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Incidence of sutural bones at asterion in dry human skulls in Northeast Brazil

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ABSTRACT

Introduction: The asterion is a craniometric point in the norma lateralis of the skull situated at the junction between lambdoid, parietomastoid, and occipitomastoid sutures. The aim of this study is to assess the sutural morphology of the asterion and its distance from bony landmarks in human skulls from Northeast Brazil. Materials and Methods: 60 skull halves from individuals from Northeast Brazil were analyzed. The morphological variability of the asterion and measurements of the asterion to the root of the zygomatic arch (A-RZA), the tip of the mastoid process (A-TMP), the suprameatal crest (A-SMC), and the external occipital protuberance (A-EOP) were investigated. Results: Type I asterion was observed in 19 (31.67%) of the cases, and common more in males (18.34%). Type I occurred more on the left side in males (11.67%), whereas in females on the right side (8.34%). Type II asterion was occurred more in females (43.34%), and common more on the right side in both the genders. No statistical difference was found between the sides in the location of the A-RZA, A-TMP, A-SMC, and A-EOP. There was also no statistical difference between the right and left sides between the genders ($p > 0.05$). Conclusion: The Brazilian population has a high incidence of type I asterion, different from previous studies. This data may be of use when planning for surgical approaches to the skull and also when interpreting radiological images.

Keywords: anatomy, asterion, skull, Brazil.

INTRODUCTION

The asterion is a craniometric point in the *norma lateralis* of the skull situated at the junction between lambdoid, parietomastoid, and occipitomastoid sutures [1]. It is the site of the posterolateral or mastoid fontanellae during the neonatal period which closes during the second year [1, 2, 3].

The location of the asterion is accepted as the first landmark for all posterolateral approaches to the cranial base, and surgical landmark to the transverse sinus location which is of great importance in the surgical approaches to the posterior cranial fossa [2, 4, 5, 6, 7].

Further, the distances of the asterion from the root of the zygomatic process and the tip of the mastoid process are useful in the surgical approaches to the mastoid antrum, cerebellopontine trigone surgery, and transmastoid cisternoscopy [8, 9].

At the asterion, sutural morphology was classified into two types: Type I- with sutural bone (Wormian) located among the parietomastoid, lambdoid and occipitomastoid sutures, and Type II- union of the parietomastoid, lambdoid and occipitomastoid sutures, due to absence of the sutural bone (Wormian) [10].

The occurrence of sutural bone at this craniometric point has been reported to vary among populations [4, 9, 11, 12, 13]. Data on the Brazilian population remains scarce, yet understanding the sutural morphology of asterion is important in surgical approaches to the cranial base. This study

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aimed at assessing the sutural morphology of the asterion and linear distance of the asterion from various bony landmarks in human skulls from Northeast Brazil.

MATERIAL AND METHODS

A total of 30 human adult dry skulls (13 male and 17 female) were examined to determine the incidence of sutural bones at the asterion in the Brazilian population. The dry skulls were obtained from Human Anatomy Laboratory of the Medical School Nova Esperança, Northeast Brazil. Those that had the 3rd molar erupted were considered adults and were hence studied. Damaged and pathological skulls were excluded from this study. Sexing of the skulls was done based on morphological features [14].

The morphological variability of the asterion in relation to the presence of sutural bone (Wormian) was analyzed according to the classification of Morales-Avalos et al. [10].

a) Asterion type I: sutural bone (Wormian) located among the parietomastoid, lambdoid and occipitomastoid sutures.

b) Asterion type II: union of the parietomastoid, lambdoid and occipitomastoid sutures, because of an absence of the sutural bone (Wormian).

Morphometric measurements were taken on both sides of the skull with the help of Vernier caliper accurate to 0.01mm (a total of 60 skull halves), as shown in Figure 1:

1) Distance from the centre of the asterion to root of the zygomatic arch (A-RZA);

2) Distance from the centre of the asterion to the tip of the mastoid process (A-TMP);

3) Distance from the centre of the asterion to suprameatal crest (A-SMC);

4) Distance from the centre of the asterion to external occipital protuberance (A-EOP).

The results were statistically analyzed by one-way analysis of variance (ANOVA), and the other comparisons with Student t-test, using GraphPad Prism version 6.00 for Windows, California, USA. A p-value ≤ 0.05 was considered significant.

