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Skull Fracture or Accessory Sutures: How Do We Tell the Difference?

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Abstract: ***This article examines the challenges associated with differentiating between skull fractures and accessory sutures in paediatric radiology using plain film radiography. Skull fractures are often obscured by the presence of synchondroses and unusual accessory sutures in children. The study emphasizes the importance of three - dimensional reconstructions from cranial CT scans in confidently distinguishing questionable fractures from accessory sutures. Key characteristics such as bilaterality, symmetry, associated diastasis, and the presence of soft tissue swelling are discussed for accurate differentiation. Additionally, knowledge of normal anatomy and sutural closure timing is crucial in deciphering complex accessory sutures, particularly in the occipital region. In cases where differentiation remains elusive, follow - up studies can provide insights into the healing process, aiding in a definitive diagnosis.***

Keywords: skull fractures, accessory sutures, paediatric radiology, cranial CT, radiographic differentiation

1. Introduction

Plain film radiography remains the most cost - effective method in evaluating skull fractures and can easily differentiate major sutures and common vascular grooves from fractures. However, in children this can be complicated due to the presence of numerous synchondroses and unusual accessory sutures. Plain film evaluation is especially challenging not only because of various artifacts that can degrade the study but also the inability to visualize intracranial processes, such as contusions and haemorrhage, that can substantiate a calvarial finding.

Minimal soft tissue swelling can be difficult to see even with oblique views. Superimposition of normal suture lines like the metopic suture can mimic a fracture if one is not careful to obtain additional views [1]. During the past decade, the increasing use of spiral and multidetector CT have led to the ability of workstations to generate three dimensional (3D) reconstructions of the skull. Therefore, if cranial CT is deemed clinically necessary in trauma patients, questionable fractures can be confidently differentiated from unusual accessory sutures using these additional workstation capabilities.

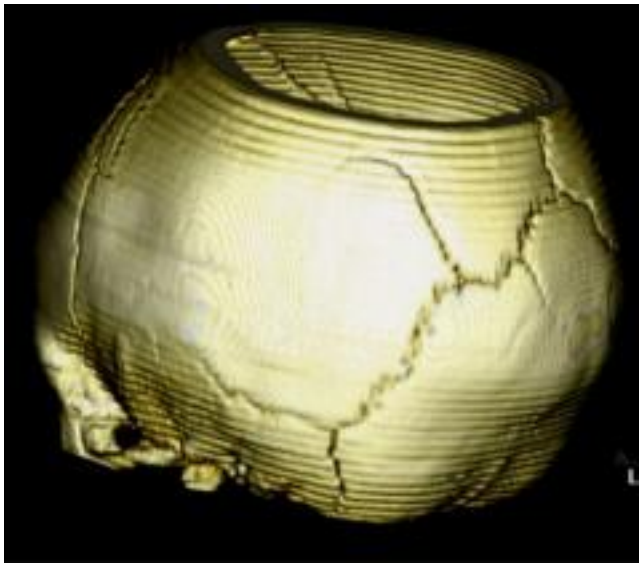

Figure 1: Accessory intraparietal or sub sagittal suture

Normal ossification centres

The parietal and occipital bones in particular are common regions for accessory sutures because of their multiple ossification centres. The parietal bone ossifies from two centres while the occipital bone ossifies from six centres [2, 3]. An accessory intraparietal or sub sagittal suture is rare but can be seen dividing the parietal bone (Fig.1). They can be explained on the basis of incomplete union of the two separate ossification centres [4]. These are usually bilateral and fairly symmetrical but can at times be unilateral.

