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Ossa wormiana-A morphological study

Rani Nallathamby*, Meril Ann Soman

Believers Church Medical College, Thiruvalla, Kerala, India

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Abstract: Goethe's osscicles or Wormian bones are islands of small bone tissue that were accidentally intercalated in the cranium sutures which were formed out of additional ossification centers which had no relation with the regular ones. These bone tissues are studied by various researchers who succeeded in associating them with various central nervous system disorders, acknowledging their presence to be important in the fields of neurosurgery, radiology and anthropology.

Keywords: Wormian; Sutural bones

Introduction

These unnamed bones were first mentioned by Paracelsus (1460 to 1541) but named after Olaus Worm. He was a Danish physician who mentioned about the bones first in a letter he wrote to Thomas Bartholin who coined the name–Ossa wormiana [1].

These ethnic variables are of interest in the fields of research related to human anatomy, radiology, anthropology, and forensic medicine. The formation of sutural bones is even though is assumed to be controlled by genetic factors [2] but still is vague. Some of the wormian bones (WB) drew much of attention from the fields of anatomy, that they received a particular name: Gonthier d'Andernach's ossicle (the obeliac sutural bone, as described by the author, Guinterius, in 1571, Paracelsian ossicle (the bregmatic sutural bone, in reference to Theophrast Bombast von Hohenheim, otherwise known as Paracelse) or epactal bone (intercalated between the occipital and parietal bones), the term coined by [3]. Paracelsian ossicle was sometimes called Ossiculum antiepilepticum because of the false belief that these bones appear in the skulls as a cure for epilepsy, may be they are mostly found in hydrocephalic skulls and in skulls with other cranial malformations with conditions that had a high propensity for presenting as seizures.

Objective

The present study aims at finding out the pattern of distribution of wormian bones in the skulls and its incidence and distribution in various cranial sutures.

Materials and Methods

This observational study was done on 100 dried adult human dried skulls from south India at Yenepoya medical college, Mangalore, Karnataka and Believers Medical College, Thiruvalla. The various sutures of the skull, namely lambdoid suture, sagittal suture, coronal suture, parietomastoid suture, squamous suture and zygomaticomaxillary suture were examined systematically to find out the presence and distribution of WB. Four skulls with complete metopic sutures were also included in the study and the presence of WB was sought for in these rare sutures. The findings were documented and the photographs of relevant WB were taken using a digital camera.

Results

According to the present study, WB were present, in addition to the expected site i.e. the lambdoid suture (Figure 1), in the coronal suture (Figure 2), sagittal suture (Figure 3), pterion (Figure 4), asterion (Figure 5) also in very unexpected sites like zygomatico-maxillary suture (Figure 6), occipito-mastoid suture

Figure 1: Wormian bones at Lambda.

***Corresponding Author:**
Rani Nallathamby,
Believers Church Medical College, Thiruvalla, Kerala, India
E-mail: raniboban@yahoo.com
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Figure 2: Wormian bone at coronal suture.

Figure 3: Wormian bones at metopic suture.

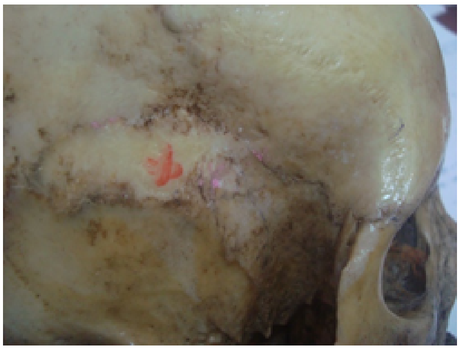

Figure 4: Wormian bone at pterion.

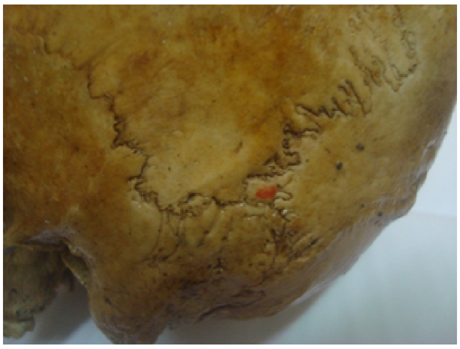

Figure 5: Wormian bone at Asterion.

