IJAE
Vol. 123, n. 2: 108-113, 2018
ITALIAN JOURNAL OF ANATOMY AND EMBRYOLOGY

Research Article - Basic and Applied Anatomy

Incidence of persistent metopic suture and extra sacral foramina in Ethiopian population

Amenu T. Wirtu[2], Soressa A. Geneti[2], Abay M. Zenebe[2], Solomon A. Ewnetu[2], Jickssa M. Gemechu[1]

[1]Oakland University William Beaumont School of Medicine, Department of Foundational Medical Studies, Rochester, MI, USA
[2]Addis Ababa University, College of Health Sciences, School of Medicine, Department of Anatomy, Addis Ababa, Ethiopia

Abstract

Lack of knowledge of variations in human morphology and their magnitude compared to normal anatomy may have significant clinical consequences. Accurate knowledge of anatomical variations provides important information in medico-legal issues, forensic interpretation, diagnostics, imaging and patient management including surgical procedures. Although underreported, it is believed that a significant proportion of clinical malpractice is due to suboptimal knowledge of anatomical variations. The present study aims to assess the anatomical variations of musculoskeletal structures in twenty-four formalin fixed cadavers used for dissection as part of Gross Anatomy course for medical students. The study was conducted in six medical schools in Ethiopia in years 2015/2016. Following critical observation and careful dissection, images were taken accordingly. Our findings show a complete persistence of metopic suture in 4.2 % of frontal bone, incidence of five anterior and posterior sacral foramina in 4.2 % of sacral bones and biceps brachii muscle with three heads of origin in 2.1 % of brachia. Altogether, the findings show the incidence of anatomical variants of clinical importance that need consideration during surgical procedures, diagnostics - especially in distinguishing fracture of bones and patient management in Ethiopian population with diverse socio-economic background and geographical origin.

Key words

Anatomical variation, Musculoskeletal, Metopic suture, Sacral foramen, Biceps brachii muscle.

Introduction

Variations of musculoskeletal structures have been rarely reported in Ethiopian population despite their clinical importance in medico-legal issues, forensic interpretation, diagnostics, imaging and patient management together with surgical procedures. Lack of knowledge of clinically important variations and their magnitude compared to normal anatomy may have significant clinical implications. Although underreported, it is believed that a significant proportion of clinical malpractice might be related to suboptimal knowledge of anatomical variations in subjects involved in the clinical practices (Yammine, 2014).

Persistence of metopic suture and the existence of sacral bone with five sacral foramina have been reported in adult south Indians (Pilli and Sunder, 2013). In the fetal skull, frontal bones exist in two halves separated by the frontal suture, and they

* Corresponding author. E-mail: gemechu@oakland.edu

http://www.fupress.com/ijae
DOI: 10.13128/IJAE-24159

remain separate until 6-8 years of age. In certain circumstances, the line of separation persists as the metopic suture in the midline of the glabella (Khamanarong et al., 2015). Metopic sutures are vertical sutures occurring as a result of failure of complete fusion between the two frontal bones. It was described that the obliteration of metopic suture begins at the level of frontal tuber and extends both upwards and downwards, and sometimes traces may be left either at the bregma or nasion if the fusion is incomplete (Bademci et al., 2007). Complete metopic suture that extend from nasion to bregma is called metopism (Khamanarong et al., 2015). This suture is not present throughout and occupies a small area between the two points when incomplete (Bademci et al., 2007), it is then known as median frontal suture and is usually present between the two super-ciliary arches of the frontal bone.

Sacral bone is assumed as the fourth segment of vertebral column and formed of five fused sacral vertebrae. It is the most variable portion of vertebrae (Goswami et al., 2014) and a number of anatomical variants occur in the pelvis (Esses and Botsford, 1997). The four pairs of anterior and posterior sacral foramina transmit the anterior and posterior rami of the upper four pairs of sacral spinal nerves respectively. The last sacral spinal nerve goes via sacral hiatus in the absence of the fifth sacral foramen.

