

Fourteen wormian bones in an adult Indian skull – A rare case report

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Received 03 June; accepted 09 August; published online 01 September; printed 16 September 2013

ABSTRACT

Multiple wormian bones are the prominent features of various cranial dystosis. The wormian bones are formations associated with insufficient rate of suture closure and regarded as epigenetic and hypostotic traits. It was reported that there exists racial variability among the incidence of these bones. During the routine osteology demonstration classes for medical undergraduate students, a series of Wormian bones in the lambdoid suture was discovered. All together there were fourteen (14) wormian bones. There were six (6) sutural bones on the left half and two (2) sutural bones on the right half of the lambdoid suture. All the sutural bones were irregular in shape. The sagittal suture was very wavy. The edges of many wormian bones showed serpiginous appearance while others were plane. There were six (6) interparietal bones. **A similar case has not yet been reported in the world literature.**

Key words: (Osteology) (Lambdoid suture) (Sagittal suture) (Serpiginous appearance)

Abbreviation: CNS - Central Nervous System

To Cite This Article:

Sreekanth Tallapaneni, Chigurupati Namrata, Swathi Veliginti, Abishek Mogili, Shahzeb Zaman, Faraz Adil Hashmi. Fourteen wormian bones in an adult Indian skull – A rare case report. Medical Science, 2013, 1(3), 55-59

1. INTRODUCTION

Sutural bones/wormian bones:

Isabare M defined the sutural bones as "The bones persisting within the suture and not incorporated into the adjacent bone during mineralization and maturation are called wormian bones after the Danish anatomist 'Olaus Worm'.

Sutural bones/Wormian bones/Supernumerary ossicles are the intercalated bones found in the cranium, accidentally having no specific or regular relation to their normal ossification centres. They occur more frequently in men and are seen occupying the sutures or filling fontanelles of the neonatal cranium (Fabrizo, 2008). Usually there are 2 to 3 wormian bones in single skull. Rarely, they occur in great numbers (Srivastava, 1992). In the skulls of hydrocephalic neonates they can be seen more in number as the cranium in these cases is associated with rapid expansion (Warwick, 1980). Wormian bones are present in both normal and abnormal cases. Radiologists have reported cases of WB associated with rickets, hypothyroidism, Down syndrome, osteogenesis imperfecta, pycnodysostosis and cleidocranial dysplasia (Frank Gaillard, 2008; Amit Tripathi, 2011). Conversely, the presence of WB in four fetuses, were reported without any associated anomalies (Philippe Jeanty et al., 2005). They can be found as normal variants and

seem to be determined genetically in certain populations (Kaplan, 1991). The factors predisposing for the formation of wormian bones are as follows:

1. *Adaptation to cranial enlargement:* The number of wormian bones increases with the capacity of the skull, regardless of the cause of enlargement (Philippe Jeanty et al., 2005).
2. A similar relationship exists with the total length of sutures, greater the sutural length of a skull greater the number of wormian bones. It is suggested that sutural diastasis induces the formation of ectopic ossification centres. The formation and distribution of supernumerary ossicles may reflect different stress types (tension, pressure, etc.), acting on the cranial vault during late prenatal and early postnatal periods of bone growth (Barberini et al, 2008).
3. *Artificial cranial deformation:* The frequency was found to be more among the artificially deformed skulls (Wilczak, 2009).
4. *Genetic factors:* The wormian bones are inherited as a dominant trait with incomplete penetrance (50%) and

