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## ANATOMICAL VARIATIONS IN THE FORMATION OF PTERION AND ASTERION IN SOUTH INDIAN POPULATION

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### ABSTRACT

**Background of the study:** Pterion is an H-shaped sutural convergence formed by frontal, parietal, temporal and sphenoid bones of the skull. Pterion is common site for the formation of accessory or epiteric bones which may be a pitfall when misinterpreted as fractures in radiological study. The sutural point formed by the junction of the parietal, temporal and occipital bones are called asterion. The asterion is a vital surgical landmark for the location of ending of transverse sinus and beginning of sigmoid sinus. These reasons motivated us to study the pterion and asterion in south indian population and note its variation. **Aim of the study:** To analyse the anatomical variations in the formation of pterion and asterion in south indian population.

**Materials and method:** The present study was done in 150 dry human adult skulls from the bone bank of anatomy departments of Annapooranna medical college, Vinayaga missions kirupananda variyar medical college, Vinayaga missions homeopathy medical college, salem. The sutural pattern of the pterion in left and right sides of each skull bone was noted based on the descriptions by Murphy (sphenoparietal, frontotemporal, stellate and epiteric types). The asterion and its types: Type I when a sutural bone is present and type II where sutural bone is absent, was observed and recorded.

**Observation:** Sphenoparietal type of sutural pattern was observed in 80%. Asterion type I was observed in 7.6%. **Conclusion:** Pterion pattern in south indian population revealed that sphenoparietal type (80%) of pterion is the most common presentation found regionally and internationally. 11% of epiteric type of pterion was observed. Asterion type I (7.6%) was noted in this study.

**Keywords:** Sphenoparietal, Epiteric bone, Frontotemporal, Stellate, Accessory bone

### INTRODUCTION

H-shaped<sup>1</sup> sutural bony convergence of frontal, parietal, temporal and sphenoid bones of the skull constitutes the pterion. Pterion is located on each side of the skull at a distance of 4.0cm above the zygomatic arch and 3.5cm behind frontozygomatic suture. It is a common site for the formation of accessory or epiteric bones which may jeopardize or be a pitfall<sup>2</sup> for the interpretation and intervention in the treatment of fractures. It is an imperative landmark just superficial to the vital meningeal

vessels, functional motor speech area, lateral sulcus etc. Direct or indirect blow to the pterion may result in fracture causing epidural haematoma<sup>3</sup> which may need burr hole evacuation. Pterional approach for surgeries in middle and anterior cranial fossa, stenting aneurysm or excising tumours are done better than supraorbital approach<sup>4</sup>.

Murphy<sup>5</sup> describes four types of pterion: 1. Sphenoparietal, 2. Frontotemporal, 3. Stellate and 4. Epiteric. The occurrence of pterion type varied significantly on the left and right sides of

the skull<sup>6</sup>. In Indian population studies stellate type of pterion is reported around 5%<sup>7</sup> whereas international population like Kenyans<sup>8</sup> report 7%, Korean<sup>9</sup> and Nigerian<sup>10</sup> population have found 0%. Saxena R.C<sup>7</sup> reports 0% incidence of epiteric type of pterion in north Indian adult population while Chirag<sup>11</sup> observed 11.3% of epiteric type in Gujarat population.

The asterion is a sutural convergence of the parietal, temporal and occipital bones. It helps to locate the termination of transverse sinus and beginning of sigmoid sinus. Asterion is an important key for surgical approaches<sup>12</sup> to the posterior cranial fossa. The sutural morphology is classified into two types<sup>8</sup>, Type I when a sutural bone is present at its convergence and type II when sutural bone is absent. Asterion Type I incidence is reported as 20% by Mwachaka PM<sup>8</sup> and 23.15% by Hussain<sup>13</sup>.

Sutural pattern formation and variations differ regionally and internationally. Knowledge of the types and anatomical variations in the formation of pterion and asterion pattern will be a significant aid to the neurosurgeons. Present study aims to worthfully fulfill it by doing a frontier study of pterion and asterion in South Indian population along with comparison among regional and international population.

#### **Aim of the study:**

To analyse the anatomical variations in the formation of pterion and asterion in South Indian population.

