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Research Article

MORPHOLOGIC AND MORPHOMETRIC EVALUATION OF THE WORMIAN BONES IN DRY INDIAN SKULLS – A SINGLE CENTERED STUDY

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ABSTRACT

Background: Wormian bones, also known as ossa suturalia, are small, auxiliary, atypical bones found on the sutures of the skull. They originate from atypical ossification centers that are added to the regular structure of the skull bones in the cranium. These bones were also referred to as supernumerary, intercalary, intersutural, and ossicles. **Aims and Objectives:** To ascertain the morphologic and morphometric properties of wormian (sutural) bones and to look into their occurrence. **Methods:** 56 dry human skulls of unknown sex and age were used for this investigation in the anatomy department , Government Medical College Srinagar. The study did not include the malformed heads. The location, quantity, side, and shape of wormian bones were identified once the skulls were examined to check for their presence. Furthermore, the digital caliper was used to measure the width-length of the skulls and the vertical-horizontal diameters of the wormian bones to the nearest 0.1 mm. Wormian bone occurrences in various types of skulls were studied, and the cranial index was computed.
Results: The prevalence of wormian bones was 42.86 % overall, with the majority (57.14 %) found on the lambdoid suture. At the lambdoid suture, wormian bones were observed at a rate of 62.5%; at the occipito-mastoid suture, 9.37%; on the pterion, bregma, parietotemporal, sagittal, and coronal sutures, they were not observed. worm-like bones were seen at a rate of 65.62% on the left side of the skull and 34.38% on the right. Our research indicates that the morphologies of wormian bones were perceived as irregular (28.12%), triangular (15.62%), and quadrangular (56.26%). The average measurements of wormian bones were 10.93±4.39 mm for horizontal diameter and 12.29±4.48 mm for vertical diameter. Our study's findings for the cephalic index indicate that the majority of our Skulls of the dolichocephalic category can have wormian bones or not.**Conclusion:** Understanding the variances and features of the skull is crucial for the domains of forensic medicine, anatomy, radiography, and neurosurgery as well as for clinical procedures or literature data.

INTRODUCTION

The neurocranium and visserocranium, two groups of 22 bones that fuse together after birth, make up the human skull. The bones of the cranium are joined with brain sutures (Yücel, 2018; Reveron, 2017). According to Patel et al. (2015) and Sreekanth & Samala (2016), wormian bones, also known as sutural bones, are accessory tiny bones that develop inadvertently or intercalate between or close to cranial sutures, separating them from the typical ossification center of the skull. Olaus Wormian, a Danish anatomist, first reported Wormian bones in 1643. Thomas Bartholin initially used the term "Ossa wormiana" to refer to these bones (Albay et al., 2013; Sreekanth & Samala). According to Showri and Suma (2016), these bones were also referred to as ossicles, intersutural bones, intercalary bones, or supernumerary bones. But as of yet, the process by which wormian bones originate remains unclear (Gümüsburun et al., 1997). According to some writers (Sanchez-Lara et al., 2007; Bellary et al., 2013), wormian bones are the result of both intrinsic and extrinsic causes, such as neural strain near sutures.

The current study set out to ascertain the morphologic and morphometric properties of wormian (sutural) bones as well as to look into their incidence.

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MATERIAL AND METHOD

56 dry human skulls of unknown sex and age were used for this investigation in the anatomy department , Government Medical College Srinagar. The study did not include the malformed heads. The location, quantity, side, and shape of wormian bones were identified once the skulls were examined to check for their presence. Furthermore, the digital caliper was used to measure the width-length of the skulls and the vertical-horizontal diameters of the wormian bones to the nearest 0.1 mm. Wormian bone occurrences in various types of skulls were studied, and the cranial index was computed.

The following was the formula used to calculate the cephalic index: Cranial breadth (Euryon)*100 / Cranial length (Opisthocranion-Glabella) is the formula for the cephalic index (CI).

The classification of Williams et al. (Table I) was used to categorize the different types of craniums into four categories (Anjum et al., 2016).

Table I. Cephalic index classification.

Shape	Dolichocephalic	Mesocephalic	Brachycephalic	Hyperbrachycephalic
Cephalic index	CI < 74.9	75<CI<79.9	80<CI<84.9	85<CI<89.9

The SPSS programme and the Descriptive Statistical Methods (mean, standard deviation and %) were used for data analysis.

