

# THE OCCURRENCE OF WORMIAN BONES WITHIN THE CRANIAL SUTURES AND THEIR CLINICAL SIGNIFICANCE

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## ABSTRACT

**Introduction:** The Wormian bones are irregular isolated bones, are not normally present within the cranial sutures. They may or may not be associated with clinical abnormalities. They appear in addition to the usual centers of ossification of the cranium. In the present study, the aims were to find the occurrence of Wormian bones within the cranial sutures in dry adult Indian skulls.

**Material and Methods:** The study included 50 human adult dry skulls of Indian population which were obtained from the Anatomy Museum of Chirayu Medical College and Hospital, Bhopal. They were examined systematically various sutures and its meeting point for the presence or absence of Wormian bones.

**Results:** The Wormian bones were observed in 16 skulls (32%) and remaining 34 skulls (68%) didn't show these variant bones. They were observed at the lambdoid suture in 44% cases (22 skulls; 7-right side; 15-left side), at the asterion in 6% (3 skulls; 1-right side; 2-left side), at the pterion in 2% (1 skull; 1-right side only), at the lambda in 6% cases (3 skulls) and at the occipitomastoid suture in 6% cases (3 skulls; 2-right side; 1-left side).

**Conclusion:** The present study observed Wormian bones in 32% of the cases from Indian population. This incidence rate is lower compared to other reports and may be due to racial variations. These variant bones were more frequently seen at the lambdoid suture and were rare at the coronal and sagittal sutures. We believe that the knowledge of Wormian bones is of importance to the neuroanatomists, neurosurgeons, radiologists, anthropologists and morphologists.

**KEY WORDS:** Wormian bone, Lambdoid suture, Bregma, Lambda, Asterion, Pterion.

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## INTRODUCTION

Wormian bones was first described by Paracelsus (1460 to 1541 CE); named after Olaus Worm, a Danish anatomist and they are called as Ossa Wormiana, Intersutural bones and Inca bones/Goethe's ossicle [1]. Wormian bones are

small accessory bones found in the cranial sutures and their meeting point most often in the lambdoid suture separated from it and well circumscribed by a suture which makes them stand out. These bones represent additional ossification centers near the sutures. These are

frequently found in the lambdoid suture and also near the fontanelles.

**Bregma:** At birth it is a diamond shaped membranous gap called as anterior fontanelle. It is closed around 18 months after birth. In adult it forms meeting point of coronal and sagittal sutures. The Wormian bone at this point is a rare occurrence. If the presence of the Wormian bone at the Bregma may be because of appearance of an abnormal ossification center in the fibrous membrane at the anterior fontanelle of fetal life [2]. In the present study shows the occurrence of Wormian bone at this point is 0 %.

**Lambda:** At birth it is called as posterior fontanelle and it is closed at 2-3 months after birth. In adults it forms meeting point of sagittal and lambdoid sutures. In the present study we observe 6 % large sized Wormian bones at the lambda, called "Inca bone" [Figure: 2 J, M, N].

**Pterion:** In infants, it is called as anterolateral fontanelle. It is closed at 2-3 months after birth. A Wormian bone at Pterion is called "Pterion ossicle" or "Epipterion bone" or Flower's bone [3]. In the present study shows the Occurrence of this bone 2 % [Figure: 1 A].

**Asterion:** In infants, it is called as a posterolateral fontanelle. It is closed at 12 months after birth. In adults it is the meeting point of temporal, occipital and parietal bones. In the present study shows the occurrence of Wormian bone at this point is 6 % [Figure: 2 O, P, Q ].

The mechanisms responsible for the formation of Wormian bones are unknown though some studies have shown that their presence may mark some congenital anomalies of central nervous system. They occur in large numbers associated with skeletal dysplasia's [4].

**Significance Of Wormian Bones:** In the 16<sup>th</sup> century, the anatomists Andernach and Vesale were first to associate Wormian bones with cerebral disorders [5]. Some studies have shown that their presence may serve as a marker for the identification of anomalies of central nervous system. Pryles CV and Khan AJ reported the occurrence of CNS abnormalities in a population with Wormian bones varies from 93% to 100% in a random group and reaches 100% in a mentally retarded population. It is important to know that Wormian bones can mislead in the

diagnosis of fracture of skull bones. The presence of series of Wormian bones along the lambdoid suture may lead to problems in the posterior approach to the cranial cavity. These bones might lead to confusions in interpretation of the radiographs in case of head injuries. The multiple Wormian bones may be mistaken for multiple fractures [6]. Presence of Wormian bone at Pterion may pose problem in making the burr holes. The inner aspects of the Bregma and Lambda are related with superior sagittal sinus, Asterion with sigmoid sinus, Pterion with anterior division of middle meningeal vessels so that trephining of skull at this points produces obvious haemorrhage [7].

Objective of present study is to study the phylogeny and to determine the occurrence of Wormian bones within the cranial sutures and at the meeting point and compare previous studies in Indian populations.

