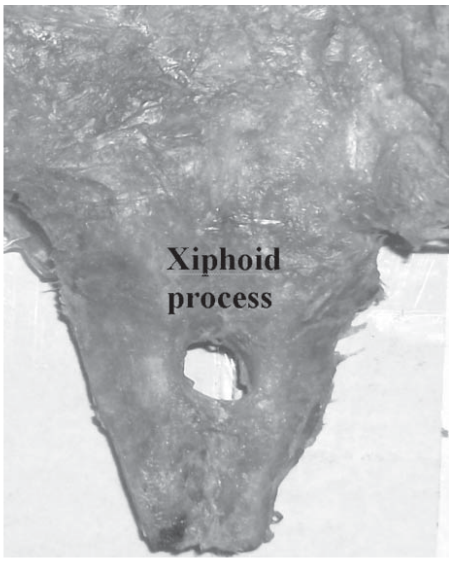

Figure 2. Macrograph showing a foramen in the xiphoid process.

Xiphoid morphology

The xiphisternum ended as a single process in 64 cases (34 males, 30 females) (80%) (Fig. 4). It bifurcated in 10 specimens (5 males, 5 females) (12.5%) (Fig. 5) and duplicated in 6 cases (4 males, 2 females) (7.5%) (Fig. 6). There were, however, no cases of trifurcation.

DISCUSSION

Sternal foramina

These are circular or oval defects in the sternum due to incomplete fusion of mesenchymal sternal

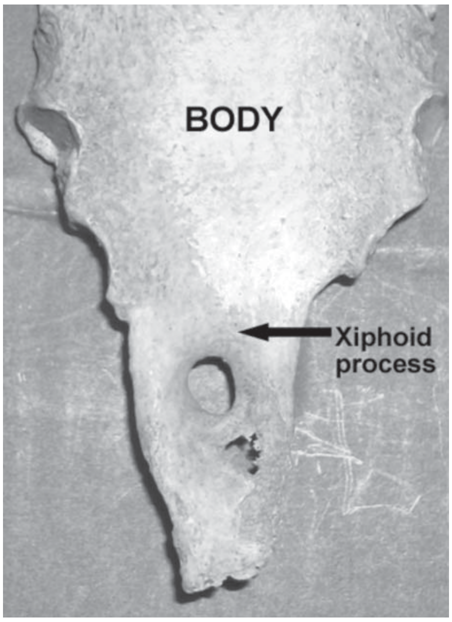

Figure 3. Macrograph showing double xiphoid foramina.

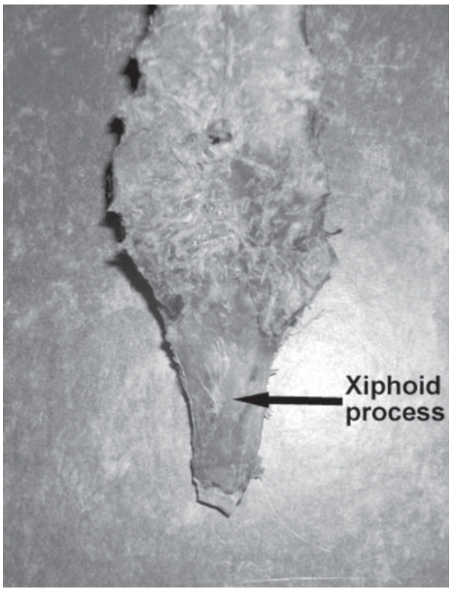

Figure 4. Macrograph showing a single-ended xiphoid process.

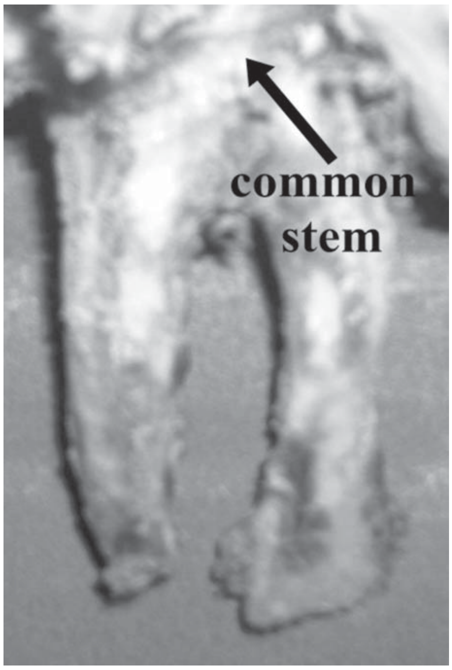

Figure 5. Macrograph showing a bifurcated xiphoid process. Note the common stem of the two processes.

