

Variations in the Occurrence of “*Os Inca*” and its Cranial Deformities in South Indian Dry Skulls

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Abstract

Background: The lambdoid suture is found on the posterior aspect of the skull that connects the parietal bones with the occipital bone. In some persons there are individual bones present around this suture called as *os inca* or inca bone or Goethe's ossicle. Occurrence of variation of the inca bones is observed in majority of human populations around the world. *Os inca* has been reported to be associated with other cranial deformities like incomplete metopic suture with asymmetrical frontal sinuses and multiple sutural deformities in a skull bone. The presence of *os inca* in a skull is of great importance to neurosurgeons, radiologists, anthropologists and anatomists.

Aim: To observe the variations in the occurrence of *os inca* and associated cranial deformities.

Materials And Methods: A total of 60 dry human skulls of unknown sex and without any gross abnormality were collected and evaluated. In each skull the presence, number and incidence of *os incae* were observed, noted and photographed. The results obtained were analysed, tabulated and represented in percentages.

Results: The inca bones were observed in 8 out of 60 skulls. Out of the 8 skulls with inca bones, 7 skulls showed single inca bone fragment and 1 skull showed double inca bone fragments.

Conclusion: Variations in the occurrence of *os inca* is often associated with cranial malformations in many of these investigations. Such findings may be used for forensic identification, anthropological studies and are significant clinically. These deformities are often detected in X-rays and this could be important for radiologists and surgeons in day to day clinical practices and warrants meticulous clinical approach.

Keywords: Cranial deformities, Metopic suture, *Os inca*, Skull bone, South Indian skulls.

INTRODUCTION

The human skull is composed of 28 separate bones, of which most are paired and few which are in the median plane are unpaired. The bones in the cranium are held firmly together by fibrous joints termed sutures, which facilitates growth in the developing skull. Individual skull bones develop from separate ossification centres. Sometimes additional ossification centres may develop in or near suture, giving rise to isolated sutural bones also called wormian bones. These sutural bones are usually irregular in size and shape and are often found at the lambdoid suture. This isolated bone at the lambda is termed as the Inca bone or *os inca* or Goethe's ossicle.[1] They may represent a pre-interparietal, a true interparietal or sometimes as a composite element.[2]

The squamous part of the occipital bone consists of two parts, the supra-occipital and interparietal. Embryologically, the interparietal portion ossifies intramembranously and in rare cases, may be separated from the supra-occipital part by a suture. It is then called as interparietal or inca bone. Wormian bones also known as extra sutural bones are extra bone piece that occur within a suture in the cranium.

Inca bones were found to be present in the Inca tribe of South Andes, America (1200-1597 A.D). The Royal family members of the Inca tribe had crown-like configuration on their head.[3] Henceforth, these ossicles have been known as Inca bones. *Os Inca* was found in great incidence in the Inca population, is suggestive of its ethnic correlation and hence their genetic inheritance. The inca bone was first described by Rivero and Tschudy in the year 1851. Since then, it has been reported in varied frequency in different populations of the world. [4]

Occurrence of variation of the inca bones was observed in majority of human populations around the world. The occurrence of inca bone in the present population of the world is generally high, whereas in the North - East Asians it occurs in low frequency, with more lesser frequency in Indians especially in South Indians. [5]

The occurrence in variation of *os inca* is very rare.[6] *Os inca* has been reported to be associated with other cranial deformities like incomplete metopic suture with asymmetrical frontal sinuses and multiple sutural deformities in a skull bone. The anatomical variations in skull are of boundless significance to neurosurgeons, radiologists, anthropologists and anatomists.[7] Information on incidence and number of fragments of Inca bones from South India is underreported. Hence, this study was undertaken to macroscopically evaluate the variation of incidence of *os inca* and to correlate it with cranial deformities using human dry skulls.

MATERIALS AND METHODS

The study was conducted in the Department of Anatomy, Saveetha Dental College & Hospitals, Chennai. A total of 60 dry human skulls of unknown sex, without any gross anomalies were collected and examined. All the dry human skulls were systematically numbered from 1 to 60. The skulls were macroscopically observed with naked eye. The skulls were examined for any associated cranial deformities such as metopic sutures and asymmetrical frontal sinuses. In each skull the presence, number and incidence of *os incae* were observed, noted and photographed. The results hence obtained were analyzed, tabulated and represented in percentages.

