

Arrested Pneumatization of the Sphenoid Sinus: Important Normal Variants Not to be Overlooked

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Abstract

Case Report

An arrested pneumatization of the sphenoid sinus is an anatomical variation. It is understood that the sphenoid bones undergo early conversion of fatty marrow before normal pneumatization. Being a developmental condition, it typically occurs as an incidental discovery. The specific clinical symptoms associated with this condition cannot be attributed. They are usually observed as an incidental finding during radiological examinations. If not recognized, it can be easily mistaken for pathological lesions. The purpose of this article was to highlight this rare condition by examining the existing literature and presenting a case report.

Keywords: Pneumatization; Sphenoid Sinus; MRI; Computed Tomography; Skull Base.

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INTRODUCTION

Pneumatization of the skull base and paranasal sinuses begins during the intrauterine period and continues until young adulthood [1-2]. Normally, the red bone marrow is replaced by fatty bone marrow before the pneumatization of the paranasal sinuses occurs. Following this transformation, invasion of epithelial cells forming the respiratory mucosa takes place. If any failure occurs during these steps, pneumatization is either reduced or absent. However, the exact mechanism behind these failures remains largely uncertain [1-2].

Individuals who exhibit varying degrees of pneumatization failure before the respiratory mucosa fully extends into areas of early fatty marrow conversion retain atypical fatty marrow adjacent to the sinuses into adulthood. If this variation is not recognized, it can sometimes pose diagnostic difficulties or lead to misinterpretation of skull base

computerized tomography (CT) and magnetic resonance imaging (MRI) findings [3]. Although arrested pneumatization is typically an incidental finding, it is important to consider the possibility of serious bone lesions in the differential diagnosis, which can cause confusion.

CASE REPORT

The MRI scan of an 8-year-old girl, performed due to headache, showed a hyper intense lesion on both T1 and T2 weighted images within the right and left sphenoid sinus (figure 1). This lesion appeared non-expansile, meaning it did not cause any significant enlargement. A CT scan of the same region revealed a non-expansile, non-calcified soft tissue density lesion within the right et left sphenoid sinus (figure 2), depict these findings. No mass effect or destructive changes were identified in the adjacent bones near the described lesion.

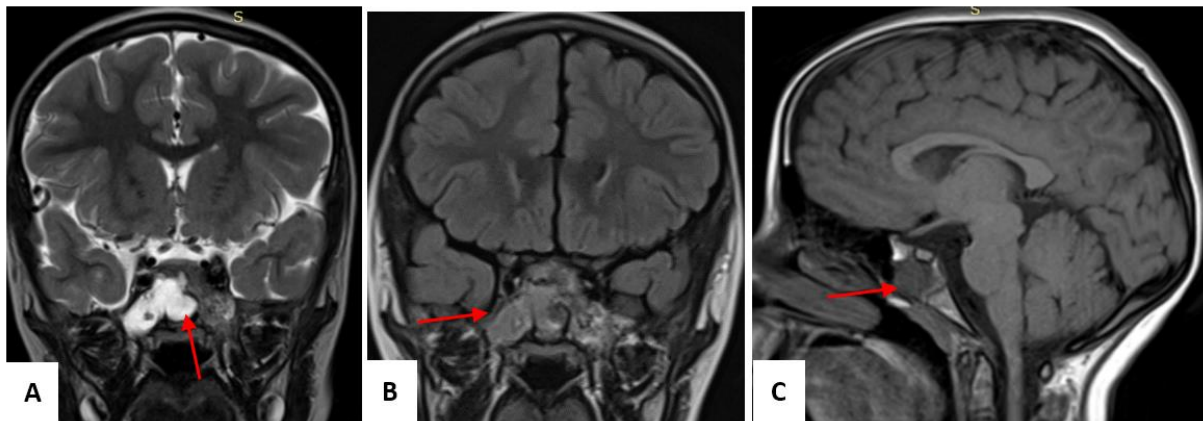


Figure 1: Brain MRI image coronal T2 and Flair (A-B) and sagittal T1 (C): MRI images show well defined lobulated non-expansive lesion located at the both right and left sphenoid sinus pneumatization site (red arrows). The lesion demonstrates increased signal on T2W and Intermediate signal intensity on T1-weighted imaging, which is consistent with fat signal