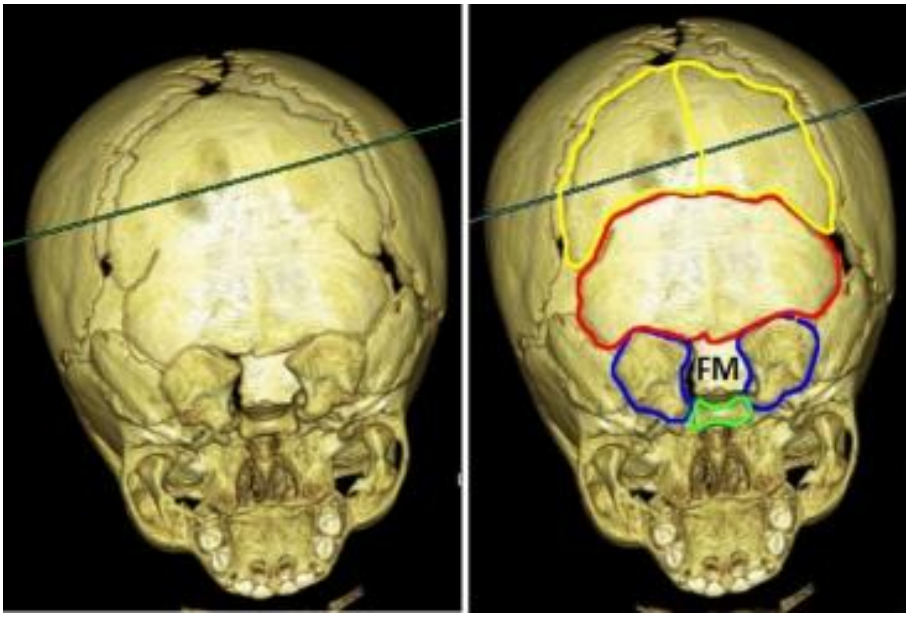

Figure 2: Three - dimensional reconstruction of the occipital bone outlining the six ossification centres including the remnant of the midline occipital fissure (arrow). Two interparietal ossification centres (yellow), single supraoccipital centre (red), two ex occipitals (violet), and single basioccipital (green). FM foramen magnum

The occipital bone has a more complex development. The foramen magnum is surrounded by four ossification centres. On each side are the exoccipitals, ventrally located is the basioccipital and dorsally, the supraoccipital centre contains the midline occipital fissure which can sometimes persist antenatally (Fig.2). This pattern of development can therefore, give rise to numerous accessory sutures that could be mistaken for fractures especially with plain film evaluation alone.

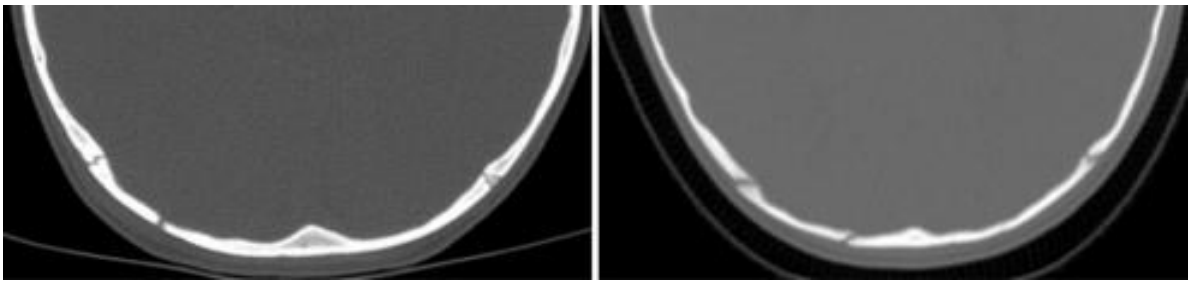

Figure 3: (a) This sharp lucency with adjacent mild soft tissue swelling represents a fracture.
b In contrast, this occipital accessory suture (yellow arrow) has a sclerotic border with irregular interdigitations similar to the adjacent lambdoid sutures (smaller arrows). Note the absence of soft tissue swelling

CT scan with 3D reconstruction is vital in the further characterization of a questionable fracture. Widening of the fracture line as it approaches the suture or there is associated diastasis of the adjacent synchondrosis or suture. (Fig.4).