(Figure 7), parieto-mastoid suture (Figure 8) and squamous suture (Figure 9). They also made their presence in the rare metopic suture (Figure 10) that was present in a single skull.

Discussion

Human crania is composed of 28 bones of which

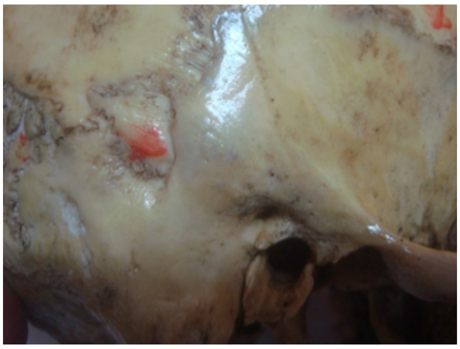

Figure 6: Wormian bone at parieto mastoid suture.

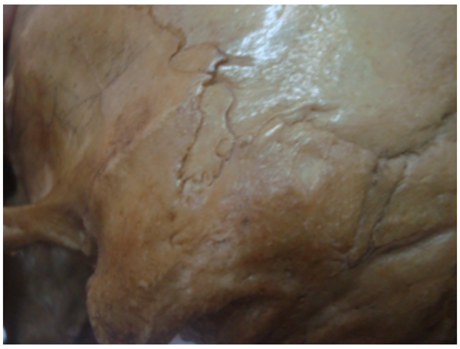

Figure 7: Wormian bone at squamous suture.

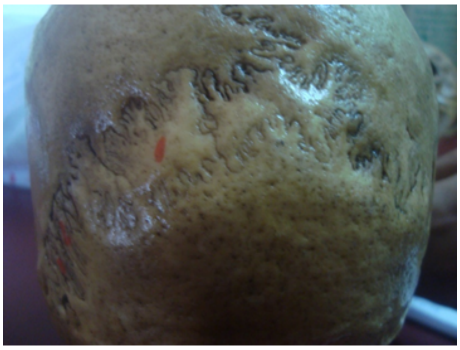

Figure 8: Multiple wormian bones at lambdoid suture.

Figure 9: Wormian bone at sagittal suture.

6 are ear ossicles of the remaining 22, 8 bones forms the nuerocranium and 14 bones forms the splanchnocranium. Nuerocranium includes bones that cover the cranial cavity and splanchnocranium includes bones that form the framework of facial skeleton. The vault of nueocranium is formed mainly

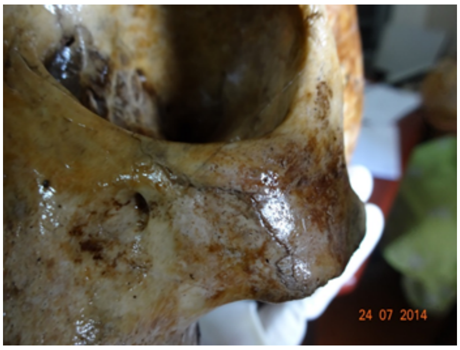

Figure 10: wormian bone at zygomatico maxillary suture.

of membraneous bones whereas the base of skull is mainly formed of bones that are ossified in cartilage. Apart from these regular bones, the nuerocranium, at times, present some islands of small bones that posess a separate ossification center of its own. These bones are known as wormian bones.

During the first two years, the growth of vault occurs primarily through ossification by the osteogenic layer along the apposed margins of the bones. This is followed by accretions and absorbtions of bone tissue in order to meet the growth changes in the curvatures of the skull. During this time, closure of fontanelles takes place by progressive ossification of bones around them. The fontanelles that close first, shows high propensity in the development of sutural bones, that may develop from rogue centers of ossification. However, they appear in great number in hydrocephalic skulls, therefore, linking their presence with the rapidity of cranial expansion [4]. Cremin [5] studied the skull radiographs of 81 cases of osteogenesis imperfecta of varying ages for the presence of wormian bones and those were compared with the incidence of wormian bones in 500 skull radiographs of normal children. Significant WB as against normal developmental variants were considered to be those more than 10 in number, measuring greater than 6 mm by 4 mm, and arranged in a general mosaic pattern, were found in all the cases of osteogenesis imperfecta but not in the normal skulls [5].