RESULTS

In this study, wormian bones were observed in 24 (42.86 %) skulls out of 56 skulls. More than five wormian bones were found in only one skull. The total number of the observed wormian bones were 64 and the greatest number of wormian bones were seen at lambdoid suture (57.14 %).Wormian bones were observed at lambdoid suture 62.5 %, occipito-mastoid suture 9.37 %, asterion 18.76 %, lambda 9.37 %; however, they were not seen at pterion, bregma, parietotemporal, sagittal and coronal sutures (Fig. 1)

Moreover, wormian bones were seen on left side at a rate of 65.62 %, and at a rate of 34.38 % on right side of the skulls .

In examining the wormian bone shapes, we found that 32 (56.26 %) had quadrangular shapes, 9 (15.62 %) had triangular shapes, and 16 (28.12 %) had irregular shapes. Furthermore, it was discovered that the average cranial breadth and length were, respectively, 128.06±11.92 mm and 166.12±5.47 mm. Based on our analysis of the cephalic index values, we found that 39.28% of the skulls were dolicocephalic, 28.57 % were mesocephalic, 10.71 % were brachycephalic, and 21.42 % were hyperbrachycephalic. Dolichocephalic skulls were the most prevalent in both the group with wormian bone presence and the group without it.

The average measurements of wormian bones were 10.93±4.39 mm for the horizontal diameter and 12.29±4.48 mm for the vertical diameter. The wormian bones were seen at lambdoid suture in 14 skulls as 40 (12 right, 28 left), at occipitomastoid suture in 6 skulls as 6 (2 right, 4 left), at lambda in 4 skulls as 6 (2 right, 4 left), at asterion in 6 skulls as 12 (6 right, 6 left). On the lambdoid suture, the mean values of the right vertical diameter were 12.67±3.62 mm and the horizontal diameter were 10.95±3.3 mm, whereas the left vertical diameter was 12.86±4.37 mm and the horizontal diameter was 11.66±5.60 mm. One wormian bone on the right had a vertical diameter of 7.7 mm and a horizontal diameter of 7.9 mm, while the occipitomastoid suture on the left had a mean vertical diameter and horizontal diameter of 15.77 mm and 9.78 mm, respectively. On asteroids, the mean vertical diameter was measured to be 14.74 mm and the horizontal diameter was measured to be 10.96 mm for the right side and 9.34 mm and 8.79 mm for the left side. Finally, the mean values of vertical and horizontal diameter for right were measured as 10.26 mm and 12.47 mm, respectively; and the mean values of vertical and horizontal diameter for left were measured as 7.83 mm and 10.79 mm at lambda.

DISCUSSION

First, laus Wormius are tiny, auxiliary, angular bones situated on cranial sutures (Cremin et al., 1982). According to Bellary et al., wormian bones are created when atypical ossification centers are added to the normal structure of the skull bones in the cranium. The emergence of wormian bones was attributed to hereditary factors, adaptation to cranial expansion, artificial cranial deformation, and metabolic problems (Patil & Sheelavant, 2012). As noted in the literature, doctors might employ multiple wormian bones, in particular, as a landmark to indicate skeletal or central nervous system dysfunction (Himabindu & Rao, 2015).

A study on the development of wormian bones found that there was a higher incidence of craniosynostosis in large wormian bones. This investigation supported the idea that wormian bone presence at high prevalence in midline with sagittal or metopic synostosis is influenced by mechanical forces (Sanchez-Lara et al.). According to some research, there may be a connection between osteogenesis imperfecta and wormian bones (Cremin et al.). Wormian bones differ in shape, quantity, position, and incidence, according to earlier research. Wormian bone incidence was shown to be higher in adults than in fetuses, according to a study that examined the relationship between artificial deformation and the condition (El-Najjar & Dawson, 1977).

Fig. 1. Wormian bones: A) at asterion B) at Lambda and lambdoid suture C) at occipitomastoid suture.