#### **MATERIALS AND METHOD**

The present study was done in 150 dry human adult skulls of unknown sex from the bone banks of anatomy departments of Annapoorana medical college, Vinayaka mission's Kirupananda Variyar medical college, Vinayaka mission's Homeopathy medical college, Salem. The present study was done after obtaining ethical clearance from the Institutional ethical committee of Annapoorana medical college. The sutural pattern of the pterion in left and right sides of each skull was noted

based on the descriptions by Murphy's<sup>5</sup>: 1-Sphenoparietal, 2-Frontotemporal, 3-Stellate and 4-Epipteretic types. The sphenoparietal type is defined as a sutural pattern in which the sphenoid and parietal bones are in direct contact. Frontotemporal type is a sutural pattern in which the frontal and temporal bones are in direct contact. The Stellate type is characterized by articulation of four bones (frontal, parietal, temporal and sphenoid) at a point. The Epipteretic type is defined by presence of a small sutural bone between the parietal bone and the greater wing of the sphenoid bone. The Asterion and its types: Type I when a sutural bone is present and type II where sutural bone is absent, was observed and recorded. Skull bone without any obvious evidences of dystrophy, deformities or trauma was considered as inclusion criteria. Bones with breakage or advanced synostosis was excluded from the study. Parameters of the study were 1. Type of Pterion pattern and 2. Type of Asterion pattern in right and left sides of the skull.

#### **RESULTS**

##### **1. Type of Pterion pattern: Table 1, Figures: 1,2,3,4.**

Murphy's sphenoparietal, frontotemporal, stellate and epiteric type of pterion pattern were observed. The sphenoparietal type was found to be most prevalent, 78.6% on the right side and 81.3% on the left side. The sphenoparietal type of pterion was found bilaterally (symmetrically) on both right and left sides in the same individual skull in 62%. The frontotemporal (4%) and stellate (6%) type of pterion occurred more on the left side while the epiteric type (14%) was found more on the right side. The stellate pterion was the least type of pterion found bilaterally (symmetrically).

##### **2. Type of Asterion pattern: Table 2, Figure: 5.**

Type I asterion was observed in 8.6% on the right side and 6.6% on the left side of the skull. Type I asterion was found bilaterally (1.6%) (symmetrically) in skulls with

epiteric and frontal temporal type of pterion. The type II variety occurred in 91% on the right side and 93 % on the left side.

### **DISCUSSION: Table :3,4,5.**

Murphy's<sup>5</sup> sphenoparietal, frontotemporal, stellate and epiteric types of pterion were observed in the south Indian population. The present study findings were compared with previous studies regionally and internationally in the table no:3,4,5. Inference was that sphenoparietal type of presentation is the most dominantly observed among all the pterion types in regional and international studies. In the present study sphenoparietal type of pterion was found symmetrically (bilaterally) in 62% and asymmetrically (unilaterally) in 80% which coincided with the findings of Oguz<sup>6</sup> and contradicted Saxena<sup>7</sup>.

In the Indian regional studies the percentage of sphenoparietal type in the present study (80%) was found to be less than Chirag<sup>11</sup> in Gujarat population (96.9%) but greater than Hussain<sup>13</sup> (69.25%). The incidence of sphenoparietal type do not coincide with previous south Indian population study done in 1993 by Manjunath<sup>14</sup>. Reason could be due to differing sample size.

Frontotemporal pterion percentage in asymmetrical (3 %) side was found least and similar to international population like Japanese<sup>15</sup> (2.6%) and Turks<sup>2</sup> (3.47%). In regional studies it coincided with findings of Saxena<sup>16</sup> (3.46%) and Manjunath<sup>14</sup> (3.52%) and differed with Hussain<sup>13</sup> (17.3%). The reason is squamous part of the temporal bone gets incorporated into the greater wing of the sphenoid bones in the process of evolution resulting in sphenoparietal type more common in humans and biped primates<sup>18</sup> than frontotemporal type<sup>6,7</sup> common in nonhuman primates<sup>6,7,15,16,17</sup>.

Stellate type of pterion incidence (5.3%) in the present study was similar to Nigerian<sup>7,9</sup> population but significantly more than Korean<sup>9</sup>

population. Present study stellate incidence (5.3%) coincided regionally with findings of Saxena<sup>16</sup> (5.17%) in north Indian population and differed from Hussain<sup>13</sup> (9.7%) Indian and Manjunath<sup>14</sup> (2.93%) south Indian population.