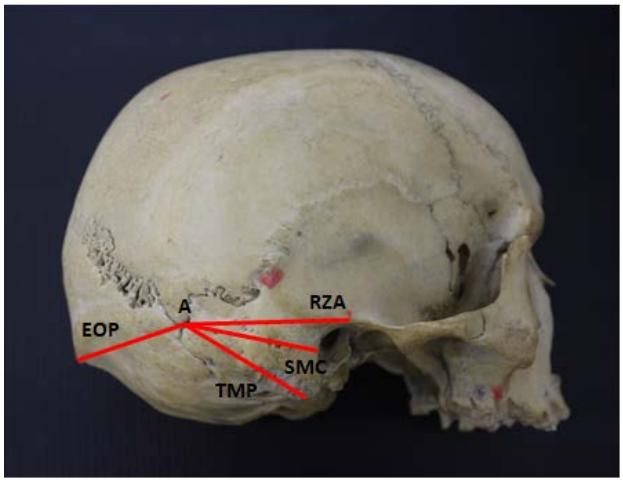

Figure 1: Posterolateral view of the base of the skull, right side. Measurements from the centre of the asterion to: Root of the Zygomatic Arch (RZA), Tip of the Mastoid Process (TMP), Suprameatal Crest (SMC), and External Occipital Protuberance (EOP).

RESULTS

We analyzed the morphometric characteristics of the asterion and bony landmarks of the posterolateral surface of the skull for 60 skull halves.

Table 1 shows the means and standard deviations of the four measurements of the asterion, in males and females and on the right and left sides. No statistical difference was found between the sides in the location of the asterion to root of the zygomatic arch (A-RZA), to tip of the mastoid process (A-TMP), to suprameatal crest (A-SMC), as well as from the external occipital protuberance (A-EOP). There was also no statistical difference between the right and left sides between the genders ($p > 0.05$).

Both type I and II asterions were observed in males and females, Figures 2 and 3. Type I asterion was observed in 19 (31.67%) of the cases, the rest being of type II variety (Table 2). Type I asterion occurred more in males (18.34%). As regards side differences, type I occurred more on the left side in males (11.67%), whereas in females occurred more on the right side (8.34%). On the other hand, type II asterion was occurred more in females (43.34%). Type II occurred more on the right side in both the genders.

Table 1. Position of the asterion from the bony landmarks of the skull (mean±SD).

Morphometric Parameters	Male			Female		
	Right	Left	P	Right	Left	P
A-RZA	47.23±5.35	47.31±6.03	0.925	43.24±5.31	43.35±4.93	0.898
A-TMP	66.15±4.81	67.62±6.94	0.163	65.35±6.09	63.76±8.72	0.483
A-SMC	39.31±4.21	39.23±3.83	0.938	38.82±4.95	38.82±3.67	0.999
A-EOP	60.15±3.95	58.62±4.09	0.170	57.88±5.91	58.88±4.98	0.267

Distances are expressed in millimeters. A: asterion; RZA: root of the zygomatic arch; TMP: tip of the mastoid process; SMC: suprameatal crest; EOP: external occipital protuberance.

Figure 2: Type I asterion.

Figure 3: Type II asterion.

Table 2. Distribution of asterion percentage in male and female (in %).

Type	Male			Female		
	R	L	T	R	L	T
I	6.67	11.67	18.34	8.34	5	13.34
II	15	10	25	23.34	20	43.34

R: Right side; L: Left side; T: Total.

DISCUSSION

Wormian bones or sutural bones are usually small irregular ossicles located within the cranial sutures. They are formed as a result of alterations in the normal formation of the flat bones of the skull and are regarded as normal variants [15]. It is important for neurosurgeons and radiologists to be aware of the presence of wormian bones as they may be mistaken for fractures in cases of head injuries [15].

In the present study type I asterion occurred in 31.67% of the cases. This frequency is higher than other American studies [9, 10, 11] and studies in other populations [11, 16, 17, 18, 19] (Table 3). The population with findings nearer to those of the present study is the Mexican (25.6%), while the farthest is South American (7.5%), Table 3. The explication for the variations in different populations can be genetic or environmental [20].

The mechanism of formation of sutural bones is not fully understood. Some authors suggest that these bones develop from pathological influence such as hydrocephalus [21]. As per another opinion, there is a close association between developing duramater and calvarial bones [22]. While others authors believe that sutural bones

develop from normal process and are genetically determined [23].

Table 3. Prevalence of the asterion in different populations.

