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Research Article

Morphometric features of asterion in adult human skulls

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ABSTRACT

Background: Asterion is the meeting point of temporal, occipital and parietal bones on the posterolateral surface of skull and surgically an important point of reference for approaching the posterior cranial fossa structures. However surgeons have been skeptical about its reliability due to population based differences in its morphology, distance with other external landmarks and also to sigmoid and transverse sinuses.
Methods: In this study 50 (27 male & 23 female) adult skulls were investigated to determine the type of asterion, its distance from important bony landmarks and also the nearby venous sinuses were measured.
Results: Our study revealed that type II (absence of sutural bones) was commoner than type I (presence of sutural bones) asterion. The asterion was 4.82 ± 0.58 cm from tip of the mastoid process on the right side and 4.70 ± 0.70 cm on the left. It was greater in males than in females, p value being statistically significant (P = 0.00 & P = 0.02 for right & left sides respectively). The distance of asterion from supramastoid crest was 4.22 ± 0.73 cm on the right and 4.23+/-0.58 cm on the left. The distance in males was more than in females. The P value 0.00 was statistically significant on the right side. Regarding the position of the asterion in relation to transverse sinus, it was on the transverse sinus in 62% cases, below it in 32% and above in 6%.
Conclusions: The data obtained shows that the asterion is located either at the level or below the level of the transverse sinus in majority of the cases. This information is useful to neurosurgeons to reduce the risk during posterior cranial fossa surgeries. This work will also be useful to anthropologists, forensic science experts for determination of sex of the skull along with other parameters.

Keywords: Asterion, Transverse sinus, Mastoid process, Approach to posterior cranial fossa

INTRODUCTION

Asterion is the confluence of the temporal, occipital and parietal bones on the posterolateral surface of the skull. It is the site of the posterolateral or mastoid fontanellae during the neonatal period which fuses at the end of first year.[1] The asterion is closely related to the transverse and sigmoid sinus internally. The posterior cranial fossa consists of dense collection of neurovascular structures in a compact area. Invasive approaches to this region make it a very risky entity because of the presence of a number of venous sinuses. A missapproach to the posterior cranial fossa may result in high incidence of bleeding, thromboembolism & infection during or after various neurosurgical procedures. So a thorough knowledge of the relations of the various surface landmarks on the posterolateral surface of the skull becomes imperative to avoid inadvertent injury or to access the intracranial structures.

The important points of reference on the posterolateral surface of the skull are asterion, inion, apex of the mastoid process & suprameatal crest. The objectives of the present study were to determine the type of asterion depending on the presence or absence of sutural bone, to measure the linear distances of asterion from various

bony landmarks, the nearest distance of the same from sigmoid & transverse sinus and also the thickness at the centre of the asterion that may be of importance to anthropologists, anatomists, forensic pathologists & neurosurgeons.

METHODS

A total of 50 skulls (27male & 23 female) available in the department of anatomy, M.M.C & R.I, Mysore were used for the study. Sexing of the skulls was done based on morphological features.

The type of asterion was determined as type I or type II depending on the presence or absence of sutural bone respectively (Figure 1, 2). The following measurements were taken bilaterally using digital vernier calipers with an accuracy of 0.01 mm, divider & a standard measuring scale.

1) AMP: Distance from the centre of the asterion to tip of the mastoid process

2) AI : Distance from the centre of the asterion to inion

3) ASC: Distance from the centre of the asterion to supramastoid crest

4) ASS: Nearest distance from the centre of the asterion to sigmoid sinus internally

5) ATS: Nearest distance from the centre of the asterion to transverse sinus internally

6) T: Thickness of asterion at its centre (Figure 3, 4)

The thickness, ASS and ATS were measured after removal of the vault of the skull. The centre of a circle with smallest radius connecting the corners of sutural bone was considered the centre in case of type II asterion. All the readings were taken twice & then averaged so as to minimize the errors. The data was analysed using SPSS software. Gender & side assessments were done using Mann Whitney U test. The transverse sinus above, below or at level in relation to asterion was also noted.

Figure 1: Type I asterion (Presence of sutural bones).

Figure 2: Type II asterion (Absence of sutural bone).

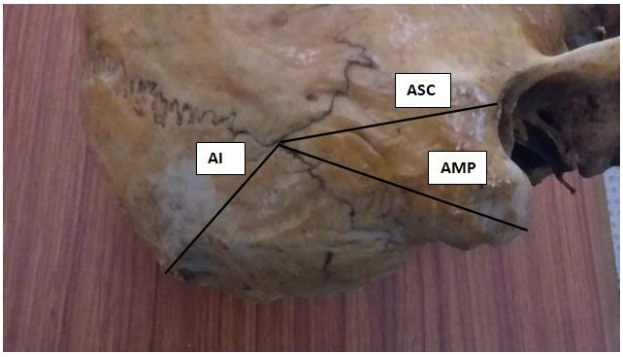

Figure 3: Measurement of asterion from AI: inion, ASC: supramastoid crest, AMP: mastoid process on right side of posterolateral surface of skull.

Figure 4: Measurement of thickness (T) of asterion.

RESULTS

The incidence of type II asterion (absence of sutural bone) was 74.1% in males & 71.7% in females and type I (presence of sutural bone) was 25.9% in males & 28.2% in females (Table 1). 35% of skulls were observed to have type II asterion bilaterally & 12% were found to have type I bilaterally. Type I was more common on right whereas type II was more frequently seen on left side (Table 2). AMP was greater in males bilaterally than in females. The P value were statistically significant (P = 0.00 on right side and P = 0.02 on the left side). The AI was more in females bilaterally than in males. The difference was not statistically significant. The ASC was more in males bilaterally than in females. The difference

was statistically significant on right side (P = 0.00). The ASS was more in females than in males on right and vice versa on the left side. The difference was not statistically significant. The ATS was more in the males bilaterally than in females. The difference was not statistically significant. The thickness of the asterion was more in females on right and the same was more on left in males. The difference was not statistically significant (Table 3).

