

## Study of Wormian Bones in Adult Human Skulls

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### **Abstract:**

**Introduction:** Wormian bones or sutural bones are asymmetrical bones that usually occur along the sutures and also anatomical points on the skull where sutures meet

**Methods:** The study comprises of 132 human adult skulls. The, incidence, types, morphology and topography of sutural bones were observed and compared with the studies done by previous authors. The bones were obtained from the Department of Anatomy, TOMCH & RC, Bangalore.

**Results:** Wormian bones were found in Lambdoid suture (45.45%), Lambda (13.63%), Parietomastoid suture (8.33%), Coronal Suture (6.06%), Asterion (5.30%), Sagittal suture (4.54%), Occipitomastoid suture (2.27%), Parietosquamous (2.27%) and Pterion (1.51%). Three different shapes of WBs was witnessed; Quadrangular (52.70%), Irregular (37.83%), Triangular (9.45%). Two different types of edges of WBs was seen; Irregular (56.75%) and Serpigenous (43.24%).

**Discussion:** the knowledge of wormian bones is important to radiologists, orthopedicians and traumatologists as it can imitate fractures and lead to confusion and eventually differential diagnosis.

**Keywords:** Wormian bones, sutures, fractures, skull

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### I. Introduction

Wormian bones are solitary, irregular bones that appear along with regular centres of ossification of cranium. Even though they are unusual, they are not considered to be rare and are noteworthy. The first account of the sutural bones was made by Paracelsus. However, they were named 'Wormian bones' after Olaus Wormian who was a Professor of Anatomy at Copenhagen and also a Danish Physician & Antiquary, described them in a letter to his colleague Thomas Bartholin, who later termed these sutural bones as Wormian bones [1].

These asymmetrical bones are also called as sutural bones as they usually occur along the sutures. They are also given the name Supernumerary bones or ossicles. Wormian bones occur most frequently on the lambdoid suture [2]. They can also be present in anatomical landmarks on the skull like bregma, pterion, asterion or lambda.

Sutural bones are inherited as autosomal dominant traits. WBs are more prevalent in adults than in foetuses. When present in children, they attribute for some diseases and play a role in the primary diagnosis of congenital brittle bone disease called Osteogenesis Imperfecta [1].

A fourfold increased incidence of sutural bones are seen in mentally retarded group than the remaining population [3].

It is said that the number of wormian bones increases as the capacity of the skull increases and this increase in WBs is not associated with the cause of the enlargement of skull. Hence these WBs are formed as an adaptation to enlargement of the cranium [4].

This study aims at reporting the incidence, location and morphology of Wormian bones as it can imitate fractures and lead to confusion to the radiologists and eventually differential diagnosis and hence it is important to surgeons and traumatologists to deal during emergencies.

### II. Materials and methods

The present study was conducted in the Department of Anatomy, TOMCH & RC in 132 fully ossified adult skulls of unknown sex and age. A skull which exhibited no wormian bones is taken as control and the length of sagittal, coronal and lambdoid sutures were noted. Measuring tape, Sliding calipers, sutural thread and scale were used for measuring the length of the sutures.

**All the skulls showing WBs were examined and the following parameters were taken into consideration:**

- a) Incidence of Wormian bones
- b) Sites of Wormian bones found in the present study
- c) Incidence and different shapes of the WBs
- d) Incidence and types of edges of the WBs
- e) Length of coronal, sagittal and lambdoid suture.

The data obtained was compared with the other studies and analysed and photos were taken.

Shape Of Wbs	No Of Skulls	Percentage
Quadrangular	39	52.70%
Irregular	28	37.83%
Triangular	7	9.45%

### III. Results

#### 3.1 The measurements taken in the control skull is as follows:

Sagittal suture – 14 cms

Coronal suture –24 cms

Lambdoid suture – 18.5 cms

In the present study, the length of the sagittal suture in all the skulls showing WBs were a minimum of 11 cms to a maximum of 15 cms. The length of the coronal suture was a minimum of 20 cms to a maximum of 25 cms. The length of lambdoid suture was a minimum of 18 cms to a maximum of 24 cms.

#### 3.2 Incidence of wormian bones

Out of 132 skulls, 74 skulls (56.06%) exhibited WBs of various types, sizes and structure.