Population/Study	Total (n)	Type (%)	
		I	II
Egypt [11]	250	14.40	85.60
Australian aborígines [16]	-	19.8	80.2
Turkey [17]	302	9.92	90.08
Kenya [18]	79	20.0	80.0
India [19]	78	13.46	86.54
North America [11]	50	12.0	88.0
South America [11]	53	7.5	92.5
Mexico [9]	88	25.6	74.4
Brazil (Present study)	30	31.67	68.33

Table 4. Distance between the asterion and various bony landmarks on the surface of the skull in different populations.

Population/Study	Anatomical Landmarks			
	A-RZA	A-TMP	A-SMC	A-EOP
USA [25]	57±8.5	49.2±4.4	41.4±4.3	-
Uruguay [4]	-	49.7	44.9	64.4
Turkey [12]	54.6±5.5	49.1±5.4	45.4±5.2	-
Kenya [5]	58.65±2.31	47.75±3.30	-	-
Mexico [9]	54.74±4.46	51.53±4.97	44.16±5.81	61.51±7.44
India [20]	-	47.60±6.40	42.28±6.60	57.15±8.38
China [7]	54.35±5.46	48.9±2.90	-	-
Brazil (Present study)	45.28±5.40	65.72±6.64	39.05±4.17	58.88±4.73

Distances are expressed in millimeters. A: asterion; RZA: root of the zygomatic arch; TMP: tip of the mastoid process; SMC: suprameatal crest; EOP: external occipital protuberance.

The MSX2 gene, which encodes a home domain transcription factor, plays a crucial role in craniofacial morphogenesis by influencing fusion of sutures [24].

The type 2 asterion was found in the present study and all studies reported in Table 3, with the prevalence varying from 74.40% to 92.5%. The present study findings are near to the study reported by Galindo-de León et al. [9] in the Mexican population (Table 3).

The presence of the sutural bones should be kept in mind by radiologists and neurosurgeons while interpreting X-rays. A thorough knowledge of the location and morphometric features of the transverse and sigmoid sinus with other superficial landmarks is essential during posterolateral approaches to the posterior cranial fossa [20].

In the current study, the measurements obtained from the asterion to the bony landmarks on the surface of the skull (root of the zygomatic arch and tip of the mastoid process), are different of earlier studies [5, 7, 9, 12, 25] (Table 4). However, the measurements from the asterion to the suprameatal crest and external occipital protuberance, are similar to earlier studies [4, 9, 20] (Table 4).

Differences in the measurements between different populations can be attributed to the morphological characteristics of the races. The measurements of the asterion with other bony landmarks provide a database for the clinical-surgical practice and also for a forensic and anthropological application [20]. Further, it can also

is useful for the identification of human male and female skulls in association with other parameters.

CONCLUSION

Our study showed that the Brazilian population has a high incidence of type I asterion, different from that observed in previous studies. This data may be of use when planning for surgical approaches to the skull and also when interpreting radiological images.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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RESUMO

Incidência de ossos suturais no astério em crânios humanos secos no Nordeste do Brasil

Introdução: O astério é um ponto craniométrico na norma lateral do crânio situado na junção entre as suturas lambdóide, parietomastóideo e occipitomastóideo. O objetivo deste estudo é avaliar a morfologia sutural do astério e sua distância de pontos de referência ósseos em crânios humanos do Nordeste do Brasil. Materiais e Métodos: Foram analisados 60 hemicrânios de indivíduos do Nordeste do Brasil. A variabilidade morfológica do astério, e medidas do astério à raiz do arco zigomático (A-RAZ), ao ápice do processo mastóide (A-APM), a crista suprameatal (A-CSM) e a protuberância occipital externa (A-POE) foram investigadas. Resultados: O astério tipo I foi observado em 19 (31,67%) dos casos, sendo mais comum no sexo masculino (18,34%). O tipo I ocorreu mais no lado esquerdo no sexo masculino (11,67%), enquanto no sexo feminino, no lado direito (8,34%). O astério tipo II ocorreu mais no sexo feminino (43,34%), e foi mais comum no lado direito, em ambos os sexos. Não foi encontrada diferença estatística entre os lados na localização do A-RAZ, A-APM, A-CSM e A-POE. Também não houve diferença estatística entre os lados direito e esquerdo entre os sexos ($p>0,05$). Conclusão: A população Brasileira apresenta alta incidência de astério tipo I, diferente de estudos anteriores. Esses dados podem ser úteis no planejamento de abordagens cirúrgicas no crânio e também na interpretação de imagens radiológicas.

Palavras-chave: anatomia, astério, crânio, Brasil.