Original communication

Anatomy Journal of Africa, 2014; 3 (1): 255 - 259

ANATOMICAL FEATURES OF THE STERNUM IN A KENYAN POPULATION

***Hemed El-Busaidy, Wyclife Kaisha, Jameela Hassanali, Hassan Saidi, Julius Ogeng'o, James Munene**

Correspondence to * Hemed El- Busaidy, Department of Human Anatomy, University of Nairobi, P.O. Box 00100 – 30197 Nairobi, Kenya. Tel: +254 732 666 777; Email: elhemed@gmail.com

ABSTRACT

Variations in breadth, thickness and asymmetry of the sternum may increase the risk of migration of suture material through the sternum during median sternotomy. We investigated these anatomical features in a Kenyan population. Eighty one dry adult sterna were studied at the Department of Human Anatomy, University of Nairobi, Kenya. Sternal asymmetry was taken as displacement of the manubriostarnal junction by more than 10mm from the midline. Data was analyzed by SPSS version 17.0 and sex differences determined using student's t- test. The average thickness of the manubrium was 12.1 ± 1.3mm and 10.4 ± 1.2mm in males and females respectively (p= 0.163). The body thickness was 10.2 ± 1.2mm and 8.3 ± 1.1mm in males and females respectively (p= 0.159). In 13 cases (16.0%), the average manubrial thickness was less than 10mm, while in 7 cases (8.6%), the average body thickness was less than 8mm. Asymmetrical sterna were present in 16 cases (19.8%). The Kenyan sternum showed morphometric variations from previous reports. The variations may complicate median sternotomy and have been associated with fracture susceptibility. Further research is needed to correlate these findings. However, careful evaluation of chest injuries and due caution during median sternotomy are recommended

Key words: Sternum; Anatomical features; Median sternotomy; Sternal puncture

INTRODUCTION

The sternum, a flat bone located in the middle of the chest, forms part of the anterior thoracic wall overlying the heart and great vessels in the middle mediastinum. Its caudal end, the xiphoid process, is related to the central tendon of the diaphragm and inferior border of the heart (Skandalakis et al; 2006).

Median sternotomy is still a common cardiothoracic approach in Kenya used for repair of congenital heart diseases and valve replacement (Odhiambo et al, 1992). In this procedure, the sternum is split from the jugular notch to the end of xiphoid process. Variations in sternal thickness and breadth have been associated with migration of suture material through the sternum during median sternotomy (Osada et al, 1990; Shaffir et al, 1988) leading to poor surgical outcomes (Losanoff et al, 2002).

The sternum is also a common site for bone marrow biopsy due to its larger breadth and subcutaneous position. The sternal thickness is a critical factor in this procedure as fatality incidences have been widely reported (Bhootra et al, 2004, Inoue et al, 2010). The thickness may also influence susceptibility to sternal fractures in chest trauma (De Waele et al, 2002) or after moderate pressure on the chest such as cardiopulmonary resuscitation (Baubin et al, 1999, Rabl et al, 1996). The current study aimed to investigate these anatomical features of the sternum in a Kenyan population.

To cite. El-Busaidy H, Kaisha W, Hassanali J, Hassan H, Ogeng'o J, Munene J. Anatomical features of the sternum in a Kenyan population. Anatomy Journal Of Africa 2014; 3 (1): 228-232.

MATERIALS AND METHODS

A total of eighty one adult sterna (46 males, 35 females) of age range 18- 45 years were studied. These were obtained from the Department of Human Anatomy, University of Nairobi. Only the manubrium and body of the sternum were considered in this study. Broken and deformed sterna and those with unfused symphysis were excluded.

The breadth and thickness of the manubrium was measured immediately below the clavicular notches and immediately above the sternal angle (Fig 1a, Selthofer et al, 2006). An average of the two was then obtained. For the body, the breadth and thickness were measured at second, third, fourth, fifth and sixth intercostal notches (Fig 1a) and their averages computed. A digital vernier calipers was used to take the measurements (ABC Mitutoyo, Japan, Accurate to 0.01mm) Fig 1b. Sternal asymmetry was taken as displacement of the manubriostarnal junction by more than 10mm from the midline. Representative sterna were photographed using Fujifilm A235 digital camera, with a resolution of 12.2 megapixels.