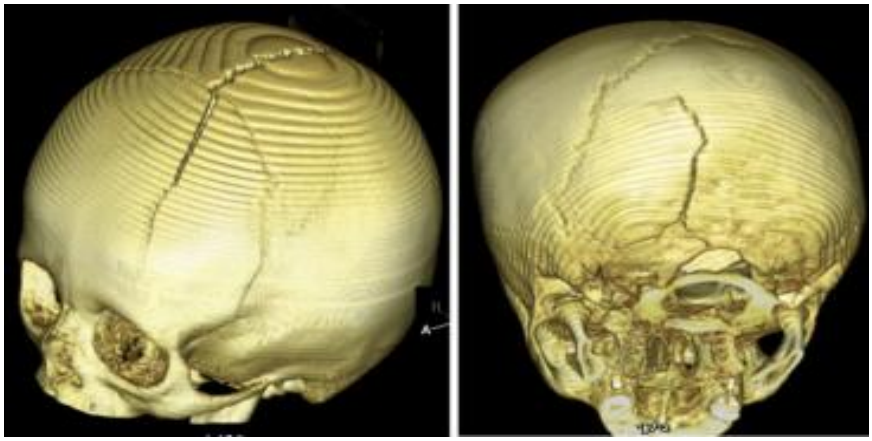

Figure 4: (a) Notice how the fracture line is narrow proximally but progressively widens as it extends into the sagittal suture. (b) In a different patient, the left occipital bone fracture (arrow) extends into and slightly widens he posterior intraoccipital synchondrosis (small arrow)

An accessory suture will usually not produce this appearance. High impact fractures can cross suture lines or extend from one major suture to another, whereas accessory sutures join and merge with the major suture (Fig.5).

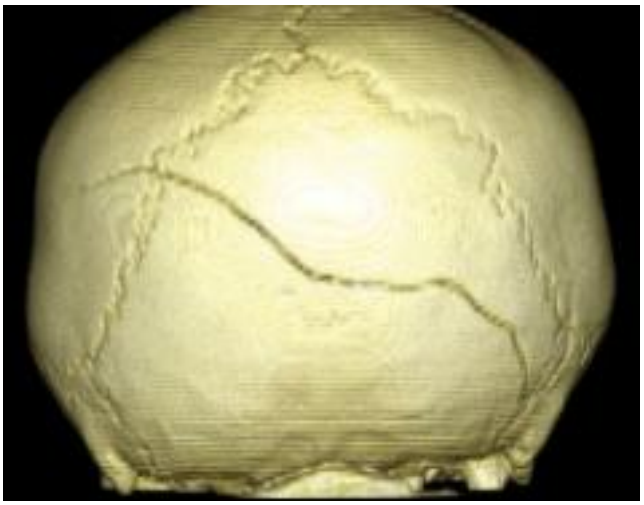

Figure 5: High impact injury with a non - depressed fracture line extending from both lambdoid sutures and crossing over into the left parietal bone. Accessory sutures will not produce this appearance

In terms of bilaterality, accessory sutures are often present on both sides and are fairly symmetric especially in the parietal bones [2]. Occipital accessory sutures can be complex and multiple but are also frequently bilateral [5]. However, skull fractures can also be bilateral. When they are, these fractures are almost always associated with high impact injuries and thus will often show comminution, depression, and marked asymmetry. Hence, these complex and high impact fractures are almost never confused with developmental variants [6, 7]. Finally, soft tissue swelling or hematoma is frequently associated with Radiographic differentiation of skull fracture and accessory suture

Simple non - depressed skull fractures are sharp lucencies with non - sclerotic edges. In contrast, accessory sutures usually will show a zigzag pattern with interdigitations and sclerotic borders similar to major calvarial sutures (Fig.3). When fractures extend into a major suture, there could be acute skull fractures. One study has shown that at at least 4 mm of soft tissue swelling was present on the cranial CT scan in all cases of acute skull fractures that they reviewed [8]. However, absence of subgaleal hematoma or swelling does not entirely rule out a fracture especially if the injury is remote or imaging was performed several days after the trauma [9]. Its presence though is highly suggestive of an acute traumatic event. (Fig.6).

