Pneumatization of the sphenoid bone by posterior ethmoidal cells: report of two clinical cases

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SUMMARY

The article describes two cases of expansion of the posterior ethmoid cells deeply into the sphenoid body in combination with hypoplasia/aplasia of sphenoid sinus. In the first presented case, the sphenoethmoidal cell was in contact with the superior and posterior walls of the hypoplastic sinus. In the second case, the posterior ethmoidal cell was positioned next to the sinus, creating the illusion of its second half.

Large sphenoethmoidal cells can be easily confused with the sphenoid sinus. The presence of such anatomical variation of the ethmoidal labyrinth poses a significant risk of surgical complications including damage to neurovascular structures during transsphenoidal surgical approach to the structures of the skull base.

Key words: Sphenoethmoidal cell – Onodi cell – Sphenoid sinus – Pneumatization – Cone-beam computed tomography

INTRODUCTION

In adults, the number of posterior cells in each ethmoidal labyrinth varies from 3 to 4 (Alsaied, 2017). These air-filled spaces can potentially extend into the body of the sphenoid bone as sphenoethmoidal cells (Liu et al., 2021). In some cases, they extend up to 1.5 cm posteriorly relative to the anterior wall of the sphenoid sinus (Cherla et al., 2013; Shyamlal et al., 2024). The sphenoethmoidal cells, which lie intimately related to the optic canal, were first described by the Hungarian rhinolaryngologist Adolf Onodi in 1904 and are named after him (Onodi, 1904).

Onodi cells are detected with a frequency of 42-60% in clinical and anatomical studies, whereas in 4-29% of patients using diagnostic radiology exams (Tomovic et al., 2013; Lund et al., 2014), and they are more common in Asians compared with Caucasians (26-29% vs 8-14%) (Badia et al., 2005).

There are three types of Onodi cells (Thimmaiah and Anupama, 2017; Fadda et al., 2024). Type I (superior type) – the sphenoethmoidal cell is located above and medially to the sphenoid sinus. Type II (superolateral type) - the Onodi cell is localized on both sides of the horizontal line drawn through the superior wall of the sinus in coronal plane. Type III (lateral type) - the sphenoethmoidal cell lies entirely below the level of the superior wall of the sphenoid sinus. According to Srinivas

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and Kauser (2022), the third type of Onodi cells was the most common (corresponding to 40% of cases). The first and second types were each of them detected in 30% of investigated patients. In 8 out of 10 people, the Onodi cells were present exclusively on one side.

Cherla et al. (2013) described a rare case of a centrally located sphenoethmoidal cell. The small air cavity was located in the midline superiorly to the sphenoid sinus. AL-Zaidi and Badr (2022) found an unusually large central sphenoethmoidal cell, completely dividing the sphenoid sinus into two asymmetrical halves. The authors called the current air cell an "H-cell". According to Huang et al. (2020), the incidence of central Onodi cell type is 0.9%.

Another anatomical variation, called supraseptal posterior ethmoid cell (SPEC), is an air cell extending medially and superiorly to the posterior superior nasal septum and the body of sphenoid, but, unlike the Onodi cell, does not contact the optic canal (Liu et al., 2023). The authors found its prevalence in 5.88% of cases.

Rare variations of the sphenoethmoidal cells located below and lateral to the sphenoid sinus have also been described in the literature (Liu et al., 2019). These are the so-called Jinfeng cells.

The article describes cases of expansion of the posterior ethmoid cells into the sphenoid bone in combination with hypoplasia/aplasia of sphenoid sinus. The patients provided the written informed consent regarding radiological images, clinical assessment and publication of patient's data.

CASE REPORT 1

A 32-year-old female patient S. repeatedly sought outpatient care with complaints of difficulties in breathing through the nose, olfactory disturbances, nasal discharge, headache and facial pain/pressure.

In addition to typical manifestations of the inflammatory process in the paranasal sinuses, cone-beam computed tomography revealed a number of their structural features. The body of the sphenoid was pneumatized by the posterior ethmoidal cells (one in each ethmoidal labyrinth) up to the level of the anterior wall of the sella turcica (Fig. 1A-B). Relative to the opening of the sinus of sphenoid bone, they extended posteriorly at a distance of 11.6 mm. Right sphenoethmoidal cell mucosal thickening and complete opacification was detected (Fig. 1B). Its maximal anteroposterior and transverse diameters were 22 mm and 10 mm, respectively. The corresponding dimensions of the left sphenoethmoidal cell were 25.6 x 14.8 mm. Both sphenoethmoidal cells contact the walls of the optic canal and the internal carotid artery. In their posterior part they adjoined each other and were separated by a 0.4 mm thick layer of bone tissue (Fig. 1A).