There is also evidence of variants of muscular system in the diverse population of the world; for instance, the existence of biceps brachii muscle with three heads of attachment has been reported in Indian population (Elezy and Jayanthi, 2012). It is the only muscle in the anterior compartment of the arm which crosses glenohumeral and elbow joints. Biceps brachii muscle usually has two heads of proximal attachment, a short head which originates from coracoid process and a long head which originates from supraglenoid tubercle of the scapula. Distally, these two heads join to form a common belly and tendon which inserts on the radial tuberosity and with some fibers form the bicipital aponeurosis which merges with medial aspects of the deep fascia of forearm. Evidence indicates the existence of a third head of biceps brachii in scratch-digging mammals with powerful forelimb muscles and skeletal modifications for increased mechanical advantage (Lagaria and Youlatos, 2006). Besides, studies in human cadavers indicated the existence of a third head of biceps brachii in 2% Indians, 8% Chinese, 10% Europeans, 12% Africans, 18% Japanese (Elezy and Jayanthi, 2012). These findings pave a way forward towards understanding the developmental and evolutionary trend along mammalian species. To our best knowledge, an incidence of all the forementioned musculoskeletal variations in the population of Ethiopia remains unreported.

Materials and methods

This study was conducted in six medical schools in Ethiopia, three public and private institutions, namely Addis Ababa University, Jimma University, Wollega University, Sante Medical College, Bethel Medical College, and Africa Medical College. It was carried out in years 2015/2016, in formalin fixed cadavers used for dissection as part of Gross Anatomy course for medical students. It was conducted after an ethical approval by all institutions involved. The dissection was done in accordance with the guidelines of Cunningham's Manual of Practical Anatomy (Romanes, 1986).

Critical observation, careful dissection and acquisition of images were done in a total of 24 formalin fixed cadavers (N = 48 for arms). Accordingly, the superficial and

deep fascia were removed so as to expose the bones, muscles and neurovascular bundles. These structures were carefully handled in the laboratories and checked for the presence of any anatomical variation with special focus on the specified regions of human body. The results of the study are reported as descriptive analysis and percentage of incidence in the total number of cadavers used in this study.

Results

We found a complete persistence of metopic suture in one cadaver (4.2%; Figure 1). With regard to supernumerary sacral foramina, we found a sacrum with five pairs of sacral foramina in one cadaver (4.2%; Figure 2). Our results also showed the existence of a third head of biceps brachii muscle in one side of one cadaver (4.2% of cadavers, 2.1% of arms); that head attaches to the anterolateral aspect of the shaft of the humerus (Figure 3).

Discussion

The present investigation demonstrated the existence of clinically important anatomical variants in the population of Ethiopia. The findings include persisting metopic suture, five pairs of sacral foramina, and biceps brachii muscle with three heads at the proximal attachment. These variants do have clinical relevance during surgical procedures, in distinguishing fracture of bones, during caudal epidural nerve block and in diagnosis of muscle paralysis.

The persistent metopic suture we have found was complete, which is in agreement with the findings in Indian population (Hussain et al., 2010;Wadekar et al. 2014). In contrast, incomplete metopic suture extends a small distance either from the nasion or from the bregma, with or without the presence of wormian bones (Wilkie and Morriss-Kay, 2001). Metopism has been reported to be caused by a number of factors including abnormal ossification of cranial bones, hydrocephalus, developmen-

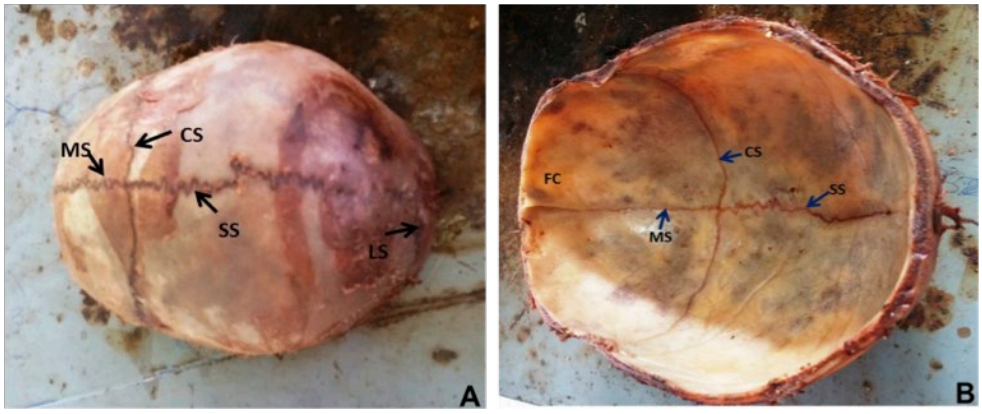

Figure 1. The image shows the persistence of metopic suture in external (A) and internal (B) aspects of the calvaria. MS - Metopic suture. CS - Coronal suture. SS - Sagittal suture. LS - Lambdoidal suture. FC - Frontal crest.