Ten skulls with wormian bones were found in a study that examined the wormian bones in 100 cadaver skulls that were on hand at the Andhra Medical College's Department of Anatomy. Four wormian bones in one skull, two wormian bones in two skulls, five wormian bones in one skull, and more than five wormian bones in two skulls were among the findings. It was suggested by Vasanthi et al. (2015) that the majority of them had a tetrahedral shape.

The incidence of wormian bones in our study was 42.86 percent , with the majority of them (57.14 percent) on lambdoid sutures. The lambdoid suture showed 40 wormian bones, the occipitomastoid suture showed 6, the lambda showed 6 bones, and the asterion showed 12 bones.

A study analyzing wormian bones in terms of gender showed overall incidence of wormian bones as 52.22 %, and emphasized that there was one wormian bone on bregma, 25 on lambda, 28 on asterion, 22 on pterion, 5 on parietal notch, 13 on occipitomastoid suture, 1 on coronal suture, 56 on lambdoid suture, 10 on sagittal suture, 5 on squamous suture and 9 on infraorbital region. Moreover, this study also reported the number of wormian bones as follows: 0 (47.8 %), 1 (14,4 %), 2 (9.4 %), 3 (9.4 %), 4 (5 %), 5 (3.9 %), more than five (9.44 %) (Patil & Sheelavant). A study in India found that the total incidence of wormian bones was 44.40 %, 37.03 % on the right side; and48.10 % on the left side. . While most of wormian bones were seen on sutura lamdoidea (48.14 %); in addition to this, incidents of other wormian bones were distributed according to locations as follows: coronal suture (0.03 %), occipitomastoid suture (0.03 %), parietomastoid suture (0.07 %), asterion (18.50 %), pterion (0.03 %), lambda (0.07%). There were no wormian bones seen on the bregma or sagittal suture. Moreover, according to Patel et al., just one wormian bone was discovered in 22% of the skulls in this study, compared to 2 in 11.10%, 3 in 0.07 %, and more than 5 in 0.03 %. According to a study done in Telangana, India, the highest percentage of wormian bones was found at the lambdoid suture (53.15%), followed by the lambda (8.1%), pterion 1.80%, asterion 2.7%, parietotemporal suture (4.5%), occipitomastoid suture (0.9%), sagittal suture (0.9%), and bregma (0.9%) sutures. 52.70 percent of wormian bones were quadrangular, 37.83 percent were irregular, and 9.45 percent were triangular-shaped, according to a study that analyzed wormian bones according to their shapes, locations, and incidence. The most frequent shape was quadrangular in this analysis as well as in our study. The results of this investigation showed that the lambdoid suture was the location of wormian bones most frequently found. Also, according to Showri and Suma's study, there were 13.63 percent at the lambda, 8.33 percent at the parietomastoid suture, 6.06 percent at the coronal suture, 5.30 percent at the asterion, 4.54% at the sagittal suture, 2.27 percent at the occipitomastoid suture, 2.27 percent at the parietosquamous, and 1.51 percent at the pterion.

In their investigation, Himabindu & Rao noted one multiple wormian bone at the lambdoid suture, one bilateral and one right-sided at the pterion, one at the right asterion, and one at the lambda (os incae). Furthermore, a case report from India (Nayak, 2008) reported several wormian bones near the lambdoid suture. The majority of the sample in the other case report, according to Tallapaneni et al. (2013), had irregular morphologies for wormian bones, and there were 14 wormian bones throughout their osteology classes. In 50 Indian skulls, the percentage of wormian bones was 32% on the left side and 22% on the right. The overall prevalence of wormian bones was 32%.

Most of the wormian bones were seen at lambdoid suture (44 %), at lambda (6 %), at occipitomastoid suture (6 %), asterion (6 %), at pterion (2 %) (Kumat et al., 2016). An investigation performed in Nigerian dried skulls showed the percentage of wormian bones as 45.46 % in total, 36.36 % at lambdoid suture while 9.09 % at pterion. They also emphasized that wormian bones were not seen at coronal suture, bregma and sagittal suture in their study samples (Uchewa et al., 2018). There were some studies focused on wormian bones at asterion.