#### 3.3 Sites of WBs found in the present study

Sites	No Of Skulls	Percentage
Lambdoid Suture	60 (17 Unilateral, 43 Bilateral)	45.45%
Lambda	18	13.63%
Parietomastoid Suture	11 (6 Bilaterally , 5 Unilaterally)	8.33%
Coronal Suture	8 (6 Bilaterally, 2 Unilaterally)	6.06%
Asterion	7 (6 Unilaterally, 1 Bilaterally)	5.30%
Sagittal Suture	6	4.54%
Occipitomastoid Suture	3 (3 Unilateral)	2.27%
Parietosquamous	3 ( 1 Unilateral & 2 Bilateral)	2.27%
Pterion	2 (1 Unilaterally, 1 Bilaterally)	1.51%

The most common location of WBs in the present study was lambdoid suture. It was found unilaterally in 16 skulls and bilaterally in 43 skulls. Totally, 60 skulls (45.45%) out of 132 examined skulls exhibited WBs in lambdoid suture. [Fig 1]The second most common situation of WBs was in Lambda [Fig 2] where it was found in 18 skulls (13.63%). The least common sites of WBs were situated in the occipitomastoid [Fig 3], parietosquamous [Fig 4] & pterion [Fig 4] where it was found in 3 skulls (2.27%) in the former two and 2 skulls (1.51%) in the latter.

#### 3.4 Shape of wormian bones

Three different shapes of WBs were found; quadrangular, triangular & irregularly shaped WBs. Out of that, quadrangular type [Fig 5] was the most common and it was found in 39 skulls (52.70%), the second most common type was the irregular shaped WBs [Fig 5] where it was found in 28 skulls (37.83%) and the least common type was the triangular shaped WBs [Fig 5] which was found in 7 skulls (9.45%)

#### 3.5 Edges Of The Wormian Bones

Two types of edges were exhibited by the WBs. The first type of WBs are with Serpigenous edges [Fig 6] when they exhibit compactly wavy pattern. The second type of WBs are with irregular edges [Fig 7] where it is wavy, but not compact. Highest number was WBs with irregular edges where it was found in 42 skulls out of 74 skulls (56.75%) and it was followed by WBs showing Serpigenous edges in 32 skulls (43.24%)

Edges	No Of Skulls	Percentage
Irregular	42	56.75%
Serpigenous	32	43.24%



**Fig 1** – showing multiple Wormian bones at Lambdoid suture.



**Fig 2** – showing Wormian bone at Lambda



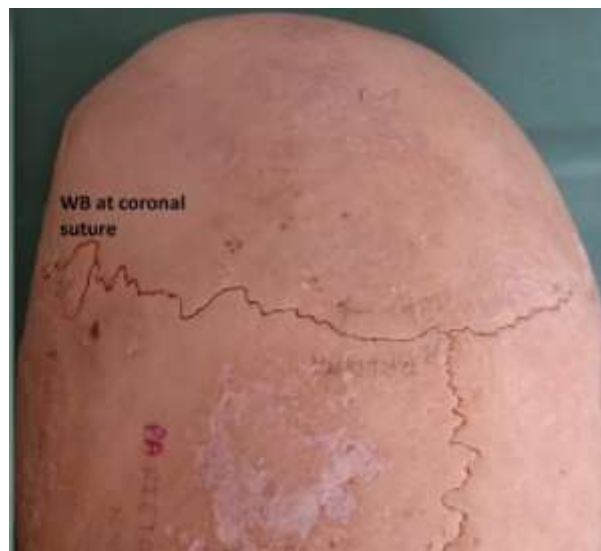
**Fig 3** – showing Wormian bone at Occipitomastoid suture.



**Fig 4** – showing Wormian bone at Parietomastoid suture and Pterion



**Fig 5** – showing wormian bones at Asterion & Pterion



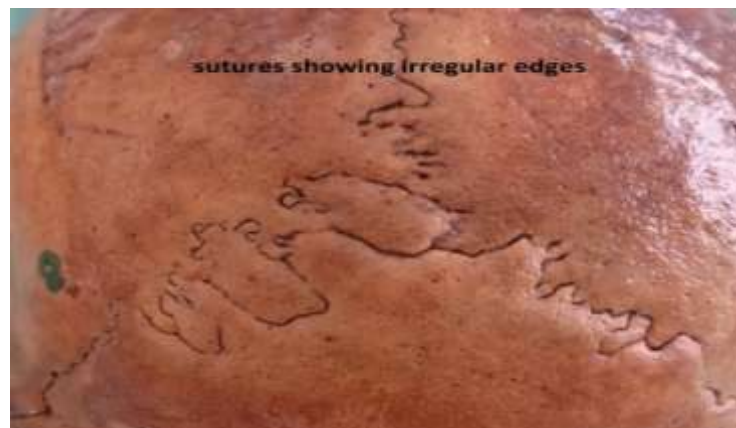
**Fig 6** – showing wormian bones at coronal suture