Wormian bones of are hypostotic epigenetic traits present as fillers in neonatal fontanelles as a result of diverse ossification centers. Wormian bones are seen in both normal and abnormal individuals with varying significance according to the location [6]. In visual evaluation, they show typical anatomy of the bones of calvaria revealing a three-layer composition: the outer and the inner table of the compact bone sandwiching the table of spongy bone. These bones are irregular in size and shapeand frequently seen around posterior fontanelles. They may represent a pre-interparietal element, a true interparietal element or a composite element. There is a relationship with the total length of sutures. Greater the sutural length of skull, greater is the number of WB. Metabolic disorders of the mesoderm show a linkage to the presence of these bones [7]. Wormian bones are found to be inherited as a dominant trait with incomplete penetrance and variable expression (16) [4]. Artificial cranial deformation is another reason for formation of WBs [8].

Based on the report of Gumusburun et al. [9], the incidence of sutural bones could be considered as an anthropological marker or an indicator of population distance for various studies. They were reported in showing high frequencies in some population and their absence in others, in the groups that are geographically nearby or groups that are exposed to similar environmental stresses [10]. Khan et al. [11], reported incidence is variable, ranging from around 10% (Caucasian), 40% (Indians), to 80% (Chinese). Gailland (2008) [4] also reported that Wormian bones are more prevalent in the male folks than the females [12].

Of the 100 skulls studied, 62 skulls showed the presence of WB. A total number of 236 WB were observed in the 62 skulls. Of this, 108 (45.7%) was on right side, 109 (46.1%) was on left side, whereas 19 (8.05%) showed their presence on midline sutures (Table 1). The distributions of sutural bones in various sutures were tabulated and graphically plotted (Table 2 & Figures 11 and 12). It was found that highest number of wormian bones are seen in association with Lambdoid suture followed by asterion. The presence of sutural bones in very rare sites–the zygomaticomaxillary suture and in metopic suture is appreciated (Figures 9 and 13) and is considered as a novel finding and report of its first kind through this study.

Andernach and Vesale, were the first to describe the association of wormian bones with cerebral disorders [13]. Radiologist Gaillard [14] and Tripathi [15] have reported their association with rickets, Downs syndrome, hypothyroidism, Osteogenesis

Table 1: Incidence of Wormian bones with reference to laterality.

No. of skulls showing wormian bones	Total no. of wormian bones present	Total no. of wormian bones present on Right side	Total no. of wormian bones present on Left side	Total no. of wormian bones present on Midline sutures
62	236	108 (45.7%)	109 (46.1%)	19 (8.05%)

Table 2: Sutural distribution of Wormian bones.

Serial no.	Suture	Percentage of skulls showing its presence	Total number of wormian bones present in each suture variety			Percentage of distribution
1	Lambda	9	14			5.9%
2	Sagittal suture	3	5			2.1%
			Right	Left	Total	
3	Lambdoid suture	49	53	63	116	49.1%
4	Coronal suture	21	23	16	39	16.5%
5	Pterion	13	8	5	13	5.5%
6	Asterion	32	13	15	28	13.5%
7	Squamous suture	10	4	6	10	4.2%
8	Occipito-mastoid suture	6	3	3	6	2.5%
9	Parieto-mastoid suture	3	3	0	3	1.3%
10	Zygomatico-maxillary suture	1	1	1	2	0.42%

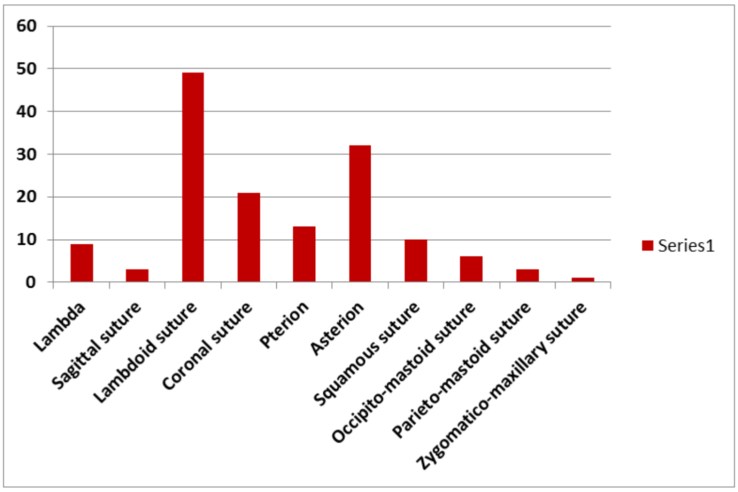

Figure 11: Sutural distribution of Wormian bones.