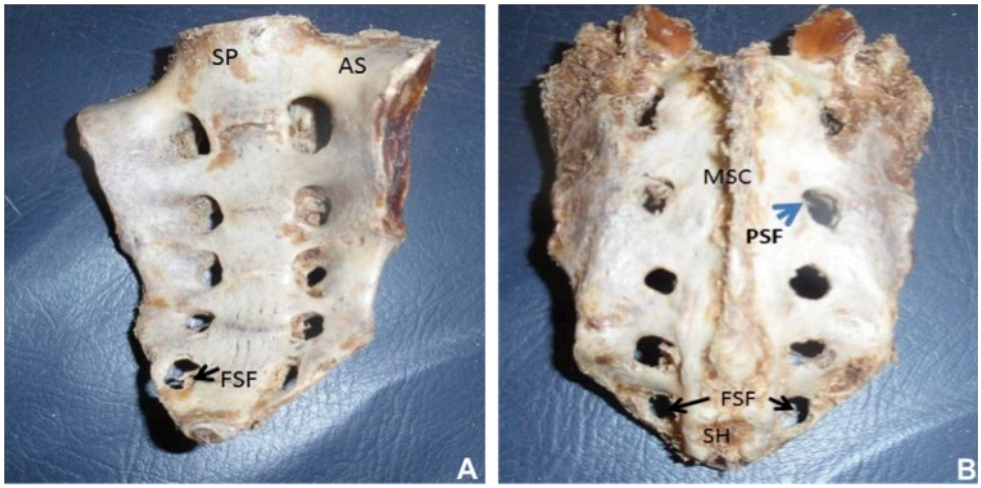

Figure 2. The image shows the existence of a fifth pair of sacral foramina; anterior view (A) and posterior view (B). SP - Sacral promontory. AS - Ala of sacrum. FSF - Fifth pair of sacral foramina. SH - Sacral hiatus. MSC - Median sacral crest. PSF - Posterior sacral foramina.

Figure 3. The image shows three heads of biceps brachii muscle. BB - Biceps brachii. AHBB - Additional head of biceps brachii (variant). LHBB - Long head of biceps brachii. SHBB - Short head of biceps brachii. CB - Coracobrachialis.

tal retardation, sexual influence, heredity, atavism, and stenocrotaphia (Pilli and Sunder, 2013). However, recently the genetic influence is getting acceptance as the most important factor among the scientific community (Pilli and Sunder, 2013). A number of studies reported the persistence of metopic suture in different populations with an

incidence of 4-5% in Americans, 7-10% in Europeans, 9.5% in Scottish, 1% in Africans, 5.1% in Mongolians, 5% in Panjab Indians, and 1% in Australians (Bryce, 1915; Jit & Shah 1948; Breathnach, 1958; Wilkie and Morriss-Kay, 2001). We found a completely persistent metopic suture with an incidence of 4.2% in Ethiopians. This information is important for the medico-legal and forensic experts (Wilkie and Morriss-kay, 2001). Moreover, the morphological detail has clinical significance to avoid misinterpretation of radiological images during skull fracture. This in turn will clear out confusion and wrong diagnosis in emergency situations (Singh, 2014). Furthermore, neurosurgeons should be aware of this sutural configuration before performing frontal craniotomy.

Sacrum is formed by fusion of five sacral vertebrae and usually contains four pairs of sacral foramina. The existence of five pairs of sacral foramina is an anatomical variant which occurs due to either sacralization or lumbarization. Lumbarization is the fusion of fifth lumbar with first sacral vertebrae, where as, sacralization is fusion of fifth sacral with first coccygeal vertebra. Singh (2014) and Goswami et al. (2014) classified sacralization into two main classes, lumbar and coccygeal sacralisation, with two subclasses in the lumbar (Type I & II) and three in coccygeal (Type III, IV, V). Based on the classificastion by Singh (2014), the fifth extra sacral foramen we found (with an incidencde of 2.4% in Ethiopians) belongs to the coccygeal sacralization (Type III), which occurs due to complete fusion of body, transverse process and cornua of coccygeal vertebra with the corresponding elements of fifth sacral vertebra. The formation of five pairs of sacral foramina may be explained in terms of abnormal embryogenesis and/or gene mutations responsible for any incidence of congenital malformations. Embryologically vertebrae are derived from the sclerotome portion of the somites. During development HOX genes are involved in the patterning of the the shapes of the different vertebrae, and mutation of the genes might lead to sacralization of coccygeal vertebrae (Sadler, 2015). Awareness of this variants in the number of sacral foramen is important for anesthetists during trans-sacral nerve block, and radiologists during interpretation of radiographs in lumbo-sacral regions.

