Sutural morphology of the pterion and asterion among adult kenyans

Mwachaka, PM.*, Hassanali, J. and Odula, P.

Department of Human Anatomy, University of Nairobi, P.O. Box 30197-00100 GPO, Nairobi, Kenya
*E-mail: pmaseghe@yahoo.com

Abstract

The pterion and asterion are points of sutural confluence seen in the norma lateralis of the skull. Their patterns of formation exhibit population-based variations. Data on the Kenyan population however remains scarce and yet the understanding of the sutural morphology of these points is important in surgical approaches to the cranial fossae. Ninety human skulls of known gender (51 male, 39 female) were examined on both sides. Four types of pteria were observed: sphenoparietal (66.7%), frontotemporal (15.5%), stellate (11.1%) and epipteric (6.7%). The epipteric type occurred more in females (10.5%) than in males (4.8%). Sutural bones were found at the asterion in 20% of the cases. Variations in the sutural morphology of the pterion and asterion in the Kenyan crania is similar to that of other populations.

Keywords: asterion, pterion, sutural bones, kenyans.

1 Introduction

The pterion is a point of sutural confluence seen in the norma lateralis of the skull where frontal, parietal, temporal and sphenoid bones meet (WILLIAMS, BANNISTER, BERRY et al., 1998). Four types of pteria have been described (MURPHY, 1956): sphenoparietal type where the greater wing of sphenoid articulates with parietal bone to form letter H; frontotemporal type where the squamous part of temporal articulates with frontal bone; stellate type where all bones articulate in the form of letter K and epipteric type where a sutural bone is lodged between the four bones forming the pterion. The types of pteria have been shown to exhibit ethnic variations (MURPHY, 1956; OGUZ, SANL and BOZKIR, 2004).

The asterion on the other hand is the junction of the parietal, temporal and occipital bones (WILLIAMS, BANNISTER, BERRY et al., 199). Occurrence of sutural bones in this craniometric point has been reported to vary among different populations (BERRY and BERRY, 1967; KELLOCK and PARSONS, 1970). Data on the Kenyan population remains scarce yet understanding the sutural morphology of these points is important in surgical approaches to the cranial fossae (ERSOY, EVLIYAOGLU, BOZKURT et al., 2003). Presence of sutural bones at these points may complicate the surgical orientation leading to pitfalls (OGUZ, SANL and BOZKIR, 2004; ERSOY, EVLIYAOGLU, BOZKURT et al., 2003).

This study aimed at assessing the sutural morphology of the pterion and asterion in crania of adult Kenyans.

2 Material and methods

After seeking ethical approval, fifty adult dry skulls (31 male and 19 female) and forty formalin fixed cadaveric heads (20 male and 20 female) were studied. The dry skulls were obtained from the National Museums of Kenya. Those that had the 3rd molar erupted were considered adults and included in the study. The formalin fixed cadaveric heads were analyzed at the Department of Human Anatomy, University of Nairobi during routine dissection. Soft tissues were removed to expose the pterion and asterion.

Each pterion was classified as sphenoparietal, frontotemporal, stellate and epipteric (Figure 1) based on descriptions by Murphy (1956). As regards the asterion, the sutural morphology was classified into two: type I (where a sutural bone was present) and type II (where a sutural bone was absent). Data obtained were analyzed using SPSS 11.5 (Chicago, Illinois) software. The Student's *t*-test was employed in the assessment of side and gender differences. A p-value ≤ 0.05 was considered significant.

3 Results

3.1 Sutural morphology of the pterion

All types of the pterion were observed. There was a notably higher occurrence of the sphenoparietal type (69.4% males, 60.5% females). The gender differences were statistically insignificant (p = 0.062) though epipteric bones occurred more in females (Table 1). The stellate and epipteric pteria occurred more on the right side while the frontotemporal type was more on the left side. The sphenoparietal pterion was equally distributed on both the left and right sides (Figure 2). The same type of pterion occurred on both right and left sides in the same individual in 78% of the cases. The sphenoparietal type occurred more bilaterally.