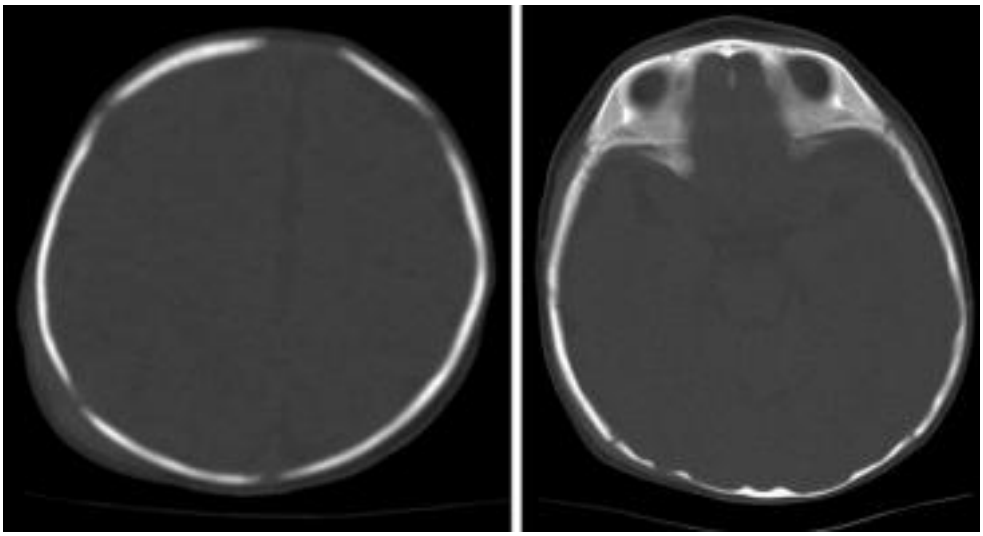

Figure 6: (a) Sharp lucency representing a fracture in the right parietal region is accompanied by a large subgaleal hematoma (b) In a different patient, the right temporal bone fracture is associated with a more subtle 3 mm soft tissue swelling

Knowledge of the normal anatomy, development and timing of sutural closure are also important in the evaluation of questionable fractures. The occipital and innominate sutures are no longer apparent by age 4 while the metopic suture completely fuses by 6 years of age [10]. An example of an accessory suture that can be misleading is the normal persistent occipital suture. It extends from the dorsal aspect of the foramen magnum and can appear wide and sharp. However, it should extend no more than 2 cm from the edge of the foramen magnum. A longer fissure would be inconsistent with its normal embryogenesis and therefore, represents a fracture [3]

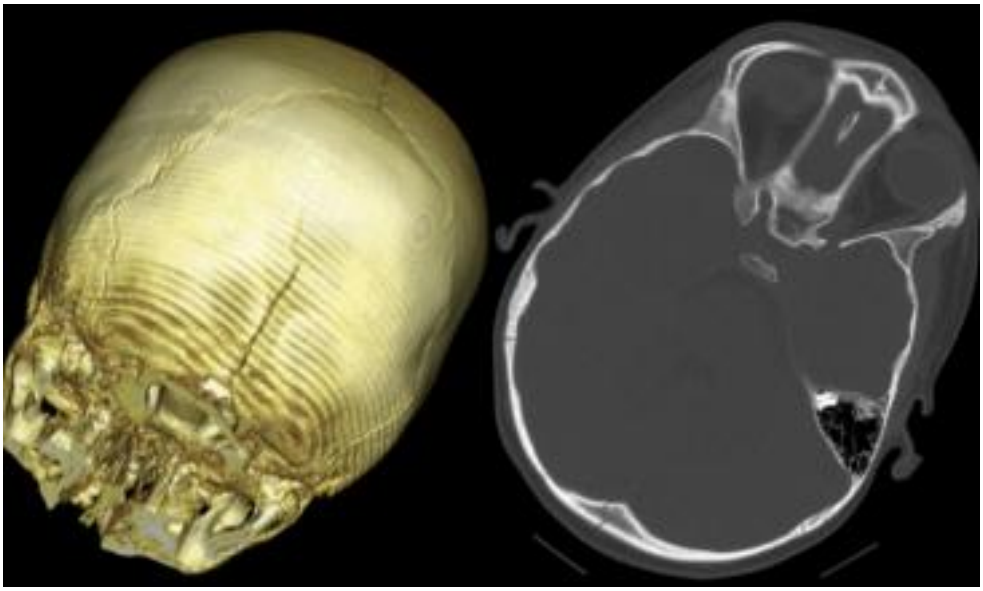

Figure 7: This midline occipital fracture extending into the fora - men magnum is easily differentiated from a normal persistent midline occipital fissure because of its length, extending 3 cm from the dorsal lip of the foramen magnum

