"The prevalence and CT detection of Onodi cell types."

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Aims and objectives

The Onodi cell has been defined by the Anatomic Terminology Group as being the most posterior ethmoid air cell that pneumatises superiorly and laterally to the sphenoid sinus and which is in intimate relation to the optic nerve [1]. In a typical case, the Onodi cell can be identified during sinus endoscopic examination as a bulge of the optic nerve canal into the posterior ethmoid cell, even when this appears to be minimal [2]. If the bulging of the optic nerve into the Onodi cell is prominent, then this bears an increased risk of damaging the optic nerve during sphenoid sinus surgery. Moreover, in most cases, the sphenoid sinus is situated behind the posterior ethmoid cell where this bulging of the optic nerve canal can only be observed on its supero- lateral wall. Therefore, the surgeon that is unprepared to take into account the ethmoid cell extending over the sphenoid sinus, may in fact be operating on an Onodi cell instead of the sphenoid sinus.

The prevalence of Onodi cells varies according to differences in how these cells are defined, and differences in methods of identification, detection techniques and racial factors. For example, a 42% incidence was demonstrated by Kainz and Stammberger using endoscopic dissection [2], which was higher than that observed with CT examination (39%) or during endoscopic surgery (14%) and only 7-8% in preoperative CT examination [3,4]. It should however be noted that these studies were based on analysing only one CT plane; the axial or coronal. In fact it is found that the prevalence of Onodi cells is higher when CT examinations are evaluated in two planes ie. axial and coronal compared to just one [5,6].

Furthermore, the prevalence of the Onodi cell is higher in Asian patients, than that reported in European countries, regardless of the method used for identification [7,8]. Nowadays, CT examination of paranasal sinuses forms an essential part of the diagnostic process before endoscopic sinus surgery. It is firstly performed in the axial plane, primarily for reasons of patient comfort and subsequently in coronal planes as preferred by surgeons.

Methods and materials

The presented study consists of retrospectively evaluating 196 CT investigations of paranasal sinuses, which had been carried out between January-December 2011 by the Division of Radiology, at the Military Medical Hospital, Warsaw using a 64 CT scanner. The patient subjects comprised adults, aged between 18-82 years, mean age 48 years. Criteria used for excluding cases from the study were: trauma, past surgery and sinus bone wall erosion together with massive polyps of ethmoid cells and the sphenoid sinus.
All CT scans of paranasal sinuses were performed in axial planes parallel to the hard palate with the collimation set at 0.625 mm. Coronal and sagittal reconstructions were obtained from the raw data using bone algorithms, thereby allowing the relationship of the most posterior ethmoid cell to the optic nerve canal (separately for left and right sides) to be analysed. The scans were firstly performed in the axial planes, followed by the sagittal and coronal reconstructions. The posterior ethmoid cells were classified into four types depending on their relation to the optic nerve canal as follows:

Type A: no contact observed between the wall of the ethmoid cell and optic nerve canal (Fig.1);

Type B: the ethmoid cell wall being adjacent to the wall of the optic nerve canal at a maximum distance of 2 mm, (as measured in the axial and sagittal planes), but not extending laterally or supero-laterally (Fig.2);

Type C: this time, the ethmoid cell wall being adjacent the optic nerve canal wall at a distance greater than 2 mm in the axial and/or sagittal planes extending laterally or supero-laterally without any bulging of the optic nerve canal into the ethmoid bone (Fig.3);

Type D: the ethmoid cell wall being adjacent the optic nerve canal wall at a distance greater than 5mm (as measured in the axial or sagittal plane), extending supero-laterally with optic nerve bulging. This bulging being defined as a protrusion of the optic nerve into the ethmoid cell visualised in at least two planes. The very thin imaging slices used, ensure that any bulging of the optic nerve canal is not missed (Fig.4).

Images for this section:
**Fig. 1:** CT scan images of the optic nerve canal observed for Type A (protrusion of the optic nerve into the sphenoid sinus, no Onodi cell) in respectively axial, sagittal and coronal planes. The sphenoid sinus is pointed by red arrow and the most posterior ethmoid cell by blue arrow.
Fig. 2: CT scan images of the optic nerve canal observed for Type B in respectively axial, sagittal and coronal planes. The sphenoid sinus is pointed by red arrow and the most posterior ethmoid cell by blue arrow.
**Fig. 3:** CT scan images of the optic nerve canal observed for Type C in respectively axial, sagittal and coronal planes. The sphenoid sinus is pointed by red arrow and the most posterior ethmoid cell by blue arrow.
Fig. 4: CT scan images of the optic nerve canal observed for Type D (protrusion of the optic nerve into the Onodi cell) in respectively axial, sagittal and coronal planes. The sphenoid sinus is pointed by red arrow and the most posterior ethmoid cell by blue arrow.
Results

Of the 196 cases studied, 87 (44.4%) were Type A, i.e. there was no contact between the optic nerve canal and posterior ethmoid cells.