Epiteric or accessory bone incidence (11.3%) in the present study was less than Korean (40%) population, coincide with findings of Chirag<sup>11</sup> (11.73%) in Gujarat population and differed with Manjunath<sup>14</sup> (17.8%) and Ankur<sup>18</sup> (4.8%).

In a same region the percentages of pterion type differ in some groups and are analogous to some groups. There were ethnic and regional variations in the pterion type. These may be due to genetic factors (MSX2 gene- home domain transcription factor) and environmental factors<sup>19</sup>. These variations may be due to independent center ossification theory and genetic<sup>19</sup> influence on the fusion of sutures and formation of pterion. Genes play a crucial role in craniofacial morphogenesis<sup>20</sup>.

The incidence of type I asterion (7.6%) coincided with the findings of international south American study by Berry<sup>21</sup> and Anatolian-Ottoman Study of Gumsburn<sup>23</sup> differed from other regional and international populations. In the present study bilateral (symmetrical) type I asterion (1.3%) was found to be associated with epiteric and frontotemporal pterion. The development of sutural bones is not implicated clearly and it can also be due to pathological<sup>22</sup> conditions like hydrocephalus or as a part of normal process determined genetically<sup>5</sup>. Asterion type II (92.3%) incidence was similar to the south Americans<sup>21</sup> and Turks population. This study is limited by the sample size and its correlation with sex of skull bone. In future studies these limitations will be considered and revised.

### **CONCLUSION**

Sphenoparietal type of pterion was found to be the predominant type regionally and internationally. South Indian population recorded 80% of Sphenoparietal type .11% prevalence of

epipteric/accessory sutural bone was observed. Asterion type I was found in 11.3%. Accessory sutural bone incidence should alert radiologist and neurosurgeons when interpreting x rays or surgically correcting a fracture. This study will definitely be an aid to the research anatomists .

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**Table no: 1 Type of Pterion patterns in South Indian population in the present study**

Pterion pattern	Unilateral /Asymmetrical side				Bilateral / Symmetrical side		Asymmetrical sides	
	Right side		Left side				Total	Average
	N= 150	%	N= 150	%	N= 150	%	N= 300	%
Sphenoparietal	118	78.6	122	81.3	93	62	240	80
Frontotemporal	4	2	6	4	2	1.3	10	3
Stellate	7	4.6	9	6	1	0.6	16	5.3
Epiptereric	21	14	13	8	5	3	34	11.3

**Table no:2 Type of Asterion patterns in South Indian population in the present study**

Asterion pattern	Right side		Left side		Bilateral		Total of both sides N= 300	Average %
	N= 150	%	N= 150	%	N= 150			
I	13	8.6	10	6.6	2	1.3%	23	7.6
II	137	91	140	93.3	123	82%	277	92.3

