

# The central Onodi cell: A previously unreported anatomic variation

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## ABSTRACT

*Preoperative recognition of the Onodi cell is necessary to avoid injury to closely associated structures, including the internal carotid artery and the optic nerve. This article describes the central Onodi cell, a variation in which a posterior ethmoid cell lies superior to the sphenoid sinus in a midline position with at least one optic canal bulge. To our knowledge, this anatomic variation has not been previously reported in the literature. Radiographic and endoscopic imaging of this unique variation is provided.*

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As the rate of endoscopic endonasal transsphenoidal approaches to resect sellar and parasellar lesions increases, so does the importance of understanding the surrounding anatomic variations.<sup>1–4</sup> In this study we describe and present radiographic and endoscopic imaging of a unique entity, the central Onodi cell. The Onodi cell was first described by Adolf Onodi in 1904<sup>5–8</sup> and has varying definitions according to different sources. The Onodi cell is a posterior ethmoid air cell that lies superior to the sphenoid sinus and is in close proximity to at least one optic nerve or internal carotid artery (ICA). This close proximity of the Onodi cells to the optic nerve and ICA is a risk factor for surgical complications. Identification of the Onodi cell is therefore imperative to minimize perioperative morbidity.

In addition to being the posterior most ethmoid cell, common descriptions of the Onodi cell include at least one of the following properties: having an endoscopically identifiable optic canal bulge (42–51% of studied specimens were found to have Onodi cells according to this criterion)<sup>9,10</sup> or having lateral and superior pneumatization relative to the sphenoid sinus and being in close association with the optic nerve, without prominence of the optic nerve tubercle or ICA being absolutely necessary.<sup>6,8,11</sup> These definitions distinguish the

Onodi cell from the overriding posterior ethmoid cell as defined by Thanaviratnanich *et al.* because of the close association of the optic nerve with the Onodi cell.<sup>12</sup>

The best radiographic tool to analyze the sphenoid sinus and its surrounding structures is the computed tomography (CT) scan, looking in all three anatomic planes when possible.<sup>5</sup> The incidence of Onodi cells as detected by CT scans is commonly cited as 8–24%.<sup>8,11,13</sup> Preoperative CT examination of the sphenoid sinus can help plan the safest and most direct route to the sella and parasellar region and can detect anatomic variations that increase the risk for intraoperative complications, including vision loss, hemorrhage, and cerebrospinal fluid (CSF) leak. Operative difficulties and complications may result from a lack of thorough radiographic evaluation to fully understand the marked variability in the anatomy of the sphenoid sinus and its related structures.

This article describes in detail the existence of the central Onodi cell as an overriding posterior ethmoid cell that lies superior and midline to the sphenoid sinus and in close association with the optic nerve. To our knowledge, this anatomic variation has not been previously reported. Radiographic and endoscopic imaging of this unique cell is provided.

## ILLUSTRATIVE CASE

A 33-year-old woman underwent an endoscopic transsphenoidal approach for resection of a Rathke's cleft cyst for symptomatic headaches. Preoperative CT scan showed a central posterior ethmoid air cell posterior to the anterior face of the sphenoid sinus (Fig. 1, A and B).

During the endoscopic endonasal approach, the central Onodi cell was identified superior to the sphenoid sinus with bilateral optic nerve bulging (Fig. 1, C and D). The Rathke's cleft cyst was drained uneventfully