The other finding of the present study was variation in the origin of heads of biceps brachii muscle. The biceps brachii muscle presents a wide range of variation, and the esistence of third head of biceps brachii has been reported (Ilayperuma et al., 2011). It has also been documented that the incidence of this variation is as much as 10% in Indians (Elezy and Jayanthi, 2012). We found here three heads of biceps brachi on one side of a male cadaver of Ethiopian population, with an incidence of 2.1%. On the other hand, the incidence of a third head of biceps brachii muscle in African population was pointed out to be 12% (Londhe Shashikala and Jadhav Ashwini, 2011), indicating a trend towards gender related tricepsy.

Altogether, these anatomically as well as clinically important musculoskeletal variations found in Ethiopians, indeed, emphasize the need for special consideration in the interpretation of modern diagnostics during fracture of bones, diagnosis of muscle paralysis and patient management during surgical procedures.

Acknowledgments

We extend our thanks to medical schools in Ethiopia; Addis Ababa University, Jimma University, Wollega University, Sante Medical College, Bethel Medical College, and Africa Medical College.

Conflict of interest

The authors declare that the study was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

Bademci G., Kendi T., Agalar F. (2007) Persistent metopic suture can mimic the skull fractures in the emergency setting. Neurocirugía (Astur)18: 238-240.

Breathnach A.S. (1958) Frazer's Anatomy of the Human Skeleton. 5th edn. J. & A.Churchill, London.

Bryce T.H. (1915) Osteology and arthrology. In: Schafer E.A., Symington J., Bryce T.H., Quain J. (Eds.) Quain's Elements of Anatomy. 11th edn. Longmans Green, London. Vol. 4 Pt.1. Pp. 1-329, specifically P. 177.

Elezy M.A, Jayanthi A.A. (2012) Study of variations in the origin of biceps brachii muscle in Kerala. Int. J. Sci. Res. 2: 1-4.

Esses S.E., Botsford D.J. (1997) Surgical anatomy and operative approaches to the sacrum. In: Frymoyer J.W., Ducker T.B., Hadler N.M. (Eds). The Adult Spine: Principles and Practice. 2nd edn. Lippincott-Raven, Philadelphia. Vol. 2. Pp. 2329-2341.

Goswami P., Yadav Y., Chakradhar V. (2014) Sacral foramina: Anatomical variations and clinical relevance in north Indians. Eur. J. Acad. Ess. 1: 29-33.

Hussain S.S., Mavishettar G.F., Thomas S.T., Prasanna L.C. (2010) Incidence of metopic suture in adult south Indian skulls. J. Biomed. Sci. Res. 2: 223-226.

Ilayperuma I., Nanayakkara G., Palahepitiya N. (2011) Incidence of humeral head of biceps brachii muscle -Anatomical insight. Int. J. Morphol. 29: 221-225.

Jit I., Shah M.A. (1948) Incidence of frontal or metopic suture amongst Punjabi adults. Indian Med. Gazette 83: 507.

Khamanarong K., Tuamsuk P., Woraputtaporn W., Namking M., Sawatpanich T., Toomsan Y., Iamsaard S. (2015) Incidence of metopism in adult Thai skulls. Int. J. Morphol. 33: 51-54.

Lagaria A., Youlatos D. (2006) Anatomical correlates to scratch digging in the forelimb of European ground squirrels (Spermophilus citellus). J. Mammal. 87: 563-570.

Londhe Shashikala R., Jadhav Ashwini S. (2011) Third head of biceps brachii muscle a case study. Biomed. Res. 22: 387-389.

Pilli N., Sunder R.R. (2013) Persistent metopic suture in various forms in south Indian adult skulls – A study. Int. J. Sci. Res. 3: 1-7.

Romanes G. J. (1986) Cunningham's Manual of Practical Anatomy. 15th revised edn.. Oxford Medical Publications, Oxford.

Sadler T.W. (2015) Langman's Medical Embryology. 13th edn. Wolters Kluwer, Philadelphia.

Singh R. (2014) Classification and analysis of fifth pair of sacral foramina in Indian dry sacra. Int. J. Morphol. 32: 125-130.

Wadekar P.R., Pundge S.J., Fulpatil M.P., Pandit S.V. (2014) Study of incidence of metopic suture in adult skulls. Indian J. Bas. Appl. Med. Res. 4: 277-283.

Wilkie A.O., Morriss-Kay G.M. (2001) Genetics of craniofacial development and malformation. Nat. Rev. Genet. 2: 458-468.

Yammine Kaissar (2014) Evidence-based anatomy. Clinical anatomy, 27:847-852.