Table 1: Incidence of different types of asterion.

Gender	Type I (presence of sutural bone) (%)	Type II (presence of sutural bone) (%)
Male (n=54)	14 (25.9%)	40 (74.1%)
Female (n=46)	13 (28.2%)	33 (71.7 %)

Table 2: Frequency of different types of asterion on right & left sides.

Side	Type I (%)	Type II (%)
Right (n=50)	15 (30%)	35 (70%)
Left (n=50)	12 (24%)	38 (76%)

Table 3: Mean and associated standard deviation of various measurements with P values.

Sl. No.	Parameter	Mean ± SD		P value
		Male (n=27)	Female (n=23)	
1	AMP-r	5.09 ± 0.49	4.55 ± 0.67	0.001*
	AMP-l	4.85 ± 0.85	4.55 ± 0.55	0.026*
2	AI-r	5.58 ± 0.95	5.89 ± 0.76	0.121
	AI-l	5.69 ± 0.85	5.70 ± 0.79	0.470
3	ASC-r	4.33 ± 0.84	4.12 ± 0.63	0.007*
	ASC-l	4.28 ± 0.75	4.18 ± 0.42	0.182
4	ASS-r	1.31 ± 0.60	1.35 ± 0.74	0.770
	ASS-l	1.44 ± 0.72	1.23 ± 0.67	0.441
5	ATS-r	0.75 ± 0.67	0.52 ± 0.70	0.144
	ATS-l	0.71 ± 0.72	0.56 ± 0.64	0.397
6	T-r	0.89 ± 0.32	0.91 ± 0.27	0.647
	T-l	0.90 ± 0.28	0.89 ± 0.19	0.612

DISCUSSION

Among all the various population groups studied type II asterion was more common than type I. The incidence of type I was more frequent in Indians, Kenyans, Mexicans & Australians compared to Americans & Turks. The mechanism for the formation of sutural bones is still debated. Some authors believe that some pathological factors like hydrocephalus have a role to play in the formation of sutural bones.[2] Some others have mentioned the role of certain genes like MSX2 in the craniofacial morphogenesis.[3] The reason for the variations in different ethnic population could be genetic or environmental (Table 4).

Table 4: Types of asterion in various population groups.

Population	N=skulls	Type I (%)	Type II (%)
Berry & Berry[8] North America 1967	50	12	88
Berry & Berry[8] South America 1967	53	7.5	92.5
Berry & Berry[8] Egypt 1967	250	14.4	85.6
Berry & Berry[8] India - Burma 1967	51	14.7	85.3
Berry & Berry[8] India - Punjab 1967	53	16.9	83.1
Kellock & Parsons[9] Australia 1970	-	19.8	80.2
Gumusburun[10] Turks1997	302	9.92	90.08
Mwachaka[2] Kenya 2009	79	20	80
Saheb[11] India 2011	125	23.15	76.85
Singh R[3] India 2012	55	16.36	83.64
Sudha[12] India 2013	150	8	92
Leon[7] Mexico 2013	88	25.6	74.4
Present study India 2014	50	27	73

Table 5: Mean ± SD of various distances in cm.

Study	AMP	AI	ASC	T
Leon[7] Mexico 2013	5.13±0.5	7.4±0.7	-	-
Day[4] USA 2000	4.9±0.5	-	-	-
Martinez[6] Spain 2005	4.9±0.5	6.4±0.7	-	-
Ucerler[13] Turkey 2006	5.12±0.5	-	-	-
Xia[14] China 2007	5.03±3.4	-	4.84±2.9	0.49±0.12
Suazo[15] Brazil 2008	4.9±2.7	-	-	-
Mwachaka[16] Kenya 2010	4.7±3.2	-	-	-
Selman[17] Iraq 2011	4.63±0.4	-	-	-
Present study 2014	4.76±0.6	5.7± 0.8	4.22±7.3	0.89±0.23

The mean and SD of AMP, AI, ASC and T were comparable with the measurements of earlier studies. The difference in reading in different populations can be attributed to difference in racial features (Table 5). Day et

al. found the level of the transverse sinus to be at the same level as asterion in 61% cases, Uz A et al. found it to be 54%, Martinez et al. found the same to be in 76.2% cases and Leon found it to be 82.4% cases.[4-7] The present study shows again majority i.e. in 62% cases the transverse sinus to be at the level of the asterion and below in 32%. Therefore in posterolateral approaches the burr hole should be located away from the asterion preferably posteroinferiorly (Table 6).

Table 6: Relationship of the asterion with transverse sinus.

Study	Level of TS (%)	Below TS (%)	Above TS (%)
Day et al.[4] 2000	61	39	-
Uz A et al.[5] 2001	54	44	2
Martinez et al.[6] 2005	76.2	23.8	-
Leon[7] 2013	82.4	12.5	5.1
Present study 2014	62	32	6

According to the present study type II asterion was the commonest (73%). The presence of the accessory sutural bones should be kept in mind by radiologists & neurosurgeons while interpreting X-rays. The type of asterion & its average distance from key bony landmarks does not differ much from that of other populations. A thorough knowledge of location & morphometric features of transverse & sigmoid sinus with other superficial landmarks is essential during posterlateral approaches to the posterior cranial fossa. The measurements of asterion with other bony landmarks provide database for the clinical-surgical practice & also for forensic & anthropological application.

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