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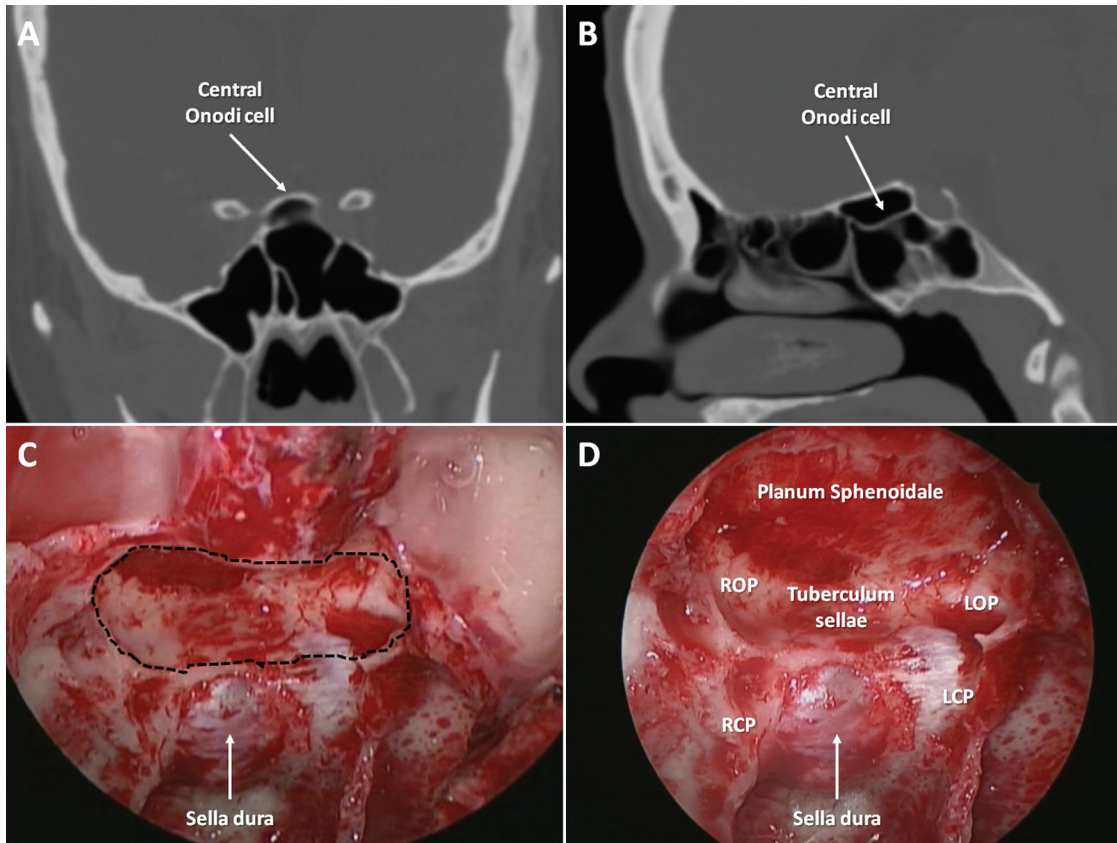
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**Figure 1.** (A) Coronal CT scan of the paranasal sinuses showing the central Onodi cell. (B) Sagittal CT scan showing the central Onodi cell superior to the sphenoid sinus and anterior to the superior face of the sella turcica. Note that opening of the Onodi cell is necessary for complete access to the superior aspect of the sella turcica. (C and D) Intraoperative 30° endoscopic view of the sphenoid/planum sphenoidale region showing the central Onodi cell with bilateral optic nerve protuberance coursing laterally along the wall of the cell. CT, computed tomography; ROP, right optic protuberance; LOP, left optic protuberance; RCP, right carotid protuberance; LCP, left carotid protuberance; dotted line, central Onodi cell's border.

without intraoperative CSF leakage. The patient did well postoperatively with improvement in her headaches and no vision changes or CSF leak.

