

Anatomical observations on *os inca* and associated cranial deformities

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The present study describes the presence of os inca, incomplete metopic suture with asymmetrical frontal sinuses and multiple sutural deformities in a skull bone. Os inca has been reported to be associated with other cranial deformities. However, the present study, besides reporting os inca and associated sutural abnormalities, also highlights the presence of an unusual pterion in such cases. The aim is to provide anatomical insight into the morphology of sutures, frontal sinuses and associated cranial abnormalities. These are important findings which may be relevant for surgeons and radiologists in clinical practice

Key words: frontal sinus, metopic suture, *os inca*, wormian bone

INTRODUCTION

Supernumerary bones represent additional ossification centres near the sutures [28]. These supernumerary bones are frequently found in the lambdoid suture and also near the fontanelles [28]. An isolated bone which is found at the lambda is known as the "Inca Bone" or "Goethe's ossicles" [28]. Past research studies have reported varieties of ossicles at or near the lambda [26].

The inca bone was first described by Rivero and Tschudy in the year 1851 [17, 20, 21]. Since then, 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 world-wide scale [6, 7, 13, 17, 20–23, 25, 26].

Metopic suture represents the union of the left and right halves of the frontal bone. It extends from the nasion to the bregma and has been found to disappear by the age of 6 to 8 years [2, 11, 27]. If the metopic suture persists beyond this time, it is known as "metopism". Past research studies have defined

complete metopic suture as that which extends from the nasion to the coronal suture or to a point 2 cm anterior to it and incomplete metopic suture as one which might be present anywhere in the upper, middle or lower part of the frontal bone [1, 2].

Incidence of metopism is reported to be 7–10% in Europeans, 4–5% in Asians, 1% in Africans, 1% in Australians and 4.4–5.5% in Indians [1, 5, 15]. The world-wide incidence of metopism has been reported to vary between 0 and 7.4% in different ethnic groups [5].

Metopism has been reported to be associated with brachycephaly or dolicocephaly [15]. Complete metopism is also reported to be associated with the absence of the frontal sinus, sutural bones, prominent external occipital protuberance and serrated sutures [3]. Past research studies have described well developed coronal sutures in skulls with metopism [3]. The present study reports an interesting finding of partially developed coronal suture and an ill defined pterion, which may be of interest to neurosurgeons.

The present study also describes the asymmetry of the frontal sinuses associated with a case of incomplete metopic suture. Metopic or sagittal sutures may be confused with midline vertical fractures of

the frontal bone [2, 16]. The presence of metopic suture may also be important for radiologists and ENT surgeons in clinical practice. As well as its radiological importance, the presence of sutural abnormalities and ossicles in the skull could have an important role to play in forensic and anthropological studies.

CASE REPORT

During routine scanning of bones in the osteology section of the Department of Anatomy we detected multiple cranial abnormalities in a human skull. The skeletal observations, including morphometric measurements, with regard to the morphology of the sutures were noted and the bone specimen photographed. In addition, a radiograph of the skull was taken and anatomical observations on the frontal sinuses and metopic suture were recorded.

Anterior view (Fig. 1)

The frontal bone showed prominent superciliary arches indicative of female sex. There was an incomplete metopic suture, of which the lower 2 cm were prominent, whereas the upper 5 cm were observed as a faint line. The metopic suture displayed serrated

margins. It was not situated in the midline and displayed deviation to the left. The superior and inferior limits of the metopic suture were designated as "S" and "I" respectively. The distance between "S" and the frontozygomatic suture at the lateral orbital margin measured 7 cm and 7.5 cm on the left and right sides respectively. The distance between "I" and the frontozygomatic suture on the lateral orbital margin measured 6 cm and 6.5 cm on the left and right sides respectively.

A radiograph (PA view) of the skull revealed asymmetrical frontal sinuses (Fig. 2). The maximum transverse measurements of the frontal sinuses were recorded on each side (scale given in Fig. 2).

The maximum transverse width of the frontal sinuses was 3 cm and 4 cm on the left and right sides respectively. The right frontal sinus was larger in size than that on the left. Furthermore, the left frontal sinus exhibited a septate appearance.

Superior view (Fig. 3)

Although the anterior and posterior parts of the sagittal suture traversed the midline, the central part deviated slightly to the right. The parietal foramen on the left was larger than that on the right. The



Figure 1. Photograph of the frontal view of skull showing: I — the inferior limit of metopic suture near the nasion; S — superior limit of metopic suture; F — frontozygomatic suture; supraorbital margin shown with arrows.