RESULTS

On the basis of the study done on the 60 dry skulls of South Indian origin, the following results were obtained (Table - 1 & 2). Out of the 60 skulls, only 8 were found to possess *os incae*. The incidence of occurrence of *os incae* thus being 13.33%. Out of the 8 skulls possessing *os incae*, 7 skulls had one *os inca* (87.5%), 1 skull had two *os incae* (12.5%) and none had three or more *os incae*. The skull containing inca bone is shown in Figure - 1 & 2. The skulls possessing *os incae* were found to have associated cranial abnormalities like metopic suture and asymmetrical frontal sinuses.

Table 1 Number & Percentage of os inca

Total Skulls Examined	Number of Skulls with <i>os inca</i>	Percentage (%)
60	08	13.33%

Table 2 Number of fragment of os inca with percentage

Number of skulls with <i>os inca</i>	Number of fragment of <i>os inca</i> with Percentage (%)		
	One	Two	Three
08	07 (87.5%)	01(12.5%)	Nil

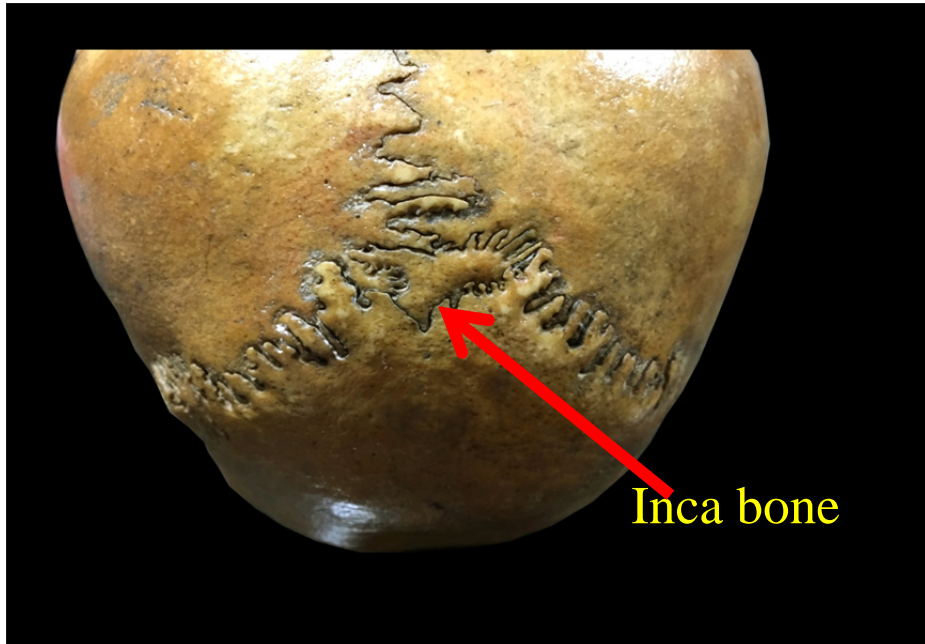


Figure 1 Photomicrograph of posterior view of skull showing the inca bone at lambdoid suture

