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The Inca Bone: *A* Throwback to an Ancient Civilization And People

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ABSTRACT

Introduction: The human skull is made up of 22 paired and unpaired bones of differing embryological origin. They are classified as viscerocranium and neurocranium. While the viscerocranium forms the skeleton of the face, the neurocranium forms the cranial cavity that surrounds and protects the brain and brainstem. Along the sutures of the neurocranium, supernumerary bones called wormian bones may be present. Aside from this a bone called the Goethe's bone or inca bone has been identified. **Methods:** 322 articulated adult skulls were taken from the archives of the Department of Anatomy, Amrita School of Medicine, Kochi. They were of undetermined age and sex, as these were not recorded at the time of acquisition. **Results:** Out of 322 skulls examined, 3 showed the presence of interparietal bones. The incidence of interparietal bone being 0.93% in the present study. Os inca totum, os inca bipartite and os inca tripartite variants were noted. **Conclusion:** The presence of this variant can be explained on the basis of ossification of the occipital bone. Inca bones may give a false appearance of fractures which may produce difficulties during burr-hole surgeries and their extensions may pave way to continuation of fracture lines. Presence of inca bones, their incidence and number of fragments is of importance to clinicians for the differential diagnosis of fractures.

Keywords: Neurocranium; Sutures; Wormian bone; Os inca; Fracture line.

Introduction

The human skull is made up of 22 paired and unpaired bones of differing embryological origin. They are classified as viscerocranium and neurocranium. The neurocranium forms the cranial cavity that surrounds and protects the brain and brainstem. The viscerocranium is limited to the anterior and lower regions of the skull include the mandible and form the facial framework. The neurocranium is formed by the unpaired occipital, sphenoid, ethmoid and frontal bones and a pair of temporal and parietal bones that are of variable size and articulate at sutures. Along the sutures, supernumerary bones called wormian bones may be present. Aside from this a bone called the Goethes bone or inca bone has been identified.

The inca bone was first described by Rivero and Tschudy in the year 1851 in the study on two Peruvian mummies. Inca bones were supposed to be present in the inca tribal's in South Andes – America in the period 1200-1597 A.D. The idea that it was a racial characteristic gave the bone its demographic name[1].

But it has been reported in varied frequency in different populations of the world. Research studies have described the frequency distribution of os inca in Native Americans, Sub-Saharan Africans, Japanese, Indians, the populations of Oceania and the Pacific, Northeast Asia and the New World and on a worldwide scale[2-4]. In the area bounded by the lambdoid suture and sutura mendosa lie the inca ossicles. They were previously known as os-inca, os-ipactal, Goethe's ossicles[5]. Gordan while describing the inca bone drew parallels between and the triangular architectural monument design of the inca tribe6. The Royal family of the inca tribe wore a crown-like configuration on their head, from which was derived the name of this bone[7].

The mendosal suture also known as biasterionic suture is an accessory suture of the occipital bone situated superior to the transverse sinus[8]. The origin of the suture is usually above the asterion and occasionally below it and runs horizontally from the medial portion of the lambdoidal suture. In their study, Hanihara and Ishida found that the frequency of this shows ethnic, racial and geographical differences[9].

Several authors have observed the variable time of closure of this suture in children from several days after birth till 10 years of age. Research has observed its presence among adults in various frequencies[9,10]. The presence of the mendosal suture and resultant inca bone can be attributed to the process of ossification

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of the occipital bone.

This study aims to determine the prevalence of inca bone in south Indian population and correlate its presence embryologically.

Materials and Methods

322 articulated adult skulls were taken from the archives of the Department of Anatomy, Amrita School of Medicine, Kochi. They were of undetermined age and sex, as these were not recorded at the time of acquisition.

Inclusion Criteria

Adult human dry skull irrespective of sex, Calvarias intact, sutures well defined.

Exclusion criteria

1. Disarticulated adult skulls
2. Fetal skull

The skulls were observed with naked eye and photographs were taken for further analysis.

Results

Out of 322 skulls examined, 3 showed the presence of interparietal bones. The incidence of interparietal bone being 0.93% in the present study.