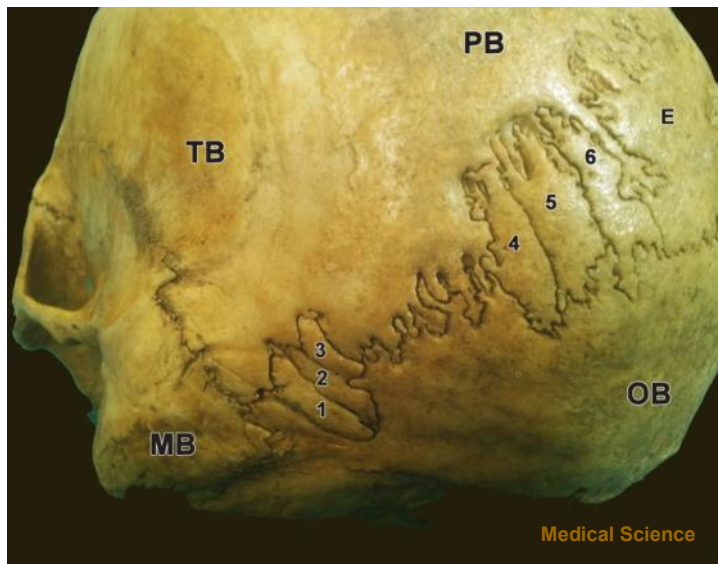


Figure 1
POSTERO-LATERAL VIEW OF THE SKULL
1, 2, 3, 4, 5, 6 – ARE ALL THE WORMIAN /SUTURAL BONES AT THE LAMBDOID SUTURE. E – IS THE INTERPARIETAL BONE, TB – TEMPORAL BONE, PB – PARIETAL BONE, MB – MASTOID (BONE) PROCESS, OB – OCCIPITAL BONE, NOTE – THE EDGES OF THE WORMIAN BONES NUMBERED 1,2 & 3 ARE PLANE, THE EDGES OF THE WORMIAN BONES NUMBERED 4,5 & 6 ARE SERPIGINOUS

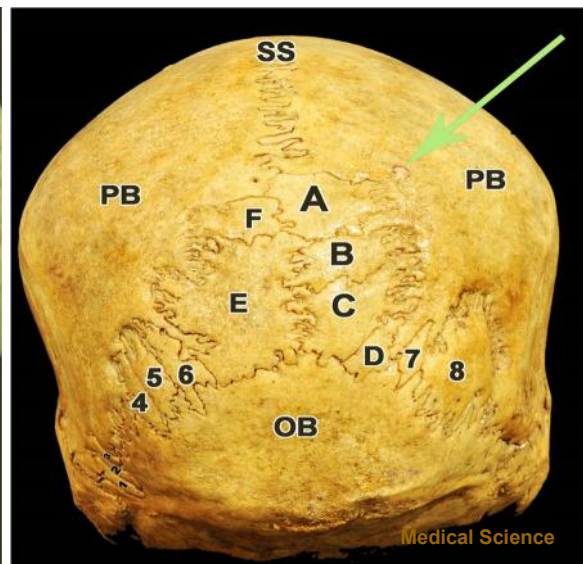


Figure 2
POSTERIOR VIEW OF THE SKULL
1, 2, 3, 4, 5, 6, 7, 8 – ARE ALL THE WORMIAN /SUTURAL BONES AT THE LAMBDOID SUTURE; 1,2,3,4,5,6 – ARE THE WORMIAN BONES ALONG THE LEFT HALF OF LAMBDOID SUTURE; 7, 8 – ARE THE WORMIAN BONES ALONG THE RIGHT HALF OF LAMBDOID SUTURE; A, B, C, D, E, F, - ARE THE INTER PARIETAL BONES WITH IRREGULAR MARGINS; D, F, B, A, C, E – IN ORDER OF THEIR INCREASES SIZES 'D' BEING THE SMALLEST AND 'E' BEING THE LARGEST; NOTE - THE EDGES OF WORMIAN BONES, ALONG THE LAMBDOID SUTURE, NUMBERED 4,5,6&8 ALMOST ALL THE INTERPARIETAL BONES SHOWED SERPIGINOUS APPEARANCE; SS – SAGGITAL SUTURE; PB – PARIETAL BONE; OB – OCCIPITAL BONE