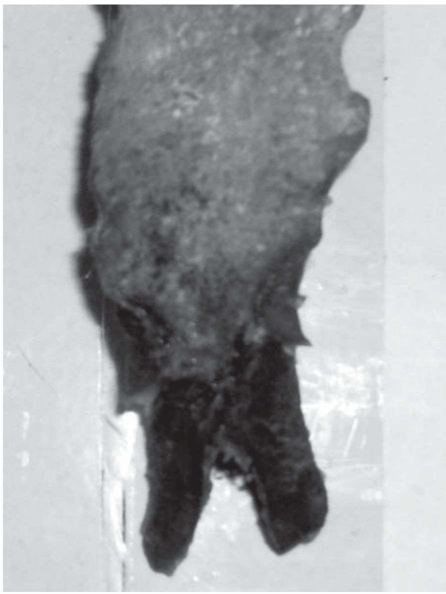

Figure 6. Macrograph showing a duplicated xiphoid process. Note the independent origins (separate stems) of the two processes.

bars in the 6th to 9th weeks of gestation [4]. Because fusion is cranio-caudal, the inferior parts of sternum are most commonly affected by these defects [7]. Although they are asymptomatic, they can pose a great hazard during sternal biopsy due to inadvertent pericardial or great vessel puncture [6, 13]. Furthermore, they can be misinterpreted as osteolytic lesions or gunshot wounds of the anterior chest wall during imaging [11, 14].

The present study reports sternal foramina in 11 specimens (13.8%). This incidence shows variation from previous findings (Table 1). This table depicts a higher frequency of sternal foramen in the study population compared to American and European populations. This difference may be attributed to geographical or population variations in the incidence of sternal foramen [10] and a probable genetic basis [3]. The current results, therefore, un-

Table 1. Population variations in incidence of sternal foramina

Authors	Population	Incidence of sternal foramina
Stark et al.	British	4.3%
Yekeler et al.	Turkish	4.5%
Aktans et al.	Turkish	5.4%
Cooper et al.	USA	6.7%
Present study	Kenyans	13.8%

derpin extra caution during sternal biopsies in the study population.

In the present study, xiphoid foramina were far less frequent than those in the sternal body (2.5% vs. 11.2%, respectively). This finding differs from previous studies. Yekeler et al. [14] demonstrated a higher incidence of foramina in the xiphoid process than the sternal body (27.4% vs. 4.5%). Bergman et al. [1] also demonstrated a higher frequency of xiphoidal than body foramina. The opposite is true in our study as sternal body foramina were by far the most frequent. This finding is clinically important as sternal biopsies are commonly done on the sternal body [12]. This variation therefore warrants consideration during sternal punctures. Furthermore, the current study reports foramina predominantly in the 5th and lower sternal segments, with no foramen demonstrated in the manubrium, second, or third intercostal spaces. This finding calls for avoidance of inferior parts of the sternum during biopsies in the study population.

Xiphoid morphology

The xiphoid process forms by fusion of the inferior ends of the mesenchymal sternal bars. As already applauded the fusion is cranio-caudal [7], it is not surprising that the xiphisternal morphology is the most variable part of the sternum [12]. Incomplete fusion of the inferior ends of the sternal bars results in variant xiphoid morphologies such as bifid, duplicated, or perforated xiphoid process [9]. In the current study, double-ended xiphoid processes (duplicated and bifurcated) occurred in 20% of cases, showing slight disparity from the previous report of 27% [14]. This variation may have radiological significance as it can raise alarm for xiphoid fracture [8]. It may therefore be considered as a differential.

CONCLUSIONS

Sternal foramina in Kenyans vary in distribution and show a higher frequency than those in other populations. These variations may complicate sternal puncture, and due caution is recommended. The variant xiphisternal morphology may raise alarm for xiphoid fracture and may therefore be considered a differential.

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