In the first skull, an os inca totum type of inca bone was noted, the mendosal suture are seen at the level of asterion (Figure 4)

In the second variant, os inca bipartite was noted, the mendosal suture was visualised above the asterion and the right segment appeared smaller than the left (Figure 5)

In the third specimen, os inca tripartite was noted, the mendosal suture was at the level of the asterion and 3 segments were of equal size (Figure 6)

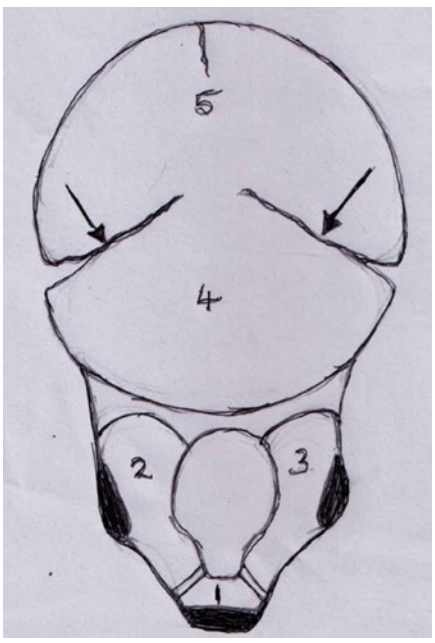

Figure 1. Parts of the occipital bone:
Basioccipital (1), paired exoccipital (2 and 3), and supraoccipital (4) derived from cartilage; interparietal (5) derived from membrane. Arrows point to mendosal sutures which separate interparietal from supraoccipital segment.

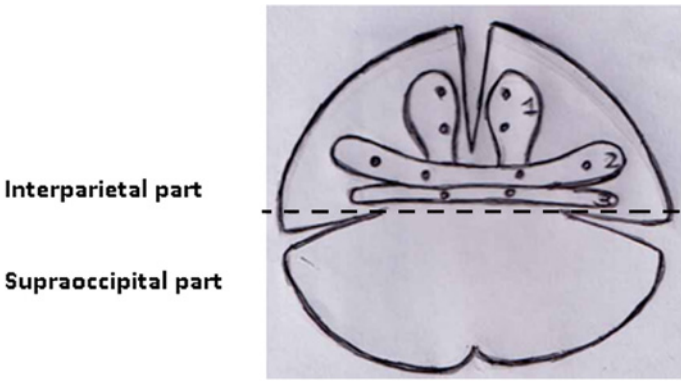

Figure 2. Ossification centre and nuclei of the occipital Squama.
• - Nuclei, 1-Middle part, 2-Lateral Part, 3- Intermediate part

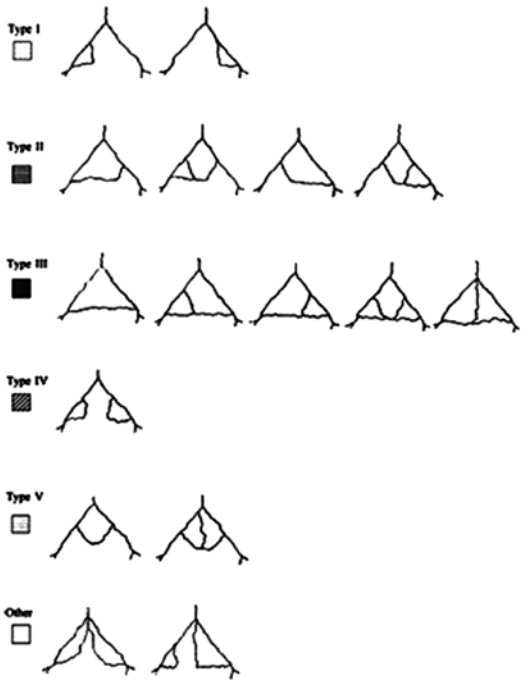

Figure 3. Hanihara and Ishida classification of different types of os inca[9].