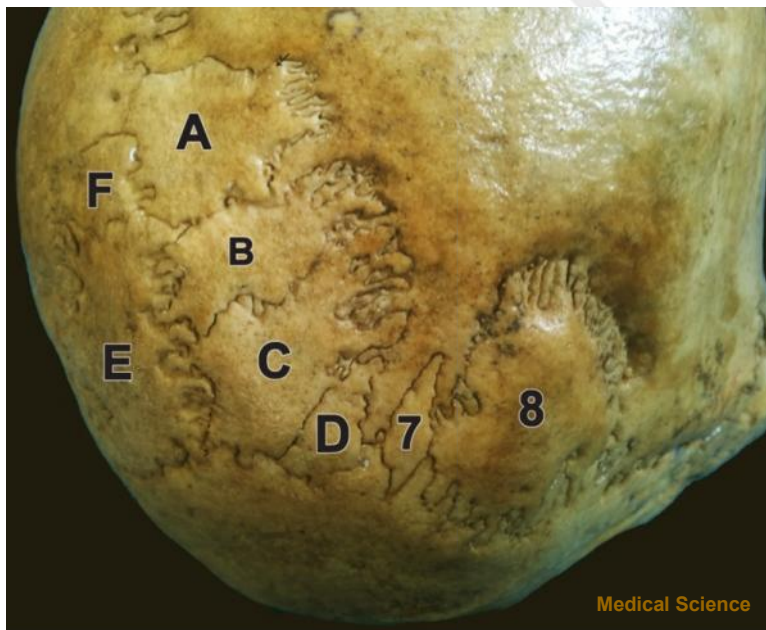


Figure 3
RIGHT POSTERO-LATERAL VIEW OF THE SKULL- ZOOM IN; A, B, C, D, E, F – ARE THE INTER PARIETAL BONES; 7 & 8 – ARE WORMIAN BONES IN THE RIGHT HALF OF THE LAMBDOID SUTURE. 7TH SUTURAL BONE IS SMALLER IN SIZE. 8TH SUTURAL BONE IS THE LARGEST IN SIZE; PB – PARIETAL BONE; OB – OCCIPITAL BONE

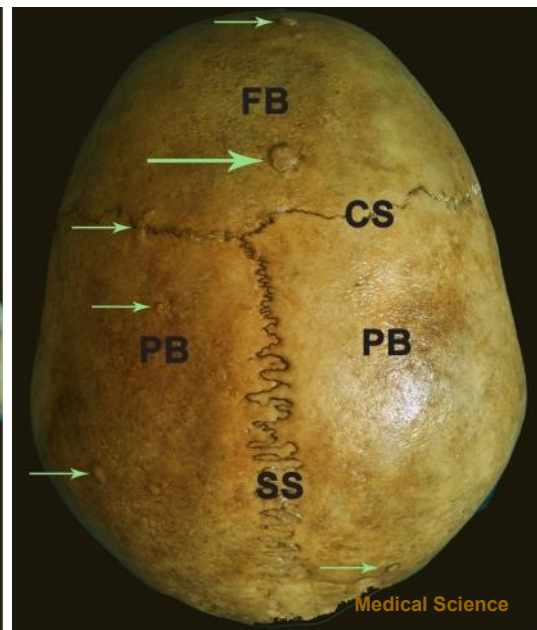


Figure 4
SUPERIOR VIEW OF THE SKULL [SKULL CAP/CALAVARIUM]; ALL THE ARROWS INDICATE THE MULTIPLE LESIONS [BLISTERINGS] OF THE SKULL; TWO LESIONS [BLISTERINGS] ARE NOTED IN THE REGION OF FRONTAL BONE; ONE LESION WITH SUBUNITS ALONG THE CORONAL SUTURE; TWO LESIONS ALONG THE LEFT PARIETAL BONE; ONE LESION OVER THE RIGHT PARIETAL BONE; PB – PARIETAL BONE; FB – FRONTAL BONE; CS – CORONAL SUTURE; SS – SAGGITAL SUTURE