The optic nerve canal wall was found to be in contact with at least one posterior ethmoid cell in 109 cases (55.6%). Of these, 31 (15.8%) showed minimal contact, (i.e. <2 mm), with no observed lateral or supero-lateral encroachments nor any bulging of the optic nerve canal, i.e. Type B.

The number of variants where the posterior ethmoid cell was adjacent to the optic nerve canal and which extended supero-laterally or laterally was 78 (39.8%). Of these cases, those that did not reveal any bulging of the optic nerve canal, i.e. Type C were 29 (14.8%), whilst those that did i.e. Type D were 49 cases (25%).

Tables 1 and 2 provide a breakdown of posterior ethmoid cells numbers graded according to their particular type.

In two cases, it was found that there were more than one posterior ethmoid cell adjacent to the optic nerve canal (Fig. 5).

Furthermore, using certain specific cases as examples, it was possible correctly identify and to avoid an over-detection of Onodi cells by performing the CT scans in 3 planes which detected horizontal septa in the sphenoid sinus that mimicked the appearance of Onodi cells (Fig. 6).

Images for this section:
<table>
<thead>
<tr>
<th>Type of the most posterior ethmoid cell</th>
<th>Relation to the sphenoid sinus</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>A + B</td>
<td>No extension</td>
<td>118 (60.2%)</td>
</tr>
<tr>
<td>C</td>
<td>Lateral or supero-lateral &lt;5mm</td>
<td>29 (14.8%)</td>
</tr>
<tr>
<td>D</td>
<td>Supero-lateral &gt;5mm</td>
<td>49 (25%)</td>
</tr>
</tbody>
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**Table 2:** Numbers of ethmoid cells defined by their relation to the sphenoid sinus.
Table 1: Numbers of ethmoid cells defined by their relation to the optic nerve canal.

<table>
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<tr>
<td>A</td>
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<td>87 (44.4%)</td>
</tr>
<tr>
<td>B</td>
<td>Contact</td>
<td>31 (15.8%)</td>
</tr>
<tr>
<td>C</td>
<td>Adjacent without bulging</td>
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</tr>
<tr>
<td>D</td>
<td>Adjacent with bulging</td>
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</tbody>
</table>
Fig. 5: CT image scans of the two cases found of >1 posterior ethmoid cell being in direct contact with the optic nerve canal.
**Fig. 6:** Horizontal septa in the sphenoid sinus mimicking Onodi cells in respectively axial, sagittal and coronal planes.
Conclusion

Identifying the anatomic variants of the Onodi cell is vital during preoperative paranasal sinus CT examination because certain operative complications may arise from critical features of anatomic variation within the sphenoid sinus region. A Systematic evaluation of CT scans has been shown to help avoid potential complications of endoscopic sinus surgery [9]. One of the critical anatomic sinus variants is that in which the optic nerve canal bulges into a sphenoethmoidal cell. In previous studies, this occurrence had been properly visualised during endoscopic examination of the sinuses, however the presence of an Onodi cell had not been clearly identified by CT scanning. Here, only one or two CT planes had been used out of the 3 possible, (ie. the axial, coronal or sagittal) [3,4], which was thus found not to be sufficiently sensitive for correctly detecting Onodi cells. Different studies have reported different frequencies of the optic nerve making contact with posterior ethmoid cells. De Lane et al. [10] demonstrated an incidence of only 3%, however this was based on CT scans made in the coronal plane performed on patients suffering from chronic inflammatory sinus diseases. A study by Yeoch et al. [11] showed an incidence of 65% in which the posterior ethmoid cells had direct relations with the optic nerve and the bulging of the optic nerve canal into a sphenoethmoidal cell was found in 51% cases; such results having been obtained by analysing anatomical dissections.

Nevertheless there is no consensus in methods of CT evaluation. In the opinion of Hoang et al [12], a preoperative sinus CT examination should be evaluated in all three planes (axial, coronal and sagittal), although a preference is stated for coronal planes as being potentially the best for identifying critical anatomic variants. In contrast, a study by Unal et al. [6], suggests that axial planes are the most preferable for detecting an Onodi cell whereas coronal scans are less useful. In the current study, multiplanar reconstructions were made and all three planes, (axial, coronal and sagittal) were analysed for visualising the positions of ethmoid cells and optic nerves, in all dimensions.

Analysing in only one plane, can result in the missing of, or over-interpretation of an Onodi cell. It was found that the axial and sagittal planes were most useful for detecting extensions of the most posterior ethmoid cell, laterally or supero-laterally to the sphenoid sinus and optic nerve bulge.

The prevalence of the Onodi cell in the population of studied adult subjects was 39.8%; with the most common type being superior and lateral extension. The results suggests that three planes (axial, coronal and sagittal) for reconstructions of the CT examinations should always be used in preoperative sinus CT evaluation to detect and describe the type of Onodi cell. Axial and sagittal planes were preferable.
Personal information

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References


