Nonunited Ossification Center of the Presphenoid Bone: Pseudomeningioma

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Three patients are described; in two of them initial plain skull films at an outside institution were interpreted as demonstrating an anterior clinoid meningioma. Evaluation of these films along with further study of the skull base with complex motion tomography demonstrated a separate and well corticated bony structure posterior and superior to each anterior clinoid in all three cases. After review of the developmental anatomy of this region, it was concluded that these bone centers represent failure of the posterior accessory centers of the presphenoid to fuse with the orbitosphenoid. The features of these nonunited centers appear to be characteristic and should allow distinction of this developmental anomaly from a pathologic process.

Abnormal bone density at the skull base is frequently a radiographic feature of a meningioma or a bone tumor [1]. We describe three patients in whom a skull base density was initially interpreted as an anterior clinoid meningioma in two and as a bony anomaly of an unknown type in one. On reviewing the developmental anatomy of this region, we postulate that the bony masses in all three cases represent failure of fusion of the posterior accessory ossicle of the presphenoid bone to the crus posterior of the orbitosphenoid bone. These findings and the description of the embryology of this entity have been given little, if any, attention in the radiologic literature.

Case Reports

Case 1

A 48-year-old woman was admitted to an outside hospital with a left Bell palsy. Plain skull films and tomography disclosed an area of abnormal density in continuity with the anterior clinoid, interpreted as a meningioma. However, there was no clinical evidence of a mass lesion, and CT of the brain at 1 cm intervals on an early-generation scanner showed no tumor.

Review of the plain films (fig. 1A) and linear tomograms (figs. 1B and 1C) demonstrated bilateral, well corticated bony masses with clear lucent lines separating them from the anterior clinoids. These findings were considered typical of nonunited ossicles and were inconsistent with meningioma, especially as the bony masses were bilateral.

Case 2

A 34-year-old woman, after a gunshot wound to the scalp, was referred from an outside radiology clinic to our neurology service for further evaluation for what was interpreted as an "abnormal skull calcification suggestive of a meningeal tumor." The neurologic examination was negative.

Careful evaluation of the skull films (fig. 2A) showed that the "abnormal calcification" was in fact a well corticated, triangular osseous structure located posterior and superior to the anterior clinoid. Bony tomography (figs. 2B and 2C) confirmed the presence of bilateral osseous anomalies similar to case 1.
Case 1

Fig. 1.—Case 1. A, Increased density (arrow) posterior to anterior clinoid with subtle lucency within density. Lateral tomograms to right (B) and left (C) of midline better demonstrate separation of anterior clinoid from more posterior bony density by linear lucency (arrows).

Case 2

Fig. 2.—Case 2. A, Well corticated, triangular osseous structure (arrow) posterior and superior to anterior clinoid. Lateral tomograms to right (B) and left (C) of midline demonstrate bilateral ossicles.

Case 3

A 26-year-old woman, with a 2 year history of headaches, dizziness, and a normal neurologic examination, had a skull series (fig. 3A) and tomography (figs. 3B–3D). They revealed bilateral, well corticated bone densities behind the anterior clinoids. There was no further radiologic workup of this patient.

Discussion

To distinguish normal variants from pathologic processes at the skull base, an understanding of the developmental anatomy of the sphenoid bone is important. Development of the sphenoid bone begins with chondrification of the entire sphenoid body during the first trimester [2]. This process begins behind the pituitary gland and extends forward, surrounding the stalk of Rathke pouch, and then forming the cartilaginous presphenoid anteriorly.

Five ossification centers appear and eventually fuse: the orbitosphenoid, presphenoid, basisphenoid, and greater wing and pterygoid plates [3]. The first three of these centers are discussed here in detail because only they are pertinent to the bony development at the level of the anterior clinoid. Figure 4 depicts these three centers and their relations to each other. Table 1 is a compilation from various sources [2–7] showing the different sections of the orbitosphenoid, basisphenoid, and presphenoid centers, the anatomic structure each becomes, and the time of ossification of each section. Although there is some controversy concerning exactly when during fetal development ossification of these various centers occurs [8, 9], it has been shown that the orbitosphenoid centers ossify first, followed by the basisphenoid and then the presphenoid centers.