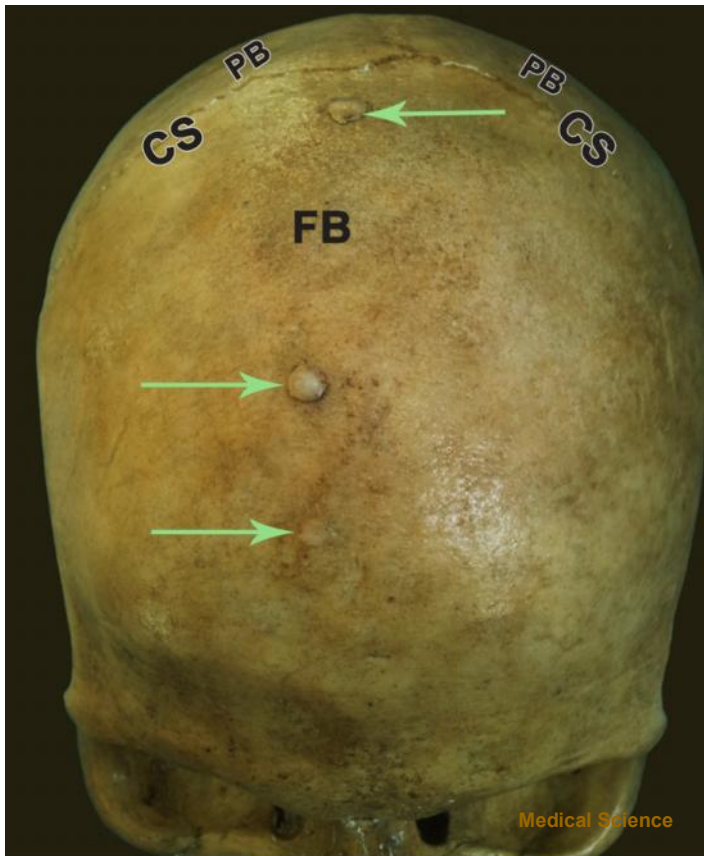


Figure 5

THE ANTERIO SUPERIOR VIEW OF THE FRONTAL BONE OF THE SKULL; ALL THE ARROWS INDICATE THE MULTIPLE LESIONS [BLISTERINGS] ON THE FRONTAL BONE; FB – FRONTAL BONE; PB – PARIETAL BONE; CS – CORONAL SUTURE

Coronal suture:

The suture which is placed between the frontal bone and the two (2) parietal bones dividing the skull into an anterior and posterior part is called the coronal suture.

variable expression (Torgeson, 1951). Their formation might be under the control of a number of genes with additive action (polygenic complex) and their phenotypic expression is conditioned by developmental thresholds (Barberini et al, 2008).

5. *Metabolic disorders:* The formation of wormian bones could result from metabolic disorders of the mesoderm (Hess, 1946).

1.1. Embryological basis

This interparietal bone is believed to be homologous to the post-parietal (dermo-occipitalis) of primitive tetrapod and exist as an unpaired bone in therapsid reptiles (Hymen, 1957). In mammalian skull the interparietal bone is present in carnivores e.g. dog and cat (Fakhruddin, 1967).

The interparietal bone in human skull is represented by that part of squamous occipitals which develop in one membrane. This ossifies in paired center which become continuous with each and with the sub occipital center. Which develop in cartilage, but like most ossification in membrane the number of center may vary (Fakhruddin, 1967). In humans the portion of squamous occipital bone above the highest nuchal line develops in membrane. Normally this part ossifies from 2 pairs of centres, with an occasional 3rd pair of centres for the upper central part of the bone. Nonunion of the parts developed from these centres can result in the formation of anomalous ossicles in this part of the bone. Such separate single or multiple ossicles developed from the first 2 pairs of centres have been named as interparietals and those developed from the occasional 3rd pair of centres have been termed preinterparietals

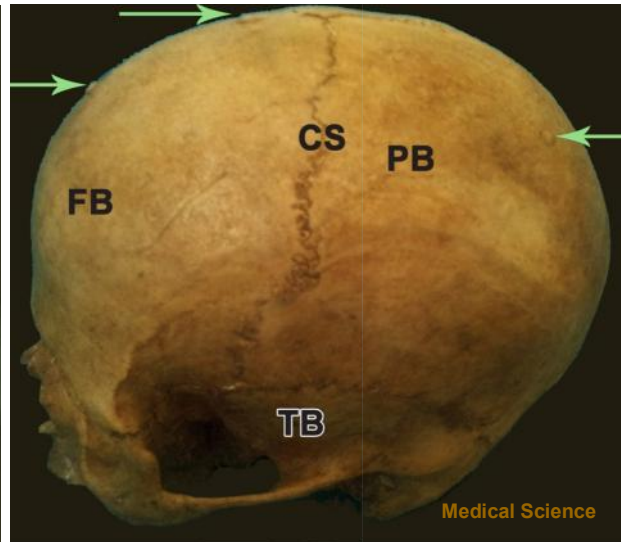


Figure 6

LEFT LATERAL VIEW OF THE SKULL; ARROWS INDICATE THE MULTIPLE LESIONS [BLISTERINGS] OF THE SKULL; TB – TEMPORAL BONE; PB – PARIETAL BONE; CS – CORONAL SUTURE; FB – FRONTAL BONE