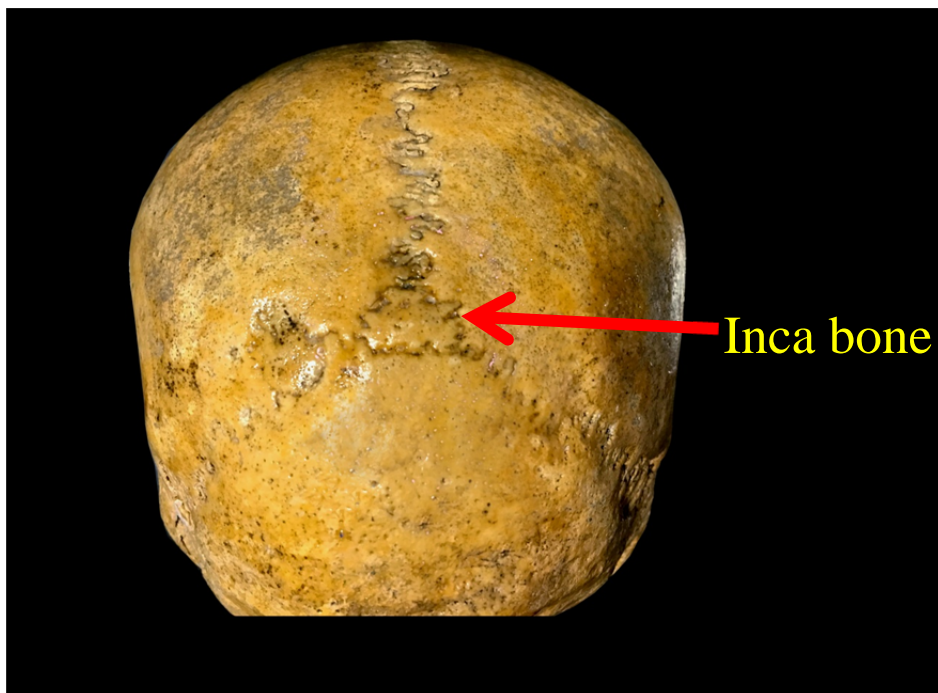


Figure 2 Posterior view of skull showing presence of os inca

DISCUSSION

Assessment of the skulls revealed the incidence of occurrence of *os incae* with associated cranial deformities and other relevant information that are clinically significant.

According to Hanihara et al.,[5] any geographical pattern of Inca bone variation is not particularly obvious however, at the same time, there are some regional variations within each geographical area. This trait is relatively uncommon in the western Eurasian and Northeast Asian samples. Yet the New World and the Sub-Saharan African samples exhibit the Inca bone in relatively high frequencies. The Northwest Coast sample of the New World and the West African sample are the only groups that show frequencies exceeding 10%. The Australian samples are outliers by Pacific standards with frequencies of 1% or less.

In RR Marathe's study[6] in Central India, gross incidence of *os incae* was 1.315% (5 Inca bones in 380 dry skulls observed). This study revealed the gross incidence of Inca ossicles in South Indian population to be 13.33% and found to be associated with cranial deformities like metopic suture and asymmetrical frontal sinuses.

In Chandrakala Aggarwal's study[7] in Rajasthan, a total of eighty-two skulls were examined. Presence of *os inca* was observed in only one skull, thus the percentage was found to be 0.99%. An abnormally high incidence (27.71 %) of *os inca* was found in the pre-Hispanic skulls dated between 300-1200 A.C[8]. Berry *et al.*, reported 2.9% - 4.6% incidence in American population of South West coast.[9] A different incidence in population of North India (0.4%) has been reported by Singh PJ.[10] In Dharwal Kumud's study[11] in Amritsar, out of 150 dry skulls only 4 were found to contain *os incae*. The incidence being 2.66%.

Inca bones may give an untrue appearance of fractures which may produce difficulties during burr-hole surgeries and their extensions may pave way to continuation of fracture lines. Because of their clinical implication, information of presence of Inca bones, their incidence and number of fragments is essential to clinicians.[9,12] The presence of *os Inca* may be thus used as a dependable evidence for familial identity in medico-legal cases.[13]

The inca bones may occur because of partial or complete failure of fusion of the ossification centres of the squamous part of the occipital bone.[2] The occipital bones ossify in four centers, one for membranous squamous part, one for the basal cartilaginous part and two for the condylar part of the occipital bone.[14] Inter-parietal bones may occur due to failure of fusion between primary and secondary centers of ossification of occipital bone.[15] The supplementary sutures present due to these bones may be misinterpreted as posterior skull fractures with grave radiological, surgical and forensic implications.[16]

The skull, the primary evidence for many medicolegal issues, possessing *os inca* can thus be used for forensic identification and anthropological studies. These findings might be suggestive of natural evolutionary

changes, probably undulating on either side of the spectrum.

CONCLUSION

Variations in the occurrence of *os inca* is of great importance in medicolegal issues and forensic studies. Their radiological, surgical and medico legal importance cannot be undermined even though their simulation as fractures may lead to unwarranted surgeries. Being rare in occurrence and being associated with other cranial deformities, the presence of inca ossicles can thus be used in forensic studies as a tool for identifying an individual as it proves to be a genuine evidence. Thus, providing anatomical insight into the morphology of sutures, frontal sinuses and associated cranial abnormalities are important findings relevant for surgeons and radiologists in clinical practice.