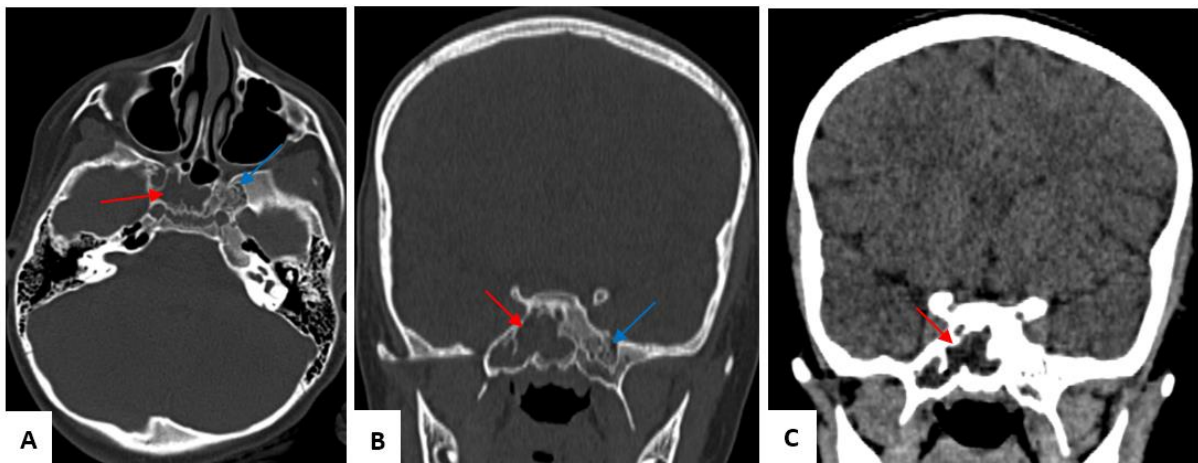


Figure 2: Brain CT in axial section (a), reconstruction coronal (b) (c): revealed: absence of aeration of the right and left sphenoidal sinus. Non-eroded, non-expansile lesion of fatty density lesion with a well-demarcated (red arrows) and internal curvilinear calcification in the location of left sphenoid sinus (bleu arrows). The margin was osteosclerotic, and the adjacent bony structure was intact and showed no mass effect

DISCUSSION

During normal development, there is a process called red-to-yellow marrow conversion, where the percentage of adipose tissue in the red marrow increases. Various studies indicate that the pneumatization of cranial bones, such as the paranasal sinuses and mastoid air cells, occurs only after the red-to-yellow conversion has occurred. If this conversion process fails to start or is not completed, the pneumatization process stops, and the area that is typically filled with air remains filled with yellow marrow [2-7]. This condition is commonly referred to as arrested pneumatization. A pseudo-tumor lesion is found at this site.

Arrested pneumatization of the skull base is a condition that is often not well recognized by many clinicians and radiologists, and it can frequently be mistaken for other pathologies such as fibrous dysplasia, chordoma, chondrosarcoma, intraosseous

lipoma, intraosseous hemangioma, hamartoma, ossifying fibroma, enchondroma, and fibrous osteoma [3].

In individuals with arrested pneumatization of the skull base, unless there are complications, they typically do not experience symptoms, and this variation is most commonly discovered incidentally during imaging procedures conducted for unrelated reasons. However, in cases where the sphenoid sinus is affected by arrested pneumatization, symptoms may occur that mimic serious disorders [4].

From an imaging perspective, a set of imaging criteria known as Welker's criteria has been proposed to establish the diagnosis of arrested pneumatization. These criteria include the following: The lesion must be located at a site of normal pneumatization or recognized accessory pneumatization; the lesion should not be expansive; the lesion should have well-defined,

sclerotic margins; the lesion should exhibit fatty content [3].

On CT scans, internal curvilinear calcifications should be present, which should have a different morphology compared to the "ring and arc" type calcifications seen in chondroid tumors. Any associated skull base foramina should maintain their normal appearance [6]. In our case, all the radiological criteria for arrested pneumatization of the sphenoid sinus are fulfilled. However, in some cases, not all radiological features may be present, necessitating regular follow-up.

In our patients, surgical intervention was not necessary. The accurate diagnosis of arrested pneumatization was achieved through characteristic brain CT and MRI scans, without the need for pathological examination. By carefully examining and understanding the images, a correct diagnosis of arrested pneumatization can be made.

CONCLUSION

In conclusion, we present a rare case of arrested pneumatization of the sphenoid sinus. This case is often misdiagnosed as serious skull base diseases. Having knowledge about the existence and imaging features of this condition will not only help prevent potential confusion in the differential diagnosis for radiologists and clinicians but also avoid unnecessary advanced investigations and interventions.

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