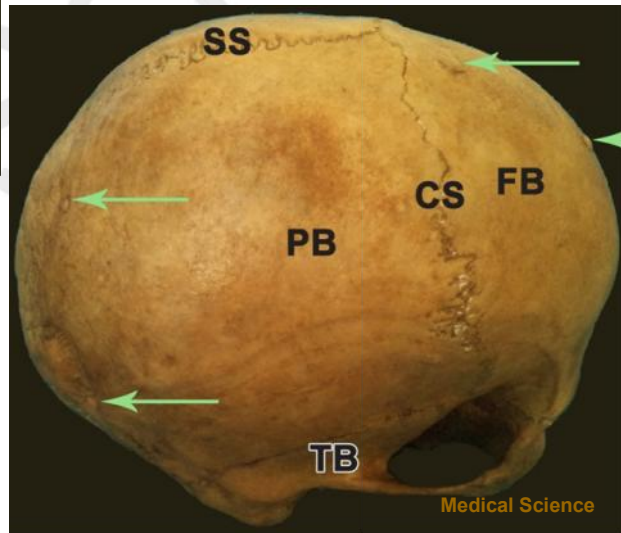


Figure 7

RIGHT LATERAL VIEW OF THE SKULL; ALL ARROWS INDICATING THE MULTIPLE LESIONS [BLISTERINGS] OF THE SKULL; TB – TEMPORAL BONE; PB – PARIETAL BONE; CS – CORONAL SUTURE; SS – SAGGITAL SUTURE; FB – FRONTAL BONE

(Ranke, 1913; Breathnach, 1965; Srivastava, 1977; Warwick and Williams, 1980; Pal, et al. 1984).

2. SCOPE OF THE STUDY

Occasionally the WBs look like fractures and may confuse the radiologist or surgeon. It is more problematic if 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 Traumatologists in day to day clinical practice. The wormian bones, in themselves, do not carry a pejorative prognosis, and thus the prognosis will depend on the type and severity of the associated diseases. The knowledge of WBs is enlightening for the neuroanatomists, neurosurgeons, orthopedicians, radiologists dealing with trauma cases, anthropologists and morphologists.

Comparison

1. The incidence of the wormian bones is variable ranging from 10% in Caucasian skulls, 40% in Indian skulls and 80% in Chinese skulls.
2. Male skulls exhibit wormian bones more frequently than female skulls.
3. Wormian are found most commonly in the lambdoid suture and very rarely in the coronal, sagittal and squamosal sutures.

Content

The terminology of "wormian bones" is derived from a 1643 description of the intersutural bones by Olaus Worm to Thomas Bartholin. However, wormian bones had been described in the past with the first description attributed to Paracelsus (1460 to 1541 CA) (Parker, 1905; Pyles, 1979). Wormian bones have been recognized in an Australopithecine skull. In the 16th century, the anatomists Andemach and Vesale were the first to associate wormian bones with cerebral disorders (Parker, 1905; Pyles, 1979). Parker mentioned several synonyms in his monograph for the wormian bones which are used according to the discoverer- ossicula Andemaci, ossa Goethiano, according to the shape-ossa triquetra, ossa triangularis, ossa quadratum, according to the localization- suturax, fontanellaires, insules, intercalaria, raphogeminantia, apicis, according to the function-complementaria, ossa accessorii, recently, wormian bones are also called ossa wormiana, intersutural bones and inca bones (Parker, 1905).

Sagittal suture:

The suture which is placed in between the two parietal bones, limited anteriorly by the coronal suture and posteriorly by the lambdoid suture is called the sagittal suture. It divides the skull into right and left halves.

Lambdoid suture:

The suture which is placed between the occipital bone and the two (2) parietal bones is called the lambdoid suture.

Lambda:

It is the meeting point between the sagittal and lambdoid suture.

2.1. Materials

A dried adult human skull was obtained from the bone bank of department of anatomy, Shadan Institute of Medical Sciences, Teaching Hospital and Research Centre, Peerancheru, Hyderabad, Andhra Pradesh, India.

2.2. Methodology

All the bones of cranium and the sutures present between them were examined systematically for the presence or absence of wormian bones. Also the associated cranial lesions (blistering) were searched for over the surfaces of the bones and along the sutures. The findings were documented and the photographs of different essential views of the cranium with relevance to wormian bones and multiple lesions (blistering) of the cranium were taken.

3. RESULT/ OBSERVATION

During the routine osteology demonstration classes for medical undergraduate students, we found a series of Wormian bones in the lambdoid suture. All together there were fourteen (14) sutural bones. There were six (6) sutural bones on the left side and two (2) sutural bones on the right side of the lambdoid suture (Figure 1, 2 & 3). There were six (6) interparietal bones (Figure 2). All the sutural bones were irregular in shape. The edges of 1st, 2nd, 3rd & 7th Wormian bones along lambdoid suture are plane. The sagittal suture

was very wavy. Multiple lesions (blisterings) of different sizes were seen on the frontal bone, both the parietal bones, left half of the coronal suture (Figure 4, 5, 6, & 7).