3.2 Sutural morphology of the asterion

Both type I and II asterions were observed (Figure 3). type I asterion was observed in 20% of the cases, the rest being of type II variety (Figure 4). Type I asterion occurred more in females (81.6%). The gender differences in the prevalence of the asterion types were not statistically significant (p = 0.078). As regards side differences, type I occurred in 20% of all the cases on both the right and left sides. Side dif-

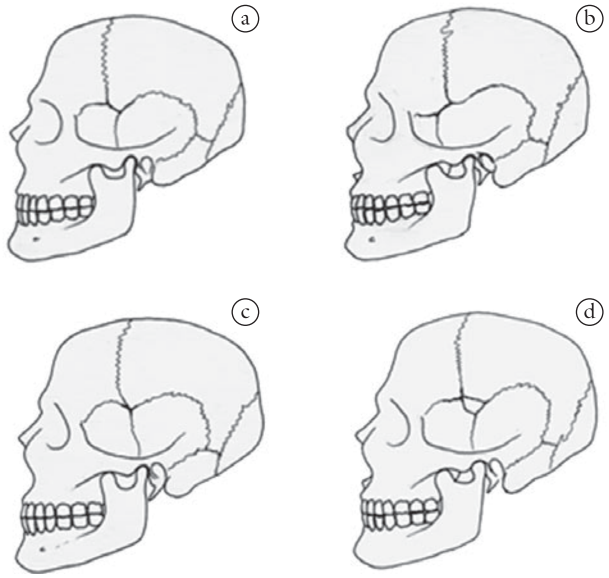

Figure 1. Murphy's classification of the shape of the pterion. a) sphenoparietal; b) frontotemporal; c) stellate; and d) epipteric.

Table 1. Frequency of pterion types observed in males and females. SP - sphenoparietal; FT - frontotemporal; St - stellate; and Ep - epipteric.

	Type of pterion (%)			
	SP	FT	St	Ep
Male (n = 94 sides)	69.4	14.5	11.3	4.8
Female (n = 64 sides)	60.5	15.8	13.2	10.5
Total (n = 158 sides)	66.0	15.0	12.0	7.0

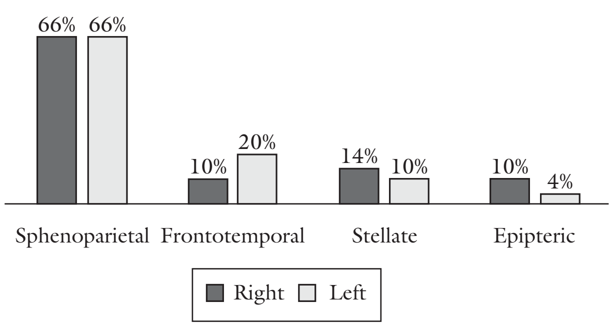

Figure 2. Prevalence of pterion types observed on the right and left sides.

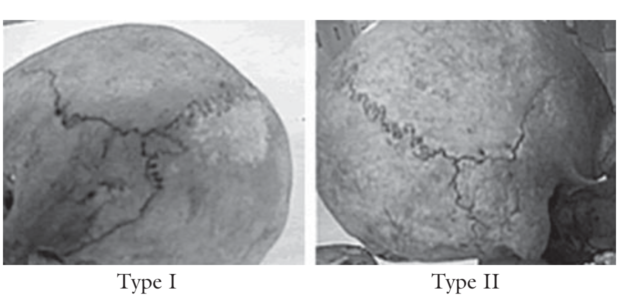

Figure 3. Type of asterion observed.

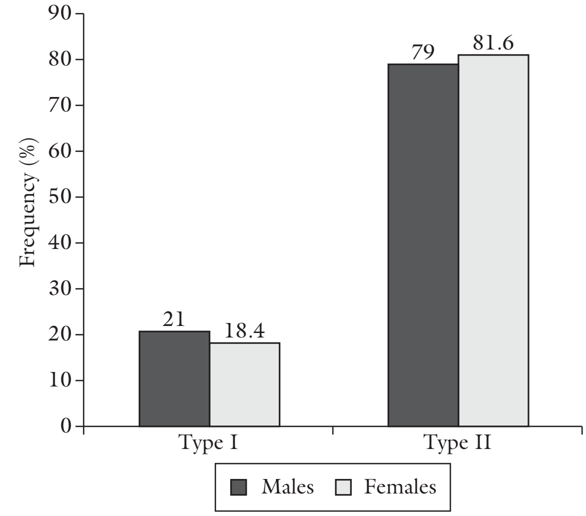

Figure 4. Prevalence of the type I and II asterion among males and females.

ferences were significant in females (p = 0.035) where type II asterion occurred more on the left side (84.2%) than the right side (78.9%). On the other hand, type I asterion was more on the right side (21.1%) than the left side (15.8%).