In his work with human embryos, Kodama [10] identified five different ossific centers of the presphenoid, three paired (main, posterior accessory, anterior accessory) and two unpaired (anterior and posterior parts of the corporal middle center), which begin to ossify in the third trimester. The main centers are the first to ossify, forming the future tuberculum sellae [10]. The anterior and posterior parts of the corporal middle center and the anterior accessory cen-
Fig. 3.—Case 3. A, Separate, well corticated ossicle (arrow) posterior and superior to anterior clinoid, consistent with nonunited ossification center. B, Anteroposterior tomogram. Posterior accessory centers are superior and anterior clinoids inferior. Lateral tomograms to right (C) and left (D) of midline demonstrate clear separation between posterior accessory centers and anterior clinoids. Separation (arrows) is more poorly delineated on B than on C and D because it runs obliquely to frontal plane.

Fig. 4.—Pertinent osseous centers include sections of orbitosphenoid, basphenoid, and presphenoid.

ters ossify later, the former fusing with the crus medialis of the orbitosphenoid to form the body of the sphenoid, while the latter centers unite to form the chiasmatic sulcus.

By the sixth fetal month union between the various parts of the orbitosphenoid and the presphenoid centers has begun. Of all the presphenoid centers, the only ones that do not, in most cases, ossify during fetal life and whose eventual fate has been unknown are the posterior accessory centers.

We believe the bilateral, well corticated bony structures in each of our cases are posterior accessory centers that have failed to fuse with the posteromedial border of the crus posterior of the orbitosphenoid (i.e., the future anterior clinoid). The location of these nonunited centers as demonstrated on the plain films and tomograms corresponds well to the location noted by Kodama [10] on his fetal anatomic specimens (fig. 5) and as shown in figure 4. It may

TABLE 1: Ossification Centers of the Sphenoid Bone

<table>
<thead>
<tr>
<th>Embryologic Origin</th>
<th>Anatomic Structure</th>
<th>Ossification by (weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orbitosphenoid:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crus anterior</td>
<td>Lesser sphenoid wing</td>
<td>12–14</td>
</tr>
<tr>
<td>Crus medialis</td>
<td>Body of sphenoid (lateral portion)</td>
<td>12–14</td>
</tr>
<tr>
<td>Crus posterior</td>
<td>Lesser sphenoid wing and anterior clinoid</td>
<td>12–16</td>
</tr>
<tr>
<td>Basisphenoid:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td>Floor of sella turcica and dorsum</td>
<td>16–20</td>
</tr>
<tr>
<td>Lateral</td>
<td>Carotid groove</td>
<td>18–22</td>
</tr>
<tr>
<td>Presphenoid:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main centers</td>
<td>Tuberculum sellae</td>
<td>28–32</td>
</tr>
<tr>
<td>Corporal middle center</td>
<td>Body of sphenoid (medial portion)</td>
<td>36</td>
</tr>
<tr>
<td>Anterior accessory centers</td>
<td>Sulcus chiasmatic</td>
<td>36–40</td>
</tr>
<tr>
<td>Posterior accessory centers</td>
<td>Unknown*</td>
<td></td>
</tr>
</tbody>
</table>

Note.—This was compiled from [2–7].

*We postulate this forms the posterior part of the anterior clinoid.
only be a coincidence that the two cases described by Kodama (Kodama G, unpublished data) and our three cases were all women.

Beyond the point of anatomic interest is the importance of not mistaking this normal variant for hyperostosis or blistering. In our cases 1 and 2, the possibility of an anterior clinoid meningioma was initially suggested on the basis of plain skull films and tomograms. The radiographs, however, demonstrate distinct ossicles, documented as bilateral in all the cases, which correspond in location to the embryologic posterior accessory centers of the presphenoid. The features of these nonunited posterior accessory centers appear to be characteristic and should allow distinction of this developmental anomaly from a pathologic process.

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