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Research article

Study of anatomical variation of asterion in human dry skulls and its surgical importance

Saravana Kumar S*, Lalitha R, Gnanavel A

Meenakshi Medical college Hospitals & Research Institute, Chennai, Tamil Nadu, India

ABSTRACT

Asterion is the meeting point of temporal, occipital, and parietal bones on the posterolateral surface of the skull. This point is surgically important in various posterior cranial fossa surgeries since it is a smaller delicate area where many vital structures are present. The Neurosurgeons have been doubtful about its accuracy due to population-based differences in its morphology and its location with relationship to sigmoid and transverse sinuses. In this study 100 (54 male & 46 female) adult skulls were measured to accurately the type of asterion, its distance from important bony landmarks, and also the nearby venous sinuses were measured. Our study revealed that type II (absence of sutural bones) is the commonest type when compared to type I (presence of sutural bones) asterion. The asterion was 4.82 ± 0.58 cm from the apex of the mastoid process on the right side and 4.70 ± 0.70 cm on the left. It was higher 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 is 4.22 ± 0.73 cm on the right and 4.23+/-0.58 cm on the left. The distance in males is higher than in females. The position of the asterion in relation to transverse sinus was at the level of the transverse sinus in 74.67% of cases, and inferior to the asterion in 22.41%, and superior to the asterion in 2.92%. The measure taken reveals that the asterion is located either at the level or below the level of the transverse sinus in the majority of the cases. This information is useful to neurosurgeons to minimize the risk during posterior cranial fossa surgeries. This study is useful for anthropologists, forensic science experts for the determination of the sex of the skull along with other parameters.

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

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Correspondence: Dr S Saravana Kumar * ✉ saraanatomy@gmail.com

Meenakshi Medical college Hospitals & Research Institute, KK Nagar, Chennai, Tamil Nadu, India

INTRODUCTION

Asterion is the junction of the parietal, temporal and occipital bones. [1]. During any surgical procedure in posterior cranial fossa the asterion is given high importance for various vital structures present in it. The posterior cranial fossa is framed by important venous structures such as the superior, occipital and lateral petrous sinuses and its confluence. The lateral venous sinus is large and originates in the confluence of the sinuses. The right lateral venous sinus is the continuation of the superior sagittal sinus and the left lateral sinus is the continuation of the straight sinus. The right and left venous sinus continue as on the inferolateral part as sigmoid sinus. This sinus is present on the mastoid portion of the temporal bone. This sigmoid sinus continues as the superior bulb of the internal jugular vein. [2].

The anatomical areas used in posterior cranial fossa surgeries asterion, external occipital protuberance, supramental crest, apex of the mastoid process, root of the zygomatic arch, Frankfurt horizontal plane, and the mastoid foramen. These reference points are of much importance in neuro surgical procedures to spot the point where the commencing trepanning will be done.

The posterior cranial fossa is a very smaller area where many vital neurovascular structures are present. This smaller delicate area is prone for accidents and brain tumors which are approached through surgical intervention. [3-5].

According to Gray's the Anatomy, [6], the sutural bone is developed from the additional ossification centers which occur with in or near the sutures. According to Hess, [7], Finkel [8] the sutural bones will result in pathological condition called as hydrocephalus. The study of Opperman et al, [9], show that there is a close organization between developing Duramater and skull bones. During sutural transplants of the foetal intact Duramater, their exists continuous fibrous suture between growing skull bones, but if the transplant is done on with the foetal Duramater which is removed the bony fusion occurs. This synergy of underlying Duramater with the developing calvarial bones has been demonstrated experimentally in

rabbit models. The Duramater promotes the location and preservation of sutures. It can also re-pattern the appearance and position of the bones and sutures of the cranial vault after evacuation of skull in the neonate.

According to Murphy, [10], Pal & Routal [11] the development of the sutural bones is genetically determined. Although the control pattern of articulation of sutural bones is not known. The MSX2 gene, which conceal a home domain transcription factor, plays a crucial role in craniofacial morphogenesis by influencing fusion of sutures. [12]. This study of asterion morphology will be useful for neurosurgeons and otorhinolaryngologist.

MATERIAL AND METHOD

100 skulls (54male & 46 female) available from the Department of anatomy, Meenakshi Medical College Hospitals and Research Institute, were used for this study. Sexing of the cranium was done based on morphological features. The category of asterion was determined as type I or type II depending on the presence or no presence of sutural bone respectively (Figure 1, 2). The following parameters were recorded bilaterally using Vernier calipers with an accuracy of 0.01 mm, divider & a standard measuring scale.

1) AMP: Distance from the middle of the asterion to apex of the mastoid process
2) AI: Distance from the middle of the asterion to inion.
3) ASC: Distance from the middle of the asterion to supramastoid crest (Figure 3).
4) ASS: Nearest distance from the middle of the asterion to sigmoid sinus internally.
5) ATS: Nearest distance from the middle of the asterion to transverse sinus internally.
6) T: Thickness of asterion at its center (Figure 4).