REFERENCES

- [1] Akram Abood Jaffar. Sutural bones. 2009; 10—25.
- [2] Williams PL, Bannister LH, Berry MM, Collins P, Dyson M, Dussek JE, et al. The skull. In. Gray's Anatomy, 38th Edition, London: Churchill Livingstone; 1995. p. 583-606.
- [3] Moseley M. In. The Archaeology of Peru. London: Thames and Hudson; 1992. The Incas and Their Ancestors; p. 8.
- [4] Srijit Das, Rajesh Suri, Vijay Kapur. Anatomical observations on *os inca* and associated cranial deformities. *Folia Morphol.* Vol. 64, No. 2, pp. 118–121. 2005.
- [5] Hanihara T, Ishida H. *Os Incae*: Variation in frequency in major human population groups. *J Anat*, 2001, 198; 137–152.
- [6] Marathe, RR et al. "Inca - Interparietal Bones in Neurocranium of Human Skulls in Central India." *Journal of Neurosciences in Rural Practice* 1.1 (2010): 14–16. *PMC*. Web. 17 Jan.2017.
- [7] Chandrakala Aggarwal, Isha Srivastava, Nirmala Swami, Priyanka Sharma, Madhu Bhati. Incidence of interparietal bone in population of Rajasthan. *Indian Journal of Basic and Applied Medical Research*; June 2015; Vol.-4, Issue- 3, P. 488-491.
- [8] Garcia HF, Murphy EG. Frequency of interparietal bone or Inca bone in pre-Hispanic atacamenos skulls of the north of Chile. *Int J Morph.* 2008 in press.
- [9] Carolineberry A, Berry RJ. Epigenetic variation in the human cranium. *J Anat.* 1967;101:361–79.
- [10] Singh PJ, Gupta CD, Arora AK. Incidence of interparietal bones in adult skulls of Agra Region. *Anat Anz.* 1979;145:528–31.
- [11] DharwalKumud. *Os Incae* Morphometric, Clinical and Medicolegal Perspectives. *J. Anat. Soc. India* 60(2) 218-223 (2011).
- [12] Nayak S, Soumya KV. Unusual sutural bones at pterion. *Int J Anat Vari.* 2008;1:19–20.
- [13] Purkait R, Chandra H. The identity of Inca, medicolegal importance and suggested nomenclature of variants. *J Anat Soc Ind.* 1989;38:162–71. Standring S, Borley NR, Collins P, Crossman AR, Gatzoulis MA, Healy JC, et al. In. Gray's Anatomy. 40th Edition. London: Churchill Livingstone; 2008. External Skull; pp. 411–8.
- [14] Matsumura G, Uchiyumi T, Kida K, Ichikawa R, Kodama G. Developmental studies on the interparietal part of the human occipital squama. *J Anat.* 1993;182:197–204.
- [15] Fujita MQ, Taniguchi M, Zhu BL, Quan L, Ishida K, Oritani S, Kano T, Kamikodai Y and Maeda H. Inca bone in forensic autopsy: a report of two cases with a review of the literature. *Legal Medicine.* (2002);4 (3): 197-201.
- [16] Agarwal SK, Malhotra VK, Tewari SP. Incidence of the metopic suture in adult Indian Crania. *Acta Anatomica*, 1979, 105: 469–474.
- [17] Mohammed Ahad, Thenmozhi M.S. Study on Asterion and Presence of Sutural Bones in South Indian Dry Skull. *J. Pharm. Sci. & Res.* Vol. 7(6), 2015, 390-392.
- [18] Deepti Anna John, Thenmozhi. Anatomical Variations of Foramen ovale. *J. Pharm. Sci. & Res.* Vol. 7(6), 2015, 327-329.
- [19] Ajrish George S, MS. Thenmozhi. Study of Occurrence of Metopic Suture in Adult South Indian Skulls. *J. Pharm. Sci. & Res.* Vol. 7(10), 2015, 904-906.