**Fig 7** – Showing Different Shapes Of Wormian Bones



**Fig 8** – showing sutures with Serpigenous edges



**Fig 9** – showing sutures with Irregular edges

#### IV. DISCUSSION

Mammals descend from primitive reptiles. Due to this evolution, skull bones of mammals undergo numerous changes [5]. WBs are present in some carnivore mammals like dogs and cats [6]. The cranial capacity is indirectly measured by measuring the sutural length. In the present study, there was no significant increase in the length of the sutures compared to the control. Presence of WBs and change in the sutural length are not associated with significant distortion of the skull [7].

##### 4.1 Incidence of Sutural Bones

In the present study, sutural bones were found in 64 skulls (52.4%) out of 132 skulls examined. WBs are more frequently seen in Chinese population compared to western population due to their traditional supine infant sleep position causing brachycephalic deformations in their crania[8]. Some authors also found WBs in 80.3% Chinese skulls [4].

**Table 4** shows the different percentages of incidence of Wormian bones in various studies.

<b>Table 4 – Showing Incidence Of Wbs In Various Studies</b>	
Murlimanju Et Al <sup>9</sup>	73.1%
Sibel Cirpan Et Al <sup>15</sup>	59.3%
Marti Et Al <sup>1</sup>	53%
Walulkar Sanjay <sup>10</sup>	34.22%
A.A Khan <sup>12</sup>	28%
<b>Present Study</b>	<b>52.4%</b>

##### 4.2 Wormian Bones at Different Sutures

In the present study, highest number of WBs was found in the lambdoid suture (45.45%). Second highest number of WBs was found in Lambda (13.63%) and the least number of WBs were found in Occipitomastoid (2.27%), Parietosquamous (2.27%) & pterion (1.51%) WBs were also found in Parietomastoid suture (9.8%), Coronal suture (6.06%), Asterion (5.30%) and sagittal suture (4.54%). None were found in Bregma.

**4.2.1** Lambdoid suture [Fig 1] – WBs in the present study was witnessed most frequently here than any other suture. Murlimanju et al[9] found the highest in lambdoid suture (56.4%) and WalulkarSanjay et

al[10]noticed the same in 74.2% of their specimens. Literature mentions that WBs are most commonly found in lambdoid suture. But, in a study by A.A Khan[11], out of 25 skulls they were found in none. WBs are most common in lambdoid suture because of their rugged nature compared to all the other sutures[12].

**4.2.2 Lambda [Fig 2]** – The second most common site of WBs in the present study is in lambda (13.63%) and it correlates with Walulkar Sanjay's[10] study where the second most common site is also lambda (10.38%). Whereas the second most common site of WBs in some studies was asterion [7, 9]. If WBs are large in size and found near the lambda, they can be called as Inca bone or true interparietal bone[13].

**4.2.3 Parietomastoid suture [Fig 4]** – WBs may appear in parietomastoid suture[14]. In some studies, WBs was not at all found in this suture[7, 9]. In a study in 25 skulls by A.A Khan et al[11], WBs in this suture was found in 2 skulls. But in the present study, it was witnessed in 11 out of 64 skulls (9.8%). This shows that if present in this region, it is less common.

**4.2.4 Coronal suture [Fig 6]** – In the present study, WBs in this location was witnessed in 8 skulls (6.06%). In 6 skulls, it was found on both right and left side and in two skulls it was found only unilaterally. Some studies found none in coronal suture[7], some studies found WBs on coronal suture in very few skulls[9, 11] and some correlates with our study[15].

**4.2.5 Asterion [Fig 5]** – In the present study, they were found in 9.45% (7 skulls). This data correlates with some studies[10, 7, 9] who found WBs in the region of Asterion in 9.09%, 6% &17.9% skulls respectively. A study by Rajani Singh[16] to check the incidence of sutural bones in asterion using 55 skulls led to finding WBs in asterion which were of two types, irregular and approximately triangular shapes. The present study also exhibited these types. It was also stated in this study that WBs in the asterion can lead to complications during cranial surgery via this point.