Figure 1: Presence of sutual bones – type I

The thickness, ASS and ATS were measured after removal of the cranial. The center of a circle with smallest radius connecting the corners of sutural bone was considered the center in case of type II asterion. All the readings were taken twice. The averages of the two measurements were taken to minimize the errors. The data was analyzed 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 2: Absence of sutural bones, bones – type II

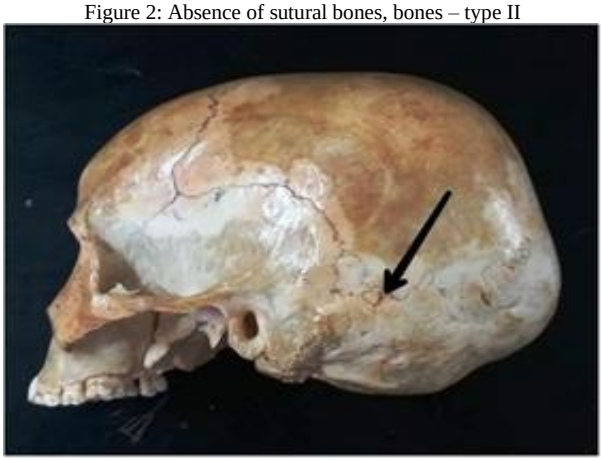


Figure 3: Measurement of asterion from ai: inion, asc: Supramastoid crest, amp: mastoid process on right side of posterolateral surface of skull

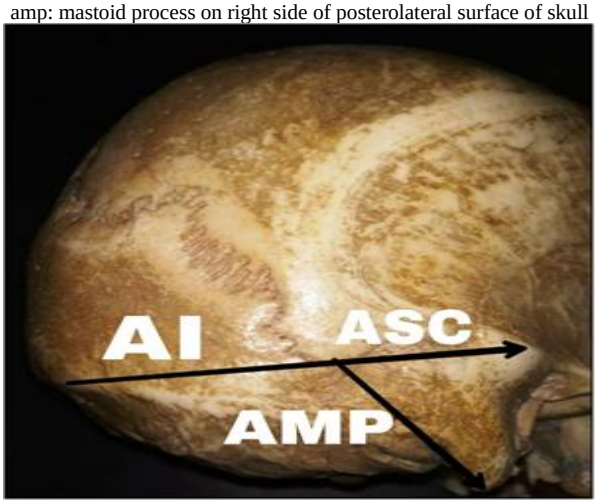
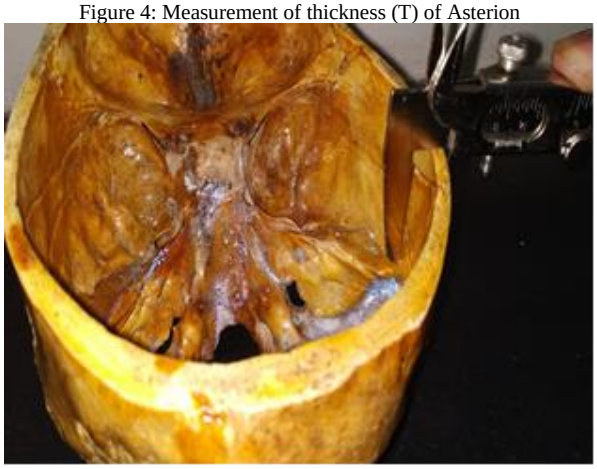


Figure 4: Measurement of thickness (T) of Asterion



RESULT

The prevalence of type II asterion (absence of sutural bone) was 74.1% in males & 71.7% in females and type I (existence 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 be type I bilaterally. Type I is the most common type on right side, and type II is seen commonly on left side (Table 2).

Table 1: Incidence of presence or absence of Asterion

Gender	Type I Presence of sutural Bones (%)	Type II Absence of Sutural Bones (%)
Male (n=54)	14 (25.9%)	40 (74.07%)
Female (n=46)	14 (30.43%)	32 (69.56%)

Table 2: Prevalence of different types of Asterion on right and left sides

Side	Type –I (%)	Type – II (%)
Right (n=100)	30 (30%)	70(70%)
Left (n=100)	24 (24%)	76 (76%)

AMP was higher 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 is high in females bilaterally than in males. The difference was not statistically significant.[16]. The ASC was more in males bilaterally when compared to the females. The difference was statistically significant on right side (P = 0.00). The ASS is high in females when compared to the males on right and vice versa on the left side. [17]. The difference was not statistically significant. The ATS was more in the males bilaterally when compared to the 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. [18]. The difference was not statistically significant (Table 3).