Data was analyzed by SPSS version 17.0 (Chicago, Illinois) and general descriptive statistics were applied to derive means and standard deviations. Sex differences were determined using independent students't- test and a p value of ≤ 0.05 was considered significant.

Fig 1a

Fig 1b

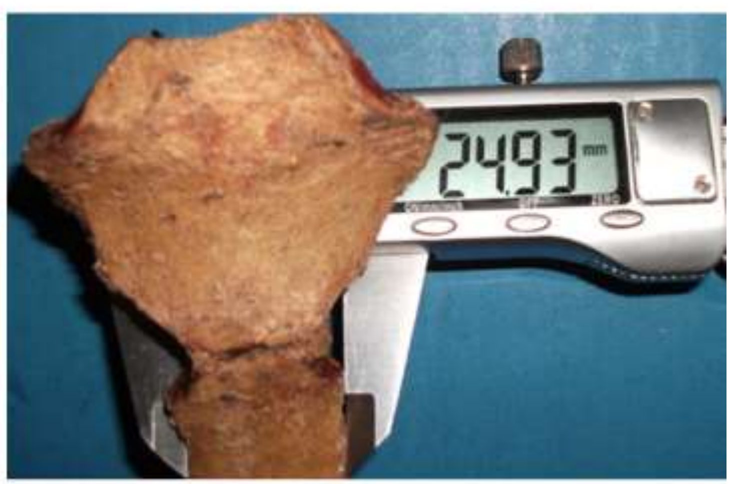

Fig 1a: Diagram showing the landmarks (**transverse white lines**) used to measure the breadth and thickness of the sternum at various intercostal segments (Selthofer et al, 2006). **Fig 1b**: Macrograph illustrating part of the materials and methods used in the present study

RESULTS

In both sexes the sternum was widest at the third intercostal notch and narrowest at the first. It was thickest at the fifth intercostal notch and thinnest at the second.

The manubrium

The average breadth and thickness of the manubrium is as shown (Table 1). In 13 cases (16.0%), the average thickness of the manubrium was less than 10.0 mm.

The sternal body

The average breadth and thickness of the sternal body are as shown (Table 2). In 7 cases (8.6%), the average sternal body thickness was less than 8.0 mm. Asymmetrical sterna were present in 16 cases (19.8%).

Table 1: Average breadth and thickness of the manubrium

Parameter	Mean ± SD	p value
Average breadth (mm)	M= 44.1 ± 4.5 F= 41.9 ± 4.4	1.137
Average thickness (mm)	M= 11.5 ± 1.3 F= 10.3 ± 1.2	0.163

M= male **F**= female

Table 2: Average breadth and thickness of the sternal body

Parameter	Mean ± SD	p value
Average breadth (mm)	M= 28.7 ± 4.7 F= 27.1 ± 4.6	0.174
Average thickness (mm)	M= 9.6 ± 1.2 F= 8.3 ± 1.1	0.159

M= male **F**= female

DISCUSSION

In the current study, the sternum was widest at the third intercostal notch. This differs from previous findings. Selthofer et al (2006) reported widest segment of the sternum at sixth and fifth intercostal notches in males and females respectively. This difference may be due to inter-population variations in the breadth dimensions of the sternum. Knowledge of these segmental variations is important during median sternotomy to avoid deviation of the suture material (Burton et al, 1996).

The average thickness of the manubrium and body in the present study was smaller than previous reports. Johnson et al (2005) reported an average manubrial thickness of 13.3mm. Selthofer et al, 2006, reported an average manubrial and body thickness of 12.6mm and 10.0mm respectively. The current study documents 16.0% and 8.6% of cases where the manubrial and body thickness were less than 10mm and 8mm respectively. We believe this is an important finding as it has been associated with migration of suture material through the sternum during median sternotomy (Burton et al, 1996).