Right and left halves of the hypoplastic sphenoid sinus were identified medially to the sphenoethmoidal cells (Fig. 1A). Both of them had a slit-like shape with a maximum transverse dimension of 3.2 mm on the right and 7.6 mm on the left side. The posterior wall of the air spaces was found at a distance of 7.2 mm to the anterior wall of the sella turcica. The two halves of the sinus communicated with the nasal cavity bilaterally in the sphenoethmoidal recesses.

A unilateral developmental feature in the anterior cells of the labyrinth was also identified: the large anterior ethmoid air cell (supraorbital ethmoid air cell) on the left extended posteriorly and was located superior to the orbit, pneumatizing the orbital plate of the frontal bone (Fig. 1D).

Anatomical variants of maxillary and frontal sinuses were not revealed.

CASE REPORT 2

A 36-year-old female patient C. asked for ENT consultation. She reported no complaints other than about the presence of mucus dripping down the back of the throat and occasional nasal obstruction.

CBCT revealed mucosal thickening in the sphenoid sinus on the right and the ethmoidal labyrinth on the left (Fig. 2A-C), as well as in other paranasal sinuses.

The left sphenoid sinus was not visualized, while the sphenoid body in the left was pneumatized by the large posterior ethmoidal cell (sphen-

oethmoidal cell) measuring 26.3 x 14.5 mm, extending backwards at a distance of 10.5 mm. The posterior wall of the cell was found at the middle of the distance between the walls of the sella turcica in sagittal plane (Fig. 2B).

The walls of the sphenoethmoidal cell were in contact with the walls of the optic canal and the internal carotid artery, with the optic nerve partially projecting into its lumen (Fig. 2B). On the ventral side of the sphenoethmoidal cell there was another small posterior ethmoidal cell. Both air cavities drained into the superior nasal meatus.

The sphenoid sinus measuring 11.6 mm and 11 mm (maximum anteroposterior and transverse diameters) was located on the right side of the midline. The air space extended to the anterior wall of the sella turcica and drained into the sphenoethmoidal recess. In addition, its walls contacted the walls of the optic canal and the internal carotid artery.

In the frontal sinus on the right side, a communication with the anterior ethmoidal cell and an opening into the middle nasal meatus was found.

COMMENTS

In the described clinical cases, the presence of the enlarged posterior ethmoid cell expanding deeply into the body of the sphenoid bone was revealed. Being isolated from the anterior ethmoid cells, it independently drained into the superior nasal meatus.

The air cavities, two in the first case and one in the second, were classified as Onodi cells because of their direct contact with the bony wall of the optic canal. Moreover, hypoplasia/unilateral aplasia of the sphenoid sinus was also detected. Such structural features of the paranasal sinuses have been described in the literature for the first time.

The development of the ethmoidal cells begins before birth (Zalzal et al., 2018). Rapid pneumatization of ethmoidal cells continues until the age of 5 years, while their maximum size is reached between 12 and 18 years of age (Lee et al., 2022). In adults, the anteroposterior size of the posterior ethmoidal cells is 13.62±1.75 mm (min–max: 9.5-19.5 mm), the transverse size (width) is 12.15±1.6 mm (min–max: 8-16.2 mm), and the height is 44.64±3.83 mm (min–max: 35.8-56 mm) (El-An-

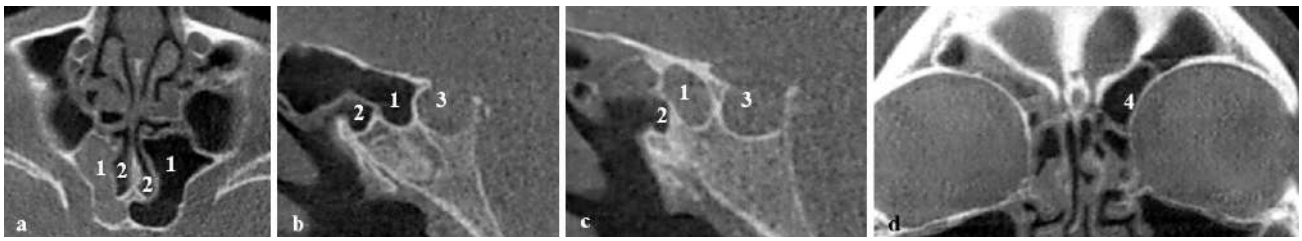

Fig 1.- A 32-year-old female patient S. Axial (a), sagittal (b, c), and coronal (d) CBCT scans. Sphenoethmoidal cell. 2. Sphenoid sinus. 3. Sella turcica. 4. Supraorbital ethmoid air cell.