Table 3: Mean and associated S.D. of various measurements with p-values

Parameter	Mean ± SD Male (n=27)	Mean± SD Female (n= 23)	p-Value
AMP-r	5.09 ± 0.49	4.55± 67	0.0001
AMP-l	4.85± 0.85	4.55 ± 55	0.026
AI-r	5.58± 0.95	5.89± 76	0.121
AI-l	5.69± 0.85	5.70± 79	0.470
ASC-r	4.33± 0.84	4.12 ±63	0.007
ASC-l	4.28± 0.75	4.18± 42	0.182
ASS – r	1.31± 0.60	1.35± 74	0.770
ASS- l	1.44± 0.72	1.23± 67	0.441
ATS - r	0.75± 0.67	0.52± 70	0.144
ATS- l	0.71± 0.72	0.56 ±04	0.397
T-r	0.89 ±0.32	0.91± 27	0.647
T-l	0.90± 0.28	0.89± 19	0.612

Table 4: Relation Ship of Asterion with transverse sinuses

No. of. Skulls	At the Level of TS (%)	Superior to the Level of TS (%)	Inferior to the Level of TS (%)
100	74.67	22.41	2.92

DISCUSSION

Among all the various population groups studied type II asterion was the commonest type. The prevalence of type I was more frequent in Indians, Kenyans, Mexicans & Australians compared to Americans & Turks. [19,20]. 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. [13]. Few authors had explained the role of certain genes like MSX2 in the craniofacial morphogenesis. [14]. The reason for the variations in different ethnic population could be genetic or environmental Table 5 [15]. The mean and SD of AMP, AI, ASC and T were comparable with the measurements of earlier studies.[21].

Table 5: Comparison of prevalence of Asterion in various population groups

Author	N= Skulls	Type I (%)	Type II (%)
Berry & Berry [19] North A 1967	50	12	88
Berry & Berry [19] South A 1967	53	7.5	92.5
Berry & Berry [19] Egypt 1967	250	14.4	85.6
Berry & Berry [19] India – Burma	51	14.7	85.3
Berry & Berry [19] India-Punjab	53	16.9	83.1
Kellock & Parsons [0]Australia	-	19.8	80.2
Gummnusburun [21] Turks 1997	302	9.92	90.08
Mwachaka [13] Kenya 2009	79	20	80
Saheb [22] India 2011	125	23.15	76.85
Singh R [14]India 2012	55	16.36	83.64
Sudha [23] India 2013	150	8	92
Leon [7]Mexico 2013	88	25.6	74.4
Present study 2019	100	27	73

The difference in reading in different populations can be attributed to difference in racial features (Table 6).

Table 6: Mean ± sd of various distances in cm

Study	AMP	AI	ASC	T
Leon [18] Mexico 2013	5.13± 0.5	7.4 ±0.7	-	-
Day [15] USA 2000	4.9± 0.5	-	-	-
Martinez [17] Spain2005	4.9± 0.5	6.4± 0.7	-	-
Ucerler [24] Turkey 2006	5.12± 0.5	-	-	-
Xia [25] China 2007	5.03± 3.4	-	4.84± 2.9	0.49 ±0.12
Suazo [26] Brazil 2008	4.9± 2.7	-	-	-
Mwachaka [27] Kenya 2010	4.7± 3.2	-	-	-
Selman [28] Iraq 2011	4.63± 0.4	-	-	-
Present Study	4.76± 0.6	5.7± 0.8	4.22 ±7.3	0.89± 0.23

Day et al. found that the location of the transverse sinus is at the same level of the 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 found it to be 82.4% cases.4-7 The current study shows again majority i.e. in 74.67% cases the transverse sinus is at the level of the asterion and below the transverse sinus in 22.41%. Therefore, in posterolateral approaches of neurosurgeries the burr hole should be located away from the asterion preferably posteroinferiorly (Table 7).

Table 7: Relationship of Asterion with transverse sinus

Study	Level of TS (%)	Below level of TS (%)	Above Level of TS (%)
Day et al [15] 2006	61	39	-
UZ. A et al [16] 2001	54	44	2
Martinez et al [17] 2005	76.2	23.8	-
Leon [18] 2013	82.4	12.5	5.1
Present Study	62	32	6

According to this study type II asterion frequency was high when compared to Type I (72%). [23,24,25]. The occurrence 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 did not vary from that of another race. [26]. A detailed insight of location &

morphometric features of transverse and sigmoid sinus with other superficial landmarks is essential during posterolateral approaches in the posterior cranial fossa. These measurements of asterion provide a vital database for neurosurgeons, otorhinolaryngologist, forensic experts and anthropologist.[27].

CONCLUSION

The present study results will be helpful for the neurosurgeons on the posterior cranial fossa through the craniometrical point. Also, for the radiologist in interpreting the images of fractured skulls. Further, it can also be useful for identification of human male and female skulls in association with other parameters. This result may also helpful to Anthropologists and forensic experts in their practice.

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