**4.2.5 Sagittal suture** –The present study revealed WBs on sagittal suture in six skulls. This supports studies by various authors who found it in seven skulls[14] and four skulls[10]. Some studies found the same in 2 skulls[11].

**4.2.6 Occipitomastoid suture [Fig 3] & Parietosquamous suture** –WBs in both the sutures were found to be 2.27% (3 skulls). Most of the studies showed absence of WBs in occipitomastoid suture[10]. In a study by Sibel Cirpan[15] in 150 skulls, WBs in occipitomastoid suture was found in 6 skulls and WBs in parietosquamous suture was witnessed in 13 skulls. In a study by A.A Khan, WBs in Parietosquamous suture was found in 2 skulls out of 25, but found none in occipitomastoid[11]. This shows that WBs in Occipitomastoid is rare and WBs in parietosquamous suture is not rare, but occur in smaller numbers.

**4.2.7 Pterion [Fig 4 & 5]** – In a study by Murlimanju et al[9] in 78 skulls, it was found in 9 skulls (11.5%). And in Sibel Cirpan's[15] study, it was found in 20 skulls out of 150 skulls examined. The present study showed a lesser incidence compared to other studies that is in 2 skulls (1.51%). In a study by Hari Prasad et al[17] which was done exclusively to study the various types of pterion and presence of WBs in it, out of 60 skulls, WBs were found only in 3 skulls. The reason for the vast difference in the incidence can be due to various reasons. Knowledge of WBs in pterion are important to surgeons as pterion is a landmark used for burr hole surgeries[17]. Due to variation in the incidence of this, further investigations should be done.

**4.2.8 Bregma** – In the present study, WBs in this region was not found among 132 skulls investigated. Berry & Berry[13] opine that Bregmatic bones or interfrontal bones may occur at the position of the anterior fontanelle. In that study among almost 8 populations (which also included Indian population), bregmatic bones was not present in a single skull also, except for Egyptian population where it was found only in 2 skulls (0.8%) among 200 skulls. This data proves that WBs at bregma are very rare.

### **4.3 Shape of Wormian bones**

In a study by Walulkar Sanjay et al[10], three shapes of WBs was found and it was irregular, oval and triangular [Fig 7] in decreasing percentage incidence respectively. But in the present study, the most common type was quadrangular followed by irregular and then triangular. Even though a study[18] was done exclusively to observe different shapes of WBs, it failed to report the reason for the different shapes and its significance.

### **4.4 Edges of Wormian bones**

42 skulls showing irregular edges [Fig 9] and 32 skulls showing serpigenous edges [Fig 8]. This correlates with a study by A.Vasanthi[7], which showed 3 skulls with serpigenous edges and 7 skulls with irregular edges.

### **There Are Many Causes For The Formation Of Wbs:**

- Embryological reasons are due to WBs formed due to extra ossification centres close to the sutures[10]. WBs can be considered only as supplementary centres of ossification and have no contribution to the solidity of the cranium[12].

- Genetic reasons are also put forward by some authors and Liu et al[20] opined that it could be due to a gene called MSX2 which plays a role in fusion of sutures. It is also said that they are inherited as dominant trait with incomplete penetrance[21]
- Hydrocephalic skulls have a large number of WBs which occur to compensate the additional cranial growth when the normal cranial capacity is not sufficient [10]
- Some authors also mention that some brain disorders lead to formation of WBs. But, Muralimanjuet al[9] states that WBs are formed in early membranous stage before formation of duramater and hence there is no correlation between brain disorders and WBs.
- Artificial cranial deformation is another reason for formation of WBs[22].

## V. Conclusion

The current study reports an incidence rate of 56.06% of WBs. Most of the skulls exhibited WBs in the lambdoid suture followed by lambda, parietomastoid, coronal, asterion, sagittal, occiptomastoid, parietosquamous and pterion. There was no correlation between the length of the sutures and the number of WBs. Three different shapes of WBs were witnessed; quadrangular, irregular and triangular, the highest of which was WBs of the quadrangular type and the least number of WBs exhibited the triangular type. Two types of edges were seen; more number of skulls exhibiting irregular edges, followed by serpigenous edges. Even though there is no true morphological significance for WBs, further investigations should be done to find the same. This study will be of great importance to orthopedicians, radiologists and traumatologists.

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