## MATERIALS AND METHODS

The study included 50 human adult dry skulls of Indian population which were obtained from the Anatomy Museum of Chirayu Medical College and Hospital, Bhopal. They were examined systematically various sutures and its meeting point for the presence or absence of Wormian bones. The number and the location of the Wormian bones along the cranial sutures and at the lambda, Pterion, Asterion were noted. The findings were documented and photographs of relevant Wormian bones were taken using a digital camera.

## RESULTS

As per the table 1: in present study we found Wormian bones in 16 skulls out of total 50 skulls. So over all incidences of Wormian bones is 32% and also Wormian bones were present on the left half of the skull in 18 skulls out of 50 skulls that is in 36% and over right half of the skull in 11 skulls out of 50 skulls that is in 22%.

**Table 1:** Overall Incidence of Wormian bone (N=50).

Wormian bones	Total (%)
Present	16 (32%)
Absent	34 (68%)
Right half	11 (22%)
Left half	18 (36%)

**Table 2:** Incidence of wormian bone at different locations (N=50).

Location of WBs	Left side	Right side	Midline	Total (%)
Bregma			Nil	0 (0%)
Lambda			3	3 (6%)
Pterion	0	1		1 (2%)
Asterion	2	1		3 (6%)
Lambdoid suture	15	7		22 (44%)
Occipitomastoid suture	1	2		3 (6%)
sagittal suture			Nil	0 (0%)

**Fig. 1:** A: Wormian bone at Pterion. B,C,D: Wormian bone at occipitomastoid suture. E,F,G,H,I: Wormian bones at lambdoid suture( unilateral or bilateral).



**Fig. 2:** J,K,L: Wormian bone at the lambdoidsuture. M,N,J: Wormian bone at the lambda. O,P,Q,: Wormian bone at the Asterion. R: Sutures are not visible.





As per the Table 2: We observed maximum number of Wormian bones at lambdoid suture 22 (44%), and out of 22 Wormian bones, 15 at the left half of the skull and 7 at the right half of the skull. At the asterion in 6% (3 skulls; 1-right side; 2-left side), at the pterion in 2% (1 skull; 1-right side only). At the Lambda 3(6%) Wormian bones, and at the occipitomastoid suture in 6% cases (3 skulls; 2-right side; 1-left side) and sutures are not visible on the one skull [figure :2 R]. We didn't get any Wormian bones at Bregma and sagittal suture.

## DISCUSSION

Wormian bones can be found as normal variants and seem to be determined genetically in certain populations. It can be recognized in an Austrolopiutheine skull [8].

In his monograph, Parker mentioned several synonyms that were used, as follows:

1. According to the discoverer: ossicula andernaci, ossa Goethiano.
2. According to shape: ossatriquetra, ossatriangularis, ossaquadratum.
3. According to location: suturax, fontanellaires, Insules, intercalcaria, raphogeminantia, apicis.
4. According to function: complmentaria, ossaaccessorii.

Wormian bones are also called ossawormiana, intersutural bones. The incidence of Wormian bones has varied with the bias of reporting authors. Najjar and Dawson suggested that the incidence is lower in fetuses (11.3%) than in adults (62.1% to 76.2%) [9]. In the present study we have observed 32% of the Wormian bones within the lambdoid suture, occipitomastoid suture and at lambda, Pterion, Asterion. This correlates with the other Indian studies. In south India done by Shivaleela C. at Sri Siddhartha medical college, Tumkur, Karnataka shows incidence of Wormian bones 43.52% [10]. Study done by Manjulapatil at St.John's medical college, Bangalore, Karnataka shows incidence of Wormian bones 52.22% [11]. Study done by Divyeshpatel at Govt medical college, Surat, Gujarat, shows incidence of Wormian bone 44.04%. Incidence of Wormian bones in humans varies from 8% to 15% in a random population and reaches 54% in a mentally impaired

population [5]. Since Embryologically Wormian bones belong to the neurocranium. They appear as isolated ectopic islands of intramembraneous ossifications. In the fetus, the diploe is not formed yet, and thus Wormian bones are composed of single layer of compact bone on the dural side [4].

Parker suggested that "the number of Wormian bones increases with the capacity of the skull, regardless of the cause of enlargement". His data was based on various skulls from normal populations and from abnormal skulls [12]. Similarly "the greater the sutural length of the skull the greater the number of Wormian bones". He suggests that sutural diastasis induces the formation of ectopic ossification centers. In 1946, Hess proposed that the formation of Wormian bones from metabolic disorders of mesoderm as a result with asymmetry of the skull, bone malformation, metopism, and congenital anomalies of CNS [13]. The Wormian bones are hypothesized to be inherited as a dominant trait [14].

## CONCLUSION

The present study indicates that Wormian bones may be present at the Pterion, Asterion, Lambda, Occipitomastoid suture and usual site in the lambdoid suture. The occurrence of Wormian bones in the skull and different location are mentioned in the table 1 and 2. The results of our study is differ from the other reports which have been reported in the literature, our study shows the lower number of incidence of Wormian bones compared to other Indian authors because racial variations seem to exist. It is important for neurosurgeons and radiologists to be aware of the presence of Wormian bones in these sutures as they may be mistaken for fractures in cases of head injuries. Therefore, this report may be useful for neurosurgeons, orthopedicians, radiologists, and anthropologists and morphologists.

**Conflicts of Interests: None**

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