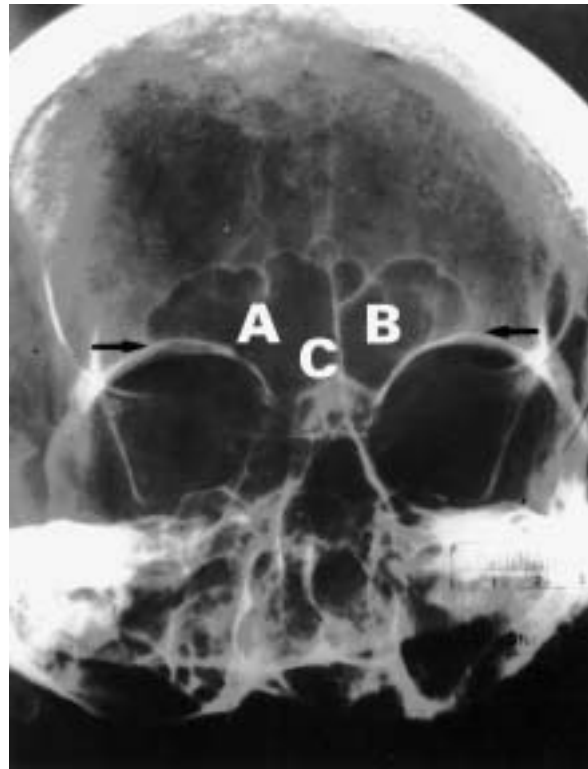


Figure 2. Radiograph of skull (PA view) showing: A, B — right and left frontal sinuses respectively; C — metopic suture; supraorbital margins are shown with arrows.



Figure 3. Photograph of superior view of skull showing: S — sagittal suture; P — parietal foramen; I — inca bone; L — lambdoid suture; E — external occipital protuberance; the supernumerary bone is shown with a dotted outline; right deviation of sagittal suture (→).

termination of the sagittal suture near the lambda was marked by the presence of the inca bone, which was triangular in shape. The width of the base and vertical height of the inca bone measured 1.3 cm and 1 cm respectively. The distance between the base of the inca bone and the external occipital protuberance measured 8 cm. The angles between the sagittal suture and the coronal suture measured 80° and 100° respectively. The left half of the coronal suture was found to be prominent in its upper part. However, the portion of the coronal suture below the left temporal line displayed synostosis.

Posterior view (Fig. 3)

On examining the external surface of the occipital bone, an additional supernumerary bone, measuring 1.9 cm transversely, was found 3 cm above the medial end of the left superior nuchal line. The superior nuchal line was very prominent on both sides.

Lateral view (Fig. 4)

The portion of the squamous part of the temporal bone forming the temporoparietal suture displayed a triangular projection directed posterosu-



Figure 4. Photograph of the lateral view of the skull (left side) showing: 1 — superior border of the temporal bone; 2 — pterion; 3 — coronal suture; 4 — lambdoid suture; 5 — superior nuchal line; the partially defined parietosphenoid suture is shown with a single arrow (↑); the supernumerary bone near asterion is shown with double arrows (↑↑).

teriorly. Interestingly, in the region of the pterion, the parietosphenoid and frontosphenoid sutures were ill defined. As a consequence, the region of the pterion was not clearly discernible. An additional supernumerary bone was noticed near the asterion on the right side.

DISCUSSION

In the present study, incomplete metopism was observed to be associated with fully developed frontal sinuses. This is in agreement with the findings of previous researchers [3]. A septate frontal sinus on the left side in association with incomplete metopic suture is an unusual finding. The asymmetry of the frontal sinus is an interesting observation in the present study. The morphometric observations of the topography of the frontal sinus clearly substantiate the finding that the frontal sinuses are asymmetrical, the right sinus being larger than the left. On the basis of the present findings, we suggest that an incomplete metopic suture might be associated with an asymmetrical frontal sinus.

Metopism is clinically important in genetics, growth and development [3]. There have been past research studies of metopic suture associated with prominent external occipital protuberance, sutural bones and well developed coronal sutures [3]. The presence of prominent external occipital protuberance and sutural bones in the present study is well in agreement with earlier studies [3]. In an earlier report, it was stated that the sagittal synostosis redirects the growth vectors of the neurocranium in a more antero-posterior fashion, which could result in

an increased number of lambdoid wormian bones [19]. In contrast, the present study reports coronal synostosis associated with *os inca* and normal sagittal suture morphology.

The clinical importance of the metopic suture lies in the fact that it is often confused with fractures or even with sagittal suture [2, 16]. The important finding that differentiates metopic suture from a fracture is the presence of serrated and sclerotic edges in a metopic suture [3].

The presence of the *inca* bone is an associated finding in individuals with metopic suture. Its formation is the result of the failure of the latter interparietal bones to fuse [12]. Research studies have reported the fact that after the second interparietal bones are formed, additional centres appear at the lambda [18]. These often form a triangular area [18].

Past research studies have shown wormian bones to be more common in crania with the *inca* bone [21]. Interestingly, in the present study we also detected one wormian bone close to the asterion and a small supernumerary bone above the left superior nuchal line.

The *inca* bone has been reported to be genetically controlled [5]. There have been reports of incidence of the *inca* bone associated with sutural bones and cranial deformities [21]. The presence of supernumerary bones is attributed to the stress which causes cranial deformation [4, 9, 10, 14, 21]. The mechanical stress to the bone in the early stages of growth and development (ontogenic stress) has been reported as a cause of sutural variation [8, 21, 24]. The presence of ossicles has also been reported to be more common at lambda and the present study substantiates this fact.

The presence of an ill defined pterion is an interesting finding which may be of importance for neurosurgeons. The presence of metopism, ossicles in the skull and sutural abnormalities may be associated with other cranial deformities and warrants meticulous clinical approach. These deformities are often detected in X-rays and this could be important for radiologists and surgeons in day-to-day clinical practice.

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