According to an analysis, 32% (12% right, 20% left) of South Indian skulls have wormian bones (Ahad & Thenmozhi, 2015). Similarly, wormian bones near asterion were found in 14.81 percent of Indian skulls studied (Singh, 2012). The study found that the incidence of wormian bones was 74.7% in the Greek population and that there was no correlation between wormian bone frequency, age, or sex. And the majority of wormian bones were sited at lambdoid suture (44.6 %), at coronal suture (39.8 %), at asterion (21 % on left, 13.9 % on right), at parietomastoid suture (15.1 % on left, 13.9 on right). Moreover, wormian bones were not found at occipitomastoid, sagittal sutures, bregma, lambda, pterion (Natsis et al., 2019). When we analyzed these results, it was seen obviously that the majority of wormian bones were seen at lambdoid suture like it was the case in our study.

In our nation, virtually little research was done on wormian bones. 302 Anatolian-Ottoman skulls were the subject of a thorough investigation. This study not only looked at the existence of wormian bones, but also assessed them in terms of their skull shapes. Based on the study's findings, the brachycephalic group had the highest percentage of wormian bones (47%) compared to the mesocephalic group (37.4%) and the dolichocephalic group (15.6%) for unilateral wormian bones. The dolicocephalic group had the highest number of wormian bones (Gümüs Burun et al.). Overall incidence of wormian bones were found as 59.3 % among West Anatolian skulls. The maximum and the minimum number of wormian bones were determined at left lambdoid suture (40.7 %) and at right occipitomastoid suture (1.3 %). No wormian bones were seen in 40.7 %; on the other hand, one wormian bone was seen in 20 %, 2 wormian bones were seen in 17.3 %, 3 in 8.7 %, 4 in 10 %, 5 in 2.7 %, more than 5 in 0.7 % skulls (Cirpan et al., 2015). A study conducted on 50 skulls with unknown age and sex, it was found that the prevalence of wormian bones was 28 % at lambdoid suture (highest amount), 2 % at coronal suture, 8 % at lambda, 4.3 % at bregma, 4 % at sutura squamosa, 8 % at sutura metopica, 18 % at asterion, 2 % at occipitomastoid suture. Vertical and transverse diameters of wormian bones were measured as 17±6 mm and 11±8 mm for right side and 16±5 mm and 9±6 mm on left side, respectively; followed by lambdoid suture 17±6 mm, 11±8 mm for right and 16±5 mm 9±6 mm for left, at lambda 33±12 mm and 32±14 mm, at asterion 11±5 mm, 10±6 mm for right, 11±3 mm, 7±3 mm for left, at occipitomastoid suture 12mm, 7 mm (n=1) (Albay et al.). When our results were compared with the literature data, it was determined that wormian bone values and incidence varied between all groups except the most of the wormian bones that

Comparison of Wormian bones in various studies							
	Sutura Coronalis	Sutura Sagittalis	Sutura Lamboidea	Bregma	Lamba	Sutura Occipito-mastoidea	Sutura Parieteo mastoidea
Gumu_burun et al.,(1997)	2.97	1.65	61.89	0.66	10.9	0.99	7.92
Albay et al.,(2012)	2	-	28	43	8	2	0
Patel et al.,(2015)	0.03	0	48.14	0	0.07	0.03	0.07
Kumar et al.,(2016)	-	0	44	0	6	6	-
Sreekanth and samala (2016)	0	0.90	53.15	0.90	8.10	0.90	4.50
Showri R. and Suma M.P.et al.,(2016)	6.06	4.54	45.45		13.63	2.27	8.33
Uchewa et al.,(2018)	0	0	36.36	0	-	-	-
	39.9		44.6	1.6	2.4		15.1 left
Natsis et al.,(2018)							13.9 right
Present study	0	0	18.75 left	0	0	3.12 left	0
	0	0	43.75right	0	9.37	6.25 right	0

were seen at lambdoid suture. These variations may be derived from racial, ethnic and genetic factors (Table IV).

Our study results were similar to the literature data in the Turkish population for the placement of wormian bones as lambdoid suture, despite the fact that there were significant variances for the rate, location, and number of wormian bones. The small sample size of our study was one of its limitations. Therefore, more research on wormian bones is required.

In summary, the findings of this research are deemed essential for anthropologists, anatomists, and forensic scientists, and they also add to the body of literature.

Clinicians like neurosurgeons and radiologists will find this data useful for the diagnosis and management of skull disorders because wormian bones can lead to errors in fracture determination.

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