4. DISCUSSION

After studying 225 adult human skulls it was opined that the shape of wormian bones were mostly irregular followed by oval shape. Also quadrangular, triangular and circular were reported but rare (Walulkar SM et al. 2006). In the present case all the wormian bones along the lambdoid suture had irregular shape. The edges of the 1st, 2nd, 3rd & 7th bones are plane. And the edges of the other bones and almost all the interparietal bones showed serpigynous appearances. After studying 180 adult human dry skulls of known age and sex, it was reported that the occurrence of wormian bone was more frequent at lambdoid suture [60%]. They were more common in females [64.8%] than in males' skulls [40.2%], (Manjula patil, 2012). The present variation occurred along the lambdoid suture with eight (8) sutural bones and six (6) interparietal bones and multiple lesions (blistering) were also seen on all the bones forming the calvarium (Skull Cap). Ten (10) wormian bones at the lambdoid suture in an Indian skull with six (6) bones on the left side of lambda and the rest were on the right side. They were irregular in shape. There were no other notable abnormalities in the skull (Satheesha B Nayak, 2008). In the present case there were fourteen (14) wormian bones six (6) on the left side of the lambda and two (2) on the right side. Totally eight (8) wormian bones along the lambdoid suture and six (6) interparietal bones. All of them had irregular margins. The edges of wormian bones numbered 4, 5, 6 & 8 showed serpigynous appearances. A rare anomaly of 5 ossicles in the pre-interparietal part of the squamosal occipital bone in a north Indian was reported (Gopinathan, 1999). The postlambdal part (upper central part) of 5 ossicles in one skull. In the present case there were 6 interparietal bones present with irregular margins. The edges of these bones showed serpigynous appearance.

5. CONCLUSION

A thorough knowledge regarding the gross incidence, sexual dimorphism and number of wormian bones in the human skull is an essential pre-requisite to the neurosurgeons, radiologists and anthropologists.

SUMMARY OF RESEARCH

The presence of series of wormian bones, interparietal bones, with multiple lesions (blistering) of cranium can mislead the radiologists reporting the X-rays/CT scans in cases of head injuries and cranial dysostosis. Also the surgical expertise of neuro surgeons could be challenged performing craniotomies posteriorly or postero laterly for operating cerebellar and cerebello pontine tumors.

FUTURE ISSUES

The prevalence of CNS abnormalities in a population with wormian bones varies from 93% to 100% in a random group and reaches to 100% in a mentally retarded population (Pyles CV and Khan AJ). The presence of wormian bones is almost invariably associated with abnormal development of CNS and may serve as useful marker for the early identification and treatment of the affected infant or child.

DISCLOSURE STATEMENT

There is no financial support for this research work from the funding agency.

ACKNOWLEDGEMENTS

THIS PUBLICATION IS DEDICATED TO MY DEAR PARENTS, SRI TALLAPANENI SANKARA RAO, AND SMT. TALLAPANENI BHAVANI DEVI FOR ALL THEIR CONCERN AND INNUMERABLE SACRIFICES THEY MADE FOR ME TO RISE UP TO THIS LEVEL.

Thanks to George J. Williams the librarian Shadan Institute of Medical Sciences Teaching Hospital and Research Centre and his family for all the support extended.

Thanks to S. Tataj Varma and his family for typing the manuscript.

Thanks to all the students whom so ever I have taught for their constant inspiration and encouragement.

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Walulkar et al. (2006):

Wormian bones are the bony ossicles i.e. supernumerary bones of the human skull that develop as extra islands of bone within the calvarial sutures of the skull. Aim of the present study is to find out the incidence and percentage frequency of wormian bones in gross, at various fontanelles or along different cranial sutures. The study also evaluates various sizes, shapes and also differentiate whether it is wormian or fractured skull as seen in medicolegal cases. The study includes 225 adult human skulls and in each skull presence of wormian bones at different sites were noted. The measurements were taken with the help of Vernier Callipers. The study revealed 34.22% gross incidence of wormian bones. 39.13% incidence rate of these bones was observed in males and 21.87% in females. These bones appear in Lambdoid sutures most commonly followed by lambda, asterion and then sagittal suture. These bones are predominantly occurred unilaterally on left side of the skull. The occurrence of wormian bones on lambdoid suture is higher in females, whereas their occurrence in remaining sites of skull is higher in males. Most commonly wormian bones are irregular in shape followed by oval shape.

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