## DISCUSSION

Although the endoscopic endonasal transsphenoidal route provides a minimally invasive approach and wide field of view for removal of sellar and parasellar lesions,<sup>10,14</sup> a thorough knowledge of sphenoid sinus anatomy is necessary to avoid such complications as arterial hemorrhage, visual loss, and cranial nerve and extraocular muscle palsies.<sup>9</sup>

During embryological development, the sphenoid bone arises from two chondral ossification centers. The sphenoid sinus develops within the lower ossification center while the upper ossification center merges with the ethmoid. Posterosuperior ethmoidal air cells can grow into the body of the upper sphenoid bone and may surround the optic canal and nerve and extend to the sella turcica, resulting in an Onodi cell.<sup>13</sup> The sphenoid cell may thus sit posterior, medial, and/or inferior to the Onodi cell.<sup>7</sup>

The Onodi cell has considerable clinical significance. The Onodi cell may be poorly aerated and drained, leading to stasis of secretions and recurrent infections.<sup>15</sup> Onodi cell sinusitis may cause visual symptoms because of the proximity of this cell to the optic nerve; a mucocele or pyelocele in an Onodi cell can compress the optic nerve, causing retrobulbar optic neuropathy,<sup>11</sup> optic neuritis, and vision loss.<sup>8,15,16</sup> The Onodi cell may also be mistaken for the sphenoid sinus, resulting in incomplete functional endoscopic sinus surgery in a patient with sphenoid sinus disease.<sup>14</sup> Because Onodi cells may also interfere with exposure of the edge of the sellar floor, Onodi cells should be removed for full exposure and allow complete tumor resection in the sellar and parasellar regions.<sup>14</sup> The presence of an Onodi cell can also increase the risk of injury to the optic nerve and ICA because of their close anatomic relationship.<sup>7</sup>

The overriding ethmoid cell is traditionally defined as a cell lying superior and posterior to the anterior surface of the sphenoid sinus. Overriding ethmoid cells have been found to coexist in 36.8% of Onodi cell-

positive specimens (defined as the most posterior ethmoid cell that features an endoscopically identifiable optic canal bulge).<sup>12</sup> No overriding ethmoid air cells have been found in Onodi cell–negative specimens.<sup>9</sup> Posterior ethmoid cells may expand beyond the ethmoid bone and grow into the sphenoid bone, usually superolaterally,<sup>17</sup> possibly surrounding the optic canal or completely overgrowing the sphenoid sinus and extending posterior to it. Tan *et al.* identified an unusual centrally placed overriding ethmoid air cell in the sphenoid cavity without an optic nerve bulge.<sup>9</sup> In this study we identified a cell that lies superior and posterior to the anterior surface of the sphenoid sinus in a midline location with at least one optic nerve bulge, which we termed “the central Onodi cell.” It is possible that the origin of this centrally located cell may have arisen from a left Onodi cell, superior to the dominant left sphenoid sinus. Nonetheless, when viewed in the context of transsphenoidal endoscopic skull base surgery, this represents a single Onodi cell with both optic canals and both carotid canals present on its walls. To our knowledge, this configuration of an Onodi cell, centrally located below the planum sphenoidale, has not been previously described in the literature. When viewed in the context of two previous analyses of Onodi cells<sup>10</sup> and variations of the sphenoid sinuses<sup>18</sup> in a subset of a previously described cohort of 170 patients undergoing CT of the paranasal sinuses and maxillofacial bones at our institution, we only found this single case with this type of configuration leading to a prevalence of 0.59% in this cohort.

The most posterior point of the Onodi cell may extend up to 1.5 cm beyond the anterior surface of the sphenoid sinus.<sup>9</sup> Therefore, if an Onodi cell is identified, the sphenoid sinus should be entered through the inferomedial floor of the Onodi cell and endoscopic anatomy should be correlated with the CT findings. Care should be taken to distinguish the Onodi cell from the sphenoid sinus to avoid complications.

## CONCLUSIONS

This article defines the central Onodi cell as a posterior ethmoid cell overriding the bilateral sphenoid sinuses in a central, as opposed to the usual superolateral, location. In addition, this cell is described as having at least one optic nerve bulge identified endoscopically. Radiographic and endoscopic imaging of such a cell is provided. An increased understanding of the morphological characteristics of the Onodi cell is

needed to maximize the efficacy and minimize injuries associated with the endoscopic endonasal transsphenoidal method to remove sellar and parasellar lesions.

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