A radiograph showed a sharp lucency in the left occipital bone that was thought to represent a fracture. CT scan with 3D reconstruction was performed and showed a well - defined lucency extending into the lambdoid suture. There is no associated diastasis or widening and it does not extend into the foramen magnum posteriorly. Soft tissue swelling or hematoma was also absent. A bone scan was performed which showed no evidence of radiotracer uptake. It was therefore felt that this is more consistent with an accessory suture. Follow - up study after 3 months however showed sclerosis of this lucency indicating that this was indeed a fracture. (Fig.8). Clinical experience has consistently demonstrated that bone scan is much less sensitive in detecting the skull. In one study, less than 40% of skull scintigrams were positive in patients with clearly visualized fractures in skull radiographs [11, 12]. The above case also demonstrates that in difficult cases, a follow - up study might be the only way to differentiate a fracture from an accessory suture. A fracture usually will show evidence of healing or sclerosis in two or three months.

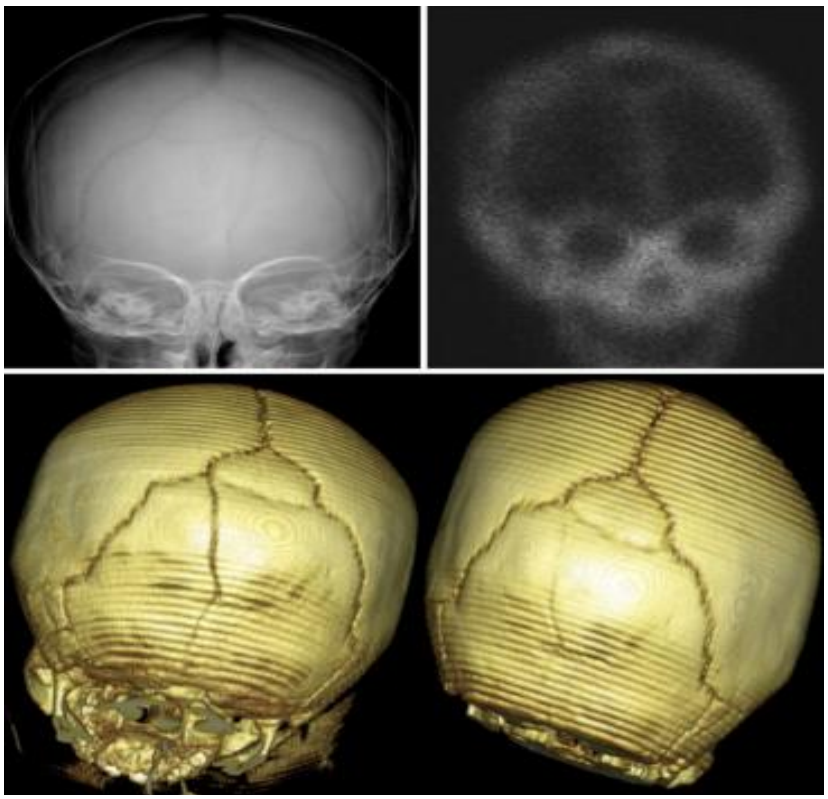

Figure 8: Occipital fracture that was mistaken for an accessory suture.
(A) Plain radiograph showed a left occipital lucency. (B) Nuclear medicine study did not show any abnormal uptake of radiotracer. (C) Together with the CT scan characteristics, it was felt that this lucency is more compatible with an accessory suture. (D) Follow - up CT scan after 3 months however showed sclerosis of this lucency indicating healing of the fracture

2. Conclusion

In summary, fractures and accessory sutures can be differentiated in most cases by observing its characteristics such as bilaterality, symmetry, associated diastasis, and presence of soft tissue swelling. Knowledge of the normal anatomy, development, and timing of sutural closure is also necessary to decipher the varied and sometimes complex nature of these accessory sutures especially in the occipital region. However, in difficult cases, it is prudent to request for a follow - up study to look for signs of healing.

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