4 Discussion

The findings of the present study support and extend those of previous studies (Table 2). Although the control of the pattern of articulation of bones forming the pterion and asterion is not known, genetic factors may play some role (WANG, OPPERMAN, HAVILL et al., 2006). The MSX2 gene, which encodes a home domain transcription factor, plays a crucial a role in craniofacial morphogenesis by influencing fusion of sutures (LIU, TANG, KUNDU et al., 1999). The basis for the ethnic variations observed could be genetic and environmental (ASALA and MBAJIORGU, 1996).

The high occurrence of the sphenoparietal pterion could have an evolutionary basis (LIU, TANG, KUNDU et al., 1999). Sphenoparietal type is the most common type in humans and biped primates such as bonobos, orangutans (ASHLEY-MONTAGU, 1933). Furthermore, it has been shown that the development of calvarial bones is tightly coordinated with the growth of the brain and requires interactions between different tissues in the sutures (KIM, RICE, KETTUNEN et al., 1998). Consequently, the increase in brain size in bipeds (ASHLEY-MONTAGU, 1933) may have caused morphological changes in neurocranium that led to meeting of greater wing of sphenoid and parietal bone.

The present study has shown that the same type of pterion occurs more bilaterally than unilaterally. This is in agreement with the findings among Indians (SAXENA, BILODI and MANE, 2003) but differs with that among Turks, where the occurrence of a pterionic type varied significantly on the left and right sides (OGUZ, SANLI, BOZKIR et al., 2004). These differences could be due to the different sample sizes used in the studies (Table 2).

In the present study, type I asterion (sutural bones) occurred in 20% of the cases. This frequency is the highest

Table 2. Frequency of pterion types observed in different populations. SP - sphenoparietal; FT - frontotemporal; St - stellate; and Ep - epipteric.

Population	N	Type of pterion (%)			
		SP	FT	Ep	St
Australian aborigines (MURPHY, 1956)	388	73	7.5	18.5	1
Turkish males (OGUZ, SANLI, BOZKIR et al., 2004)	26	88	10	2	0
Turks (ERSOY, EVLIYAOGLU, BOZKURT et al., 2003)	300	87.35	3.47	8.98	0.2
Indians (SAXENA, BILODI and MANE, 2003)	203	84.72	10.01	-	5.17
Japanese (MATSUMURA, KIDA, ICHIKAWA et al., 1991)	614	79.1	2.6	17.7	0.6
Kenyans (current study)	79	66.0	15.0	12.0	7.0

Table 3. Prevalence of the asterion in different populations.

Population	N	Type of asterion (%)	
		Type I	Type II
North Americans (BERRY and BERRY, 1967)	50	12.0	88.0
South Americans (BERRY and BERRY, 1967)	53	7.5	92.5
Egyptians (BERRY and BERRY, 1967)	250	14.4	85.6
Indians-Burma (BERRY and BERRY, 1967)	51	14.7	85.3
Indians-Punjab (BERRY and BERRY, 1967)	53	16.9	83.1
Australian aborigines (KELLOCK and PARSONS, 1970)	-	19.8	80.2
Turks (GUMUSBURUN, SEVIM, KATKICI et al., 1997)	302	9.92	90.08
Kenyans (current study)	79	20	80

among other studies (Table 3). The population with findings nearer those of the present study is the Australian Aborigines (19.8%) while the farthest is South Americans (7.5%). The mechanism of formation of sutural bones is not fully understood. Some authors suggest that these bones develop from pathological influences such as hydrocephalus (HESS, 1946; FINKEL, 1971), while others believe that sutural bones develop from normal processes and are genetically determined (MURPHY, 1956; PAL and ROUTAL, 1986).

In the current study, there were no statistically significant gender differences in the occurrence of the asterion. This is in agreement with a study on Turks that showed prevalence of type I pterion to be 16.66% in males and 12.72% in females (GUMUSBURUN, SEVIM, KATKICI et al., 1997).