Sterna in the present study were thinnest at the second, and thickest at the fifth intercostal notches. These findings are not surprising considering the biomechanical forces experienced by these parts during breathing (Nikolic et al, 2010). This finding underscores the structural adaptation of the sternum during respiration. Of significance, the thinnest segment of the sternum in this population should be born in mind during sternal biopsies to avoid complications. This segment should also be carefully evaluated for fractures in trauma to the anterior chest wall.

In the current study, 19.8% of the sterna were asymmetrical. This finding may have implications during median sternotomy as deviation of the sternotomy incision by more than 10mm from the midline is associated with post-operative sternal non-union due to unbalancing forces between the two halves (Burton et al, 1996; Grevious et al, 2009). Asymmetrical sterna may precipitate this complication and due caution is recommended during this procedure.

The Kenyan sternum showed morphometric variations from previous reports. The variations may pose challenges during median sternotomy and have been associated with fracture susceptibility. Further research is needed to correlate these findings. However, careful evaluation of chest injuries and due caution during median sternotomy are recommended

Acknowledgements: We are grateful to Prof. Ogendo for scientific critique, and staff of gross anatomy Laboratory (Jacob Gimongo, Acleus Murunga, Martin Iminyili) for technical assistance.

Source of funding: None
Conflict of Interest: None

REFERENCES

1. Baubin M, Rabl W, Pfeiffer K, Benzer K, Gilly H. 1999. Chest injuries after active compression-decompression cardiopulmonary resuscitation in cadavers. Resuscit; 43: 9-15
2. Bhootra BL .2004. Fatality following a sternal bone marrow aspiration procedure: a case report. Med Sci Law; 44: 170–172
3. Burton C, White R .1996. Review of the technique and complications of median sternotomy in the dog and cat. J. Small anim Prac; 37: 516-522
4. De Waele J, Calle P, Vermassen F .2002. Blunt cardiac injury in patients with isolated sternal fractures: the importance of fracture grading. Eur J. Trauma; 28: 3
5. Grevious M, Raja R, Ginard H .2009. Chest reconstruction and sternal dehiscence. emedicine.medscape.com; article no 1278627.
6. Inoue H (2010). Risk factors concerning sternal bone marrow aspiration and patient safety in Japan. Internal Med; 49: 1089-95
7. Johnson DL, Findlay J, Macnab AJ, Susak L .2005. Cadaver testing to validate design criteria of an Adult Intraosseous Infusion System. Military Med; 170: 251-257
8. Losanoff E, James W, Bruce W. 2002. Primary closure of median sternotomy: techniques and principles. Cardiovasc Surg; 10: 102–110
9. Nikolic V, Hudec M. 2010. Principle elements of biomechanics. Period biol; 112: 125-126

10. Odhiambo P.A. 1992. The first ten years of heart surgery in Kenya: Aspirations, dilemmas and possibilities. East Afr Med J; 9: 520-524
11. Osada T, Kawachi K, Fujikawa T. 1990. A new method for closure of median sternotomy: application of a steppler system. Japan J Thorac Surg; 43: 973-976
12. Rabl W, Baubin M, Broinger G, Scheidhauer R. 1996. Serious complications from active compression-decompression cardiopulmonary resuscitation. Intl. J. Legal Med; 109: 84-89
13. Selthofer R, Nikolić V, Mrcela T, Radić R, Leksan I, Rudez I, Selthofer K. 2006. Morphometric Analysis of the Sternum. Coll. Antropol; 30: 43–47
14. Shafir R, Weiss J, Herman O. 1988. Faulty sternotomy and complications after median sternotomy. J. Thorac Cardiovasc Surg, 96: 310–313
15. Skandalakis J, Colborn G, Weidman T, Roger S, Foster J. 2006. Thoracic wall and pleura: Skandalakis Surgical Anatomy Volume 2, McGraw-Hill, Chapter 2.