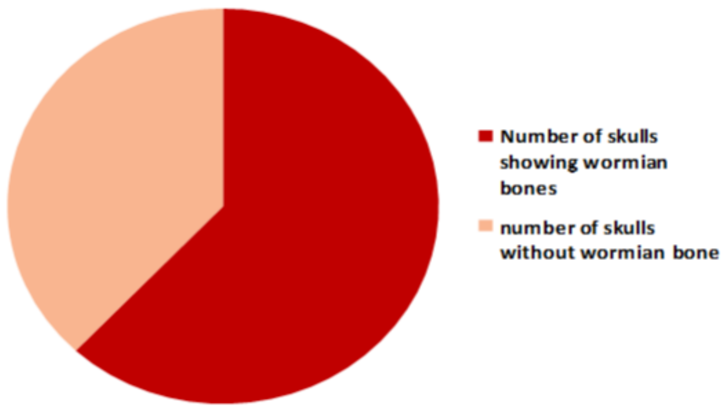

Figure 12: Incidence of Wormian bones with reference to laterality.

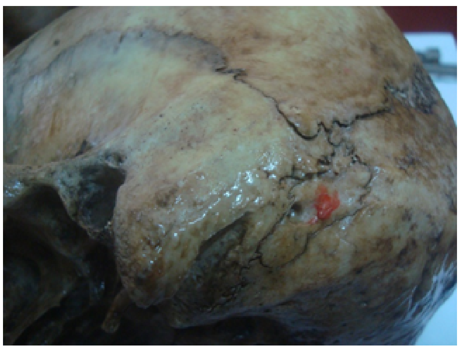

Figure 13: Wormian bone at occipito-mastoid suture.

imperfecta, and Cleidocranial dysplasia. Their frequent presence in hydrocephalus correlates with rapid cranial expansion. According to Bergman et al. [15] 40% of skulls contain WB near the lambdoid suture. The next most common site of WB is at the pterion, which is having a higher incidence among Indians. Saxena et al. [16] studied that 11.79% of Indian skulls and 5.06% Nigerians skulls had their presence. The presence of preinterparietal bone or Inca bone at the lambda has also been reported by previous workers [17-19].

There have been very few studies reporting the occurrence of WB in the coronal, sagittal, and squamosal suture. In the present study, out of 100 skulls, we found cases of WB in coronal sutures, cases in squamosal sutures, and in the sagittal sutures in another skull. However, Berry and Berry [20], in their study on epigenetic variations in the human cranium, reported the presence of WB in the coronal and squamosal sutures. However, Tewari et al. [21] studied 1500 skulls for the presence of sutural bones, but they failed to find a single case of Wormian in the coronal, squamosal, and sagittal sutures.

Knowledge of presence of more than one sutural bone at pterion is of radiological importance. The sutural bones may be mistaken for fracture of skull in case of trauma of the pterion region. They may pose problems in making burr holes at the pterion [22-25]. It is also possible that the fracture of skull is misinterpreted as a wormian bone and the patient may lose the appropriate treatment at a right time. Hence the basic knowledge about these accessory bones is important for the doctors in day to day clinical practice.

Conclusion

The present study indicates that WB may be present in the coronal, squamosal, and zygomatico-maxillary sutures in addition to the usual site in the lambdoid suture. They may be also seen in metopic sutures if present. The presence of sutural bones in very rare sites–the zygomaticomaxillary suture and in metopic suture is a novel finding of this study. The knowledge about these findings will be extremely valuable in radiological interpretation of a skull fracture, as WB may lead to a misdiagnosis of fracture skull in a normal case. Like the same, the diagnosis may also get overlooked assuming a real fracture to be a WB which demands working out for the presence of other clinical correlations. Thus it is important for neurosurgeons and radiologists and also valuable in the fields of human anatomy, research and anthropology.

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