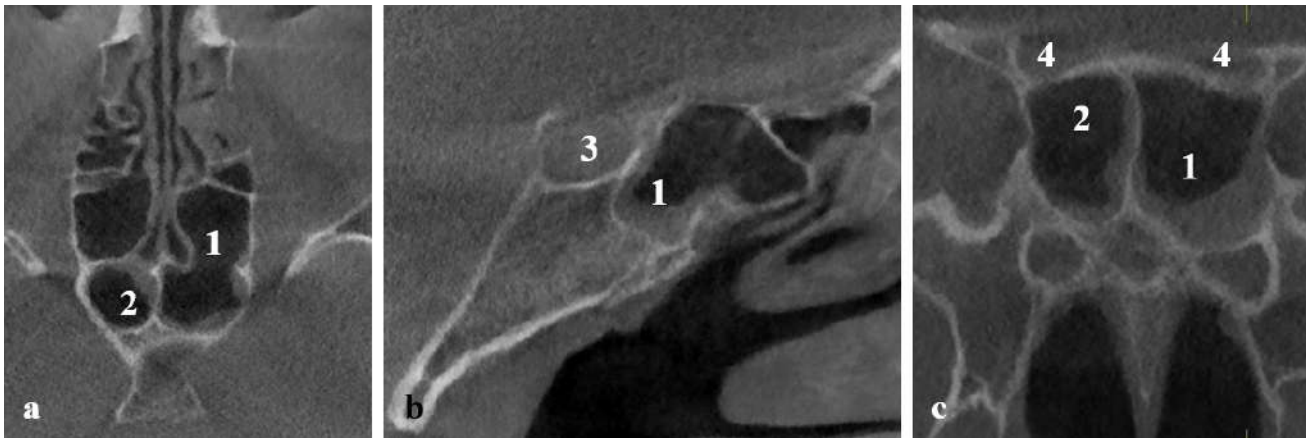

Fig 2.- A 36-year-old female patient S. Axial (a), sagittal (b), and coronal (c) CBCT scans. 1. Sphenoethmoidal cell. 2. Sphenoid sinus. 3. Sella turcica. 4. Optic canal.

war et al., 2022). The anteroposterior size of Onodi cells, which we described, was outside the range of variation of this particular parameter.

Pneumatization of the sphenoid sinus begins at the age of 2–3 years. Its size increases most intensively throughout next 3-5 or 6-10 years (Sethi et al., 2023). The sinus aplasia and hypoplasia we described are extremely rare. Jaworek-Troć et al. (2021) noted the absence of the sphenoid sinus in only 1% of cases. Hypoplasia - conchal (fetal) and presellar types of the sphenoid sinus occurs in adults with a frequency in the range of 0 - 2% and 4.1 - 24% of cases (Štoković et al., 2016; Schwerzmann et al., 2021; Tavakoli et al., 2023). These types of sinus are typical for children aged 1-3 and 4-9 years, respectively (Lee et al., 2022). Aplasia and hypoplasia of the sphenoid sinus in adults are considered one of the common anatomical variants of this structure (Park and Hwang, 2021).

A large (hypertrophic) posterior ethmoidal cell may be misinterpreted as a sphenoid sinus (Wada et al., 2015; Patil et al., 2023). In the first presented case, the sphenoethmoidal cell was in contact with the superior and posterior walls of the hypoplastic sinus. In the second case, the posterior ethmoidal cell is positioned next to the sinus, creating the illusion of its second half (Fig. 2C). The main difference in the air cavities in the sphenoid body was that the sphenoid sinus drained into the sphenoethmoidal recess, while the ethmoidal cells opened independently into the superior nasal meatus.

According to Nomura et al. (2013), in cases with two Onodi cells, the sphenoid sinus is displaced downwards and its volume is significantly reduced. Unilateral presence of the sphenoethmoidal cell is accompanied by an asymmetric reduction in the sphenoid sinus volume. However, Serindere and Belgin (2024) did not find any significant differences in the sphenoid sinus volume between patients with and without Onodi cells. In the presented clinical cases, both halves of the sphenoid sinus were hypoplastic (conchal and presellar types of pneumatization) or one of them was absent. Most likely, hypoplasia/aplasia of the sphenoid sinus and the formation of sphenoethmoidal cells are the result of unrelated processes.

In the superolateral Onodi cell type, the air cavity is adjacent to and often surrounds the optic nerve (Ozturan et al., 2013). Protrusion and dehiscence of the nerve may cause optic neuropathy, for example, in chronic sphenoid sinusitis or sphenoethmoidal mucocele (Meybodi et al., 2017; Senturk et al., 2017; Tuli et al., 2022). In the presented cases, Onodi cells with signs of inflammation were adjacent to the wall of the optic canals. However, the patients did not report any visual symptoms. Together with sphenoethmoial air cell sinusitis, the patients had radiographic signs of maxillary and frontal sinusitis, based on which the clinical diagnosis of chronic rhinosinusitis was made.

Large sphenoethmoidal cells can be easily confused with the sphenoid sinus. The presence of such anatomical variation of the ethmoidal labyrinth poses a significant risk of surgical complications including damage to neurovascular structures during transsphenoidal surgical approach to the structures of the skull base.

Further studies are needed to analyze risk of damage to neurovascular structures during transsphenoidal surgery due to the presence of large sphenoethmoidal cells associated with hypoplasia/aplasia of sphenoid sinus.

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