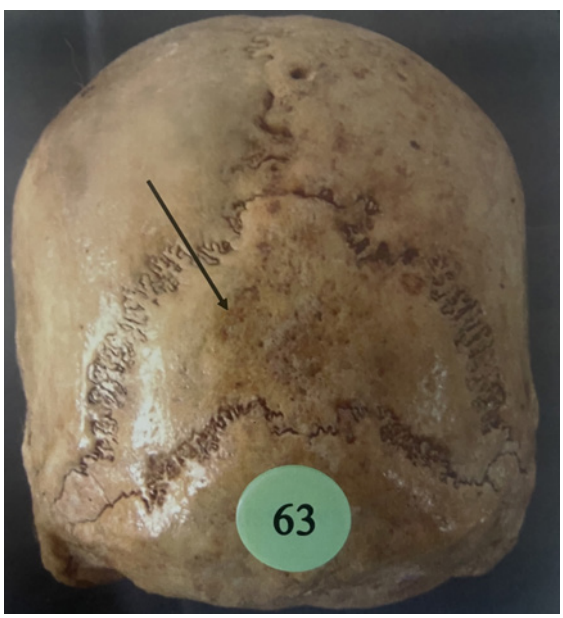

Figure 4. Os inca totum

Figure 5. Os *inca bipartite*

Figure 6. *Os inca tripartitum*

Discussion

In RR Marathe's study in Central India, incidence of os inca was 1.315%, 5 inca bones were observed in 380 dry skulls studied[11]. The study by Donapudi and Vijayanirmala revealed the gross incidence of inca ossicles in South Indian population to be 2.6%[12] in the studies on North Indian population by Singh was 1.6%[13]. In the present study we estim ated 3 os inca out of 322 skulls studied, the percentage being around 0.93.

The presence of this variant can be explained on the basis of ossification of the occipital bone. The occipital bone has 3 parts the basal, squamous and the condylar parts. They ossify from 5 sources being partly membranous and partly cartilaginous. The cartilaginous part results from the union of four centres bordering the foramen magnum while the fifth membranous element is solitary.

Thus, the occipital bone develops through two processes, endochondral ossification and cartilaginous ossification. There are four cartilaginous elements; the basioccipital, anterior to the foramen magnum, the lateral or exoccipital on each side of the foramen magnum, and the supraoccipital posterior to the foramen magnum forming the squama below the mendosal suture. The membranous element gives rise to the interparietal bone. By 12 weeks of gestation, the interparietal and supraoccipital segments fuse in the midline but remain separated laterally by the mendosal sutures. At 34 weeks there is further union of the interparietal and supraoccipital segments, and the mendosal sutures are reduced to narrow slits and complete obliteration is secured by 2 years, postnatal. If the sequence of events is disrupted involving the failure of fusion between the supraoccipital and interparietal parts a single entity inca bone or os inca totum results[14]. The os inca totum seen in this study can be explained on this basis.

According to Matsumara et al in the membranous part there are 3 pairs of ossification nuclei, one of them appears on each side of the midline between the superior and highest nuchal lines and the other two are bilaterally above the highest nuchal line. Failure of fusion of centres produces bipartite and tripartite inca[15].

Hauser & De Stefano described the various patterns of the os inca bones, classified from Type I to V. Schematic presentation of various patterns of the inca bones is provided here. All the inca bones observed in this study belong to type 3[16].

There is some obscurity in literature concerning the limits and ossification of the membranous portion of the occipital bone, known as the interparietal in man. In primates and in man, they fuse with the occipital while in some other mammals they persist as a distinct entity[17]. In rodents they fuse with both the occipital and parietal bones but in marsupials, ruminants and ungulates they fuse with parietals[18]. So phylogenetically its relation to the occipital seems to be evolutionary.

Conclusion

Inca bones may give a false appearance of fractures which may produce difficulties during burr-hole surgeries and their extensions may pave way to continuation of fracture lines. Presence of inca bones, their incidence and number of fragments is of importance to clinicians for the differential diagnosis of fractures[19].

The demerit of this study is the inability to gender differentiate the skull.

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