**Table no:3 Comparison of Pterion patterns in different International population with present study**

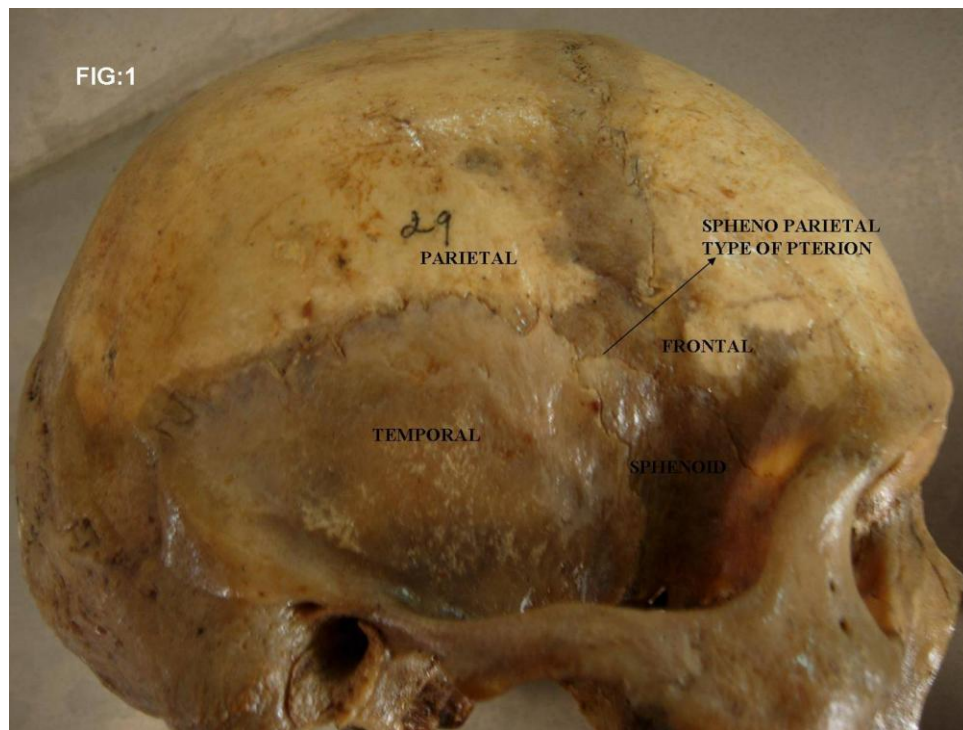
Population groups	Authors	Number of bones	Type of pterion %			
			Spheno parietal	Fronto temporal	Stellate	Epipteric
Australian	Murphy <sup>5</sup> 1956	388	73	7.5	18.5	1
Nigerian	Saxena <sup>16</sup> -1988	40	87.79	10.11	5.06	3.79
Japanese	Matsumura <sup>15</sup> 1991	614	79.1	2.6	17.7	0.6
Nigerian	Asala <sup>10</sup> 1996	212	82.1	23.6	0	40.3
Korean	Lee <sup>9</sup> 2001	149	76.5	0	0	40.3
Turks	Ersoy <sup>2</sup> 2003	300	87.35	3.47	8.98	0.2
Turks	Oguz <sup>6</sup> 2004	26	88	10	2	0
Kenyan	Mwachaka <sup>8</sup> 2009	79	66	15	12	7
SouthIndians	Present study 2013	150	80	3	5.3	11.3

**Table no: 4 Comparison of Pterion pattern in different regional populations of India**

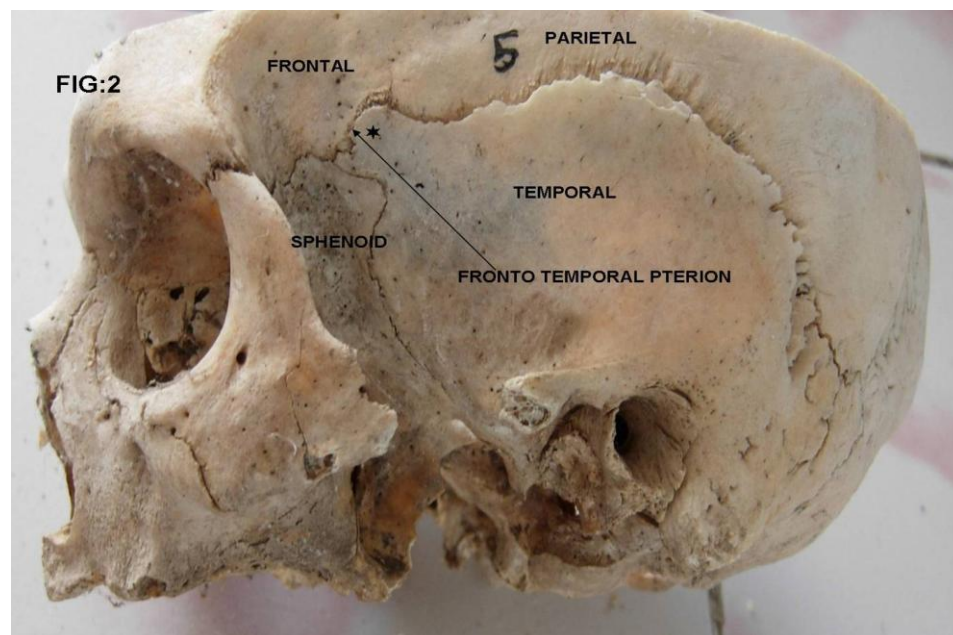
Population groups	Author & year	Number of bones	Type of pterion %			
			Spheno parietal	Fronto temporal	Stellate	Epipteric
Indian	Saxena <sup>16</sup> 1988	72	95.3	3.46	1.38	11.79
South Indian	Manjunath <sup>14</sup> 1993	172	93.55	3.52	2.93	17.3
North Indian	Saxena <sup>7</sup> 2003	203	87.72	10.01	5.17	0
Western Indian	Ankur <sup>18</sup> zalwaldia 2009	42	91.7	2.4	1.2	4.8
Gujarat	Chirag <sup>11</sup> 2011	311	96.9	2.9	0.2	11.73
Indians	Hussain <sup>13</sup> 2011	125	69.25	17.35	9.7	3.7
South Indians	Present study 2013	150	80	3	5.3	11.3