5 Conclusion

Sutural morphology of the pterion and asterion in the Kenyan population does not differ from that of other populations. This data may be of use when planning for surgical approaches to the cranium through these craniometrical points and also when interpreting radiological images.

Acknowledgements: We are especially thankful to Dr. Julius Ogeng'o, Dr. Hassan Saidi and other teaching staff at the Department of Human Anatomy, University of Nairobi, for extending their valuable support in completing this study.

References

ASALA, SA. and MBAJIORGU, FE. Epigenetic variations in the Nigerian skull: sutural pattern at the pterion. *East African Medical Journal*, 1996, vol. 73, no. 7, p. 484-486.

ASHLEY-MONTAGU, MF. The anthropological significance of the pterion in the Primates. *American Journal pf Physical Antropology*, 1933, vol. 18, no. 2, p. 159-336.

BERRY, AC. and BERRY, RJ. Epigenetic variation in the human cranium. *Journal of Anatomy*, 1967, vol. 101, p. 361-379.

ERSOY, M., EVLIYAOGLU, C., BOZKURT, M., KONUSKAN, B. and TEKDEMIR, I. Epipteric bone in the pterion may be a surgical pitfall. *Minimally Invasive Neurosurgery*, 2003, vol. 46, no. 6, p. 363-365.

FINKEL, DJ. Wormian bones: a study of environmental stress. *American Journal of Phyisical Anthropology,* 1971, vol. 35, p. 278.

GUMUSBURUN, E., SEVIM, A., KATKICI, U., ADIGUZEL, E. and GULEC, E. A study of sutural bones in Anatolian-Ottoman skulls. *International Journal of Anthropology*, 1997, vol. 12, no. 2, p. 43-48.

HESS, L. Ossicula wormiana. *Human Biology,* 1946, vol. 18, p. 61-80.

KELLOCK, WL. and PARSONS, PA. A comparison of the incidenceof minor nonmetrical cranial variants in Australian Aborigines with those of Melanesia and Polynesia. *American Journal of Physical Antropology*, 1970, vol. 33, no. 2, p. 235-239.

KIM, HJ., RICE, DPC., KETTUNEN, PJ. and THESLEFF, I. FGF-, BMP- and Shh-mediated signaling pathways in the regulation of cranial suture morphogenesis and calvarial bone development. *Development,* 1998, vol. 125, no. 7, p. 1241-1251.

LIU, Y., TANG, Z., KUNDU, RK., WU, L., LUO, W., ZHU, D. et al. Msx2 gene dosage influences the number of proliferative oesteogenic cells in growth centres of the developing murine skull: a possible mechanism for MSX2-mediated craniosynostosis in humans. *Dev Bio*, 1999, vol. 205, p. 260-274.

MATSUMURA, G., KIDA, K., ICHIKAWA, R. and KODOMA, G. Pterion and epipteric bones in Japanese adults and fetuses, with special reference to their formation and variations. *Kaibogaku zasshi Journal of Anatomy*, 1991, vol. 66, no. 5, p. 462-471.

MURPHY, T. The pterion in Australian Aborigine. *American Journal pf Physical Antropology*, 1956, vol. 14, no. 2, p. 225-244.

OGUZ, O., SANLI, S., BOZKIR, M. and SOAMES, W. The pterion in Turkish male skulls. *Surgical and Radiologic Anatomy*, 2004, vol. 26, no. 3, p. 220-224.

PAL, GP. and ROUTAL, RV. A study of sutural bones in different morphological forms of skulls. *Anthropologischer Anzeiger*, 1986, vol. 44, no. 2, p. 169-173.

SAXENA, R., BILODI, A. and MANE, S. Study of the pterion in the Awadh area-in and around Lucknow. *Kamatandu University Medical Journal,* 2003, vol. 1, no. 1, p. 32-33.

WANG, Q., OPPERMAN, L., HAVILL, L., CARLSON, D. and DECHOW, P. Inheritance of sutural pattern at the pterion in Rhesus Monkey Skulls. *Anatomical Record,* 2006, vol. 288A, no. 10, p. 1042-1059.

WILLIAMS, L., BANNISTER, L., BERRY, M., COLLINS, P., DYSON, M. and DUSSEK, E. *Gray's Anatomy.* 38 ed. London: Churchill Livingstone, 1998. p. 568-595.

Received September 26, 2008
Accepted March 2, 2009