**Table no:5 Comparison of types of Asterion patterns in different Regional and International populations.**

Population groups	Author & year	Number of bones	Type of asterion	
			Type I %	Type II %
North Americans	Berry <sup>21</sup> 1967	50	12	88
South Americans	Berry <sup>21</sup> 1967	53	7.5	92.5
Egyptians	Berry <sup>21</sup> 1967	250	14.4	85.6
Indians -Burma	Berry <sup>21</sup> 1967	51	14.7	85.3
Indians - Punjab	Berry <sup>21</sup> 1967	53	16.9	83.1
Turks	Gumusburun <sup>23</sup> 1997	302	9.92	90.08
Kenyan	Mwachaka <sup>8</sup> 2009	79	20	80
Indians	Hussain <sup>13</sup> 2011	125	23.15	76.85
South Indians	present study 2013	150	7.6	92.3

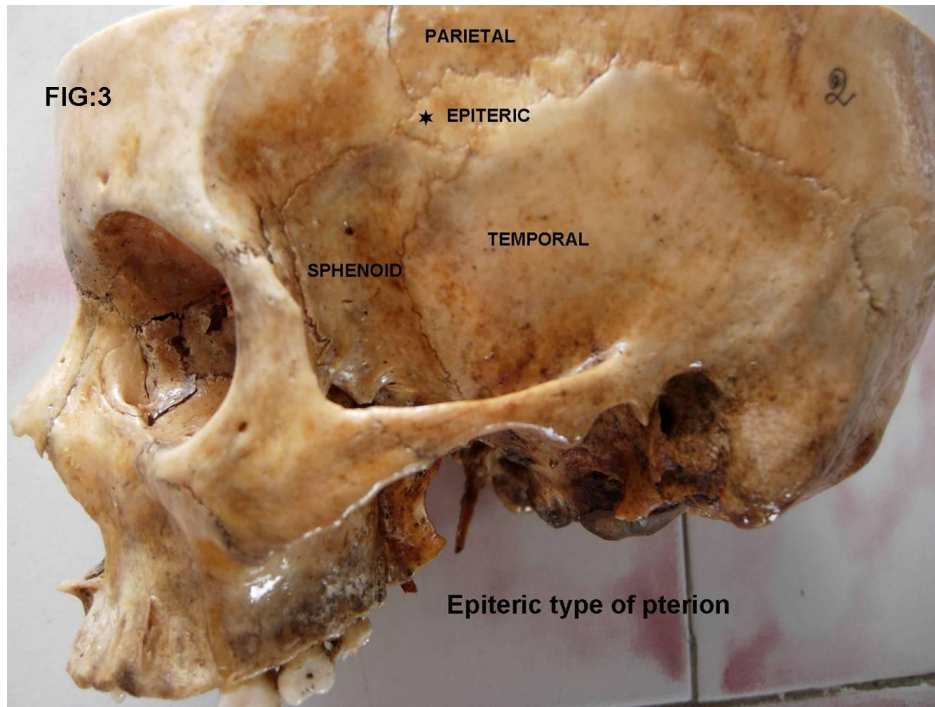


**Figure no:1 Sphenoparietal type of pterion in present south Indian population study.**

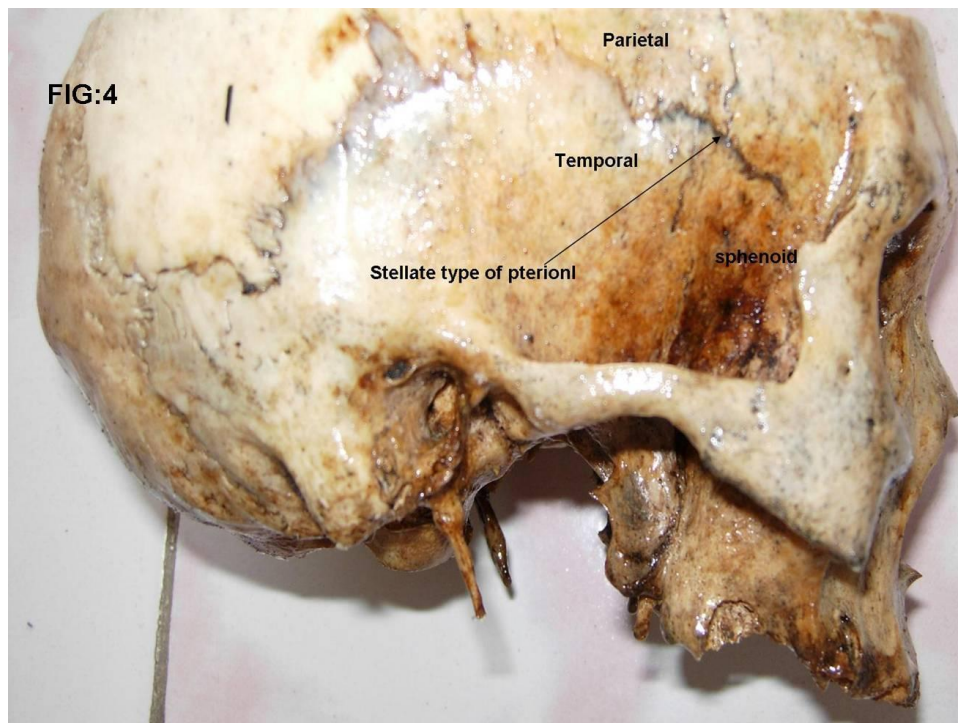


**Figure no:2 Frontotemporal type of pterion in present south Indian population study.**

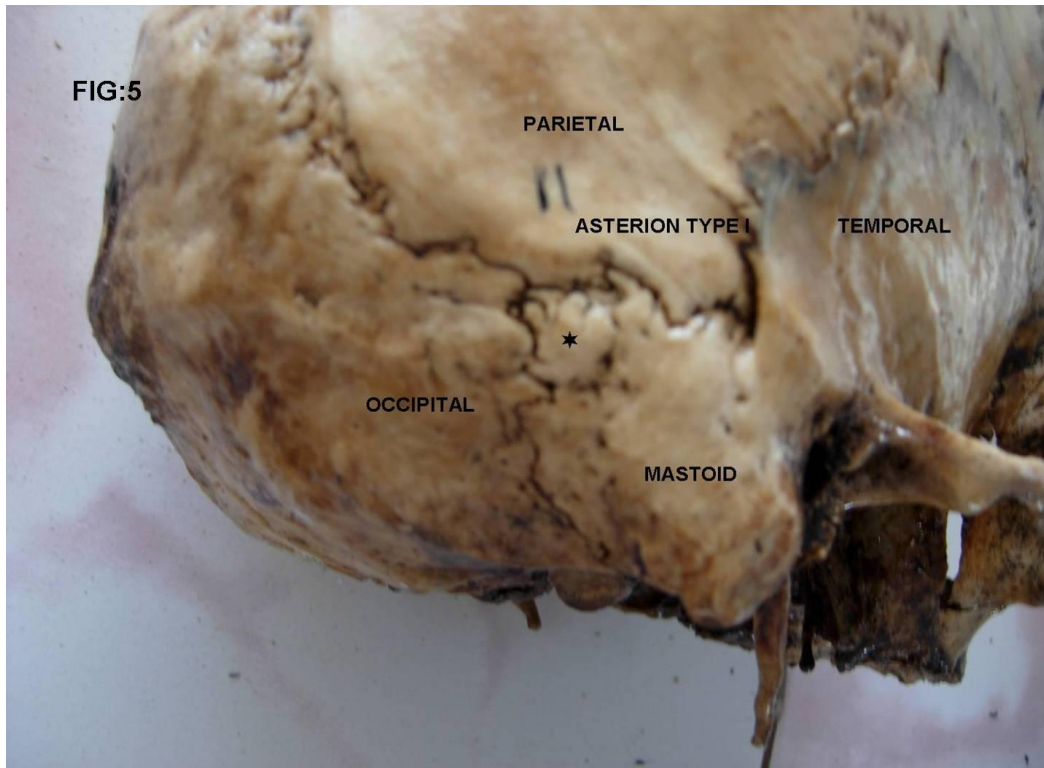




**Figure no:3 Epiteric type of pterion in present south Indian population study.**



**Figure no:4 Stellate type of pterion in present south Indian population study.**



**Figure no:5 Asterion type I pattern in present south Indian population study.**