The Prevalence and Pattern of Pneumatization of Onodi Cell in Thai Patients

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Background: The Onodi cell (sphenoethmoidal cell) is an anatomical variation of the most posterior ethmoid air cell that pneumatizes laterally and/or superiorly to the sphenoid sinus and is intimately in contact with the optic nerve. If it is infected or goes unrecognized during surgery, it may result in serious damage to the optic nerve. Nowadays, computed tomographic scans of paranasal sinuses (CT PNS) have been used to detect variations in paranasal sinus anatomy. However, there is a lack of data about the variations of Onodi cell.

Objective: To determine the prevalence and various patterns of Onodi cell.

Material and Method: Axial, coronal, sagittal and sagittal oblique (parallel to the optic canal) CT scans of the paranasal sinuses, nasopharynx, neck and orbit performed at Srinagarind Hospital between January 1, 2004 and November 30, 2006 were reviewed. A pilot study was carried out to investigate the inter-rater reliability of the identification of Onodi cell between the radiologist and rhinologist until the kappa value was 0.74. During the main study, the radiologist and rhinologist interpreted the CT scans independently. If there was a discordant opinion concerning the presence of Onodi cell, a consensus was reached by discussion between the rhinologist and the radiologist.

Results: 187 CT scans (374 sides) were included. Sagittal oblique view detected Onodi cell in 185 sides 49.5% (95% CI: 44.4-54.5). The patterns of Onodi cell were classified into three patterns. In the first pattern, the Onodi cell extended only superiorly to sphenoid sinus (46%; 95% CI: 38.9-53.1). In the second pattern, it extended only laterally to sphenoid sinus (1%; 95% CI: 0.3-3.9). The last pattern was a combined type, lateral and superior to sphenoid sinus (53%; 95% CI: 45.8-60.0).

Conclusion: The prevalence of Onodi cell diagnosed by CT scans was 49.5% (95% CI 44.4-54.5) and the most common pattern was the combined type. This information may be useful for those who perform endoscopic sinus surgery.

Keywords: Onodi cell, Sphenoethmoidal cell, Posterior ethmoid air cell, Computed tomography scans

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The Onodi cell (sphenoethmoidal cell)\(^{(1)}\) (Fig. 1) is an anatomical variation of the most posterior ethmoid air cell which pneumatizes superolaterally to sphenoid sinus and is intimately related to the optic nerve. If it is infected or goes unrecognized during surgery, it may result in serious damage to the optic nerve. Nowadays, computed tomographic scans of paranasal sinuses are used to detect variations in paranasal sinus anatomy. However, there is a lack of data about the variations of Onodi cell.

The reported prevalence of Onodi cell varies according to the method of identification used. Driben et al\(^{(2)}\) showed that the prevalence of Onodi cell was 39% on endoscopic examination in cadavers vs. 7% on axial view of CT scans. Weinberger et al\(^{(3)}\) showed that the prevalence of the Onodi cell was 14% on endoscopic examination in cadavers vs. 8% on coronal view of CT scans. Arslan et al\(^{(4)}\), Unal et al\(^{(5)}\), and Nitinavakarn et al\(^{(6)}\) studied CT scans using two views (axial and coronal). These studies showed that the prevalence was 12%, 8% and 25% respectively. Yeoh et al\(^{(7)}\) and Thanaviratananich et al\(^{(8)}\) performed endoscopic examinations of the posterior ethmoid sinuses in Asian cadavers. They found that the prevalence were 51% (95% CI: 41.4-60.5) and 60% (95% CI: 47.9-71.0) respectively. These studies as above showed that endoscopic examination could...
detect Onodi cell more accurately than CT scans using two views.

CT scanning technology has advanced significantly in recent years. They can now be performed with thinner slices and provide details in three views (axial, coronal, and sagittal views). Bansbreg et al.\(^9\) and Batra et al.\(^10\) studied in CT scans and showed that the prevalence of Onodi cell as determined with three views was more than when only two views were used (48% and 28.1% respectively). However, these studies did not compare the results with the results of endoscopic examinations and did not describe variations in the anatomical pattern of Onodi cell. Therefore, the present study was conducted to give a more thorough evaluation of prevalence of Onodi cell.

**Material and Method**

The present study included axial, coronal, sagittal, and sagittal oblique (parallel to the optic canal) CT scans of the paranasal sinuses, nasopharynx, neck, and orbit were performed by Somaton plus 4 CT scanner (Siemens Medical System, Erlangen, Germany) at Srinagarind Hospital, Thailand. One hundred eighty seven CT scans performed between January 1, 2004 and November 30, 2006 were reviewed. All the patients were at least 18 years old. Patients who had trauma, surgery, cancer, severe infections of the posterior paranasal sinuses, and poor quality CT scans were excluded. The axial cuts used were parallel to the hard palate with a slice thickness of 4 mm and a gap of 3.5 mm. Coronal cuts were perpendicular to hard palate with a slice thickness and gap of 1.25 mm and 2 mm respectively. The sagittal cuts were parallel to nasal septum, with a slice thickness of 1.25 mm and a gap of 2 mm. The sagittal oblique view used cuts parallel to the optic nerve with very thin slices (1.25 mm) and a gap of 0.5 mm. This view showed the relationship of the optic nerve to the posterior ethmoid air cell very clearly (Fig. 2). A pilot study was evaluated in 10 sides of the CT PNS of fresh cadavers. It showed that the detection of Onodi cell was in 100% agreement with the endoscopic examinations of the posterior ethmoid sinus. Therefore, the sagittal oblique view was used as the gold standard in the present study. In the inter-rater reliability of interpretation of Onodi cells between the radiologist and rhinologist were tested and the kappa value was 0.74. During the main study, the radiologist and rhinologist interpreted the CT scans independently. If there were discordant views concerning the presence of an Onodi cell, a consensus was achieved by discussion between the rhinologist and the radiologist.

A sample size of 187 patients with CT paranasal sinuses was estimated to be able to detect 60% prevalence of Onodi cell \(^8\) with the precision of 8% and a two-sided test with type 1 error of 5%. The present study used a sagittal oblique view as the gold standard to detect Onodi cells, which closely abuts the optic canal.

After an Onodi cell was detected in a sagittal oblique view, the relationship of the Onodi cell and the sphenoid sinus were evaluated by axial, coronal and sagittal views. Patterns of an Onodi cell were classified into three types according to its extension laterally and/or superiorly to the lateral and/or superior walls of sphenoid sinus. Classifications of the patterns were three types: superior extension (override), lateral extension and combined types (Fig. 3-7).

Coronal views sometimes showed a posterior ethmoid cell that extended superiorly and/or laterally to the sphenoid sinus but did not closely abut the optic canal. These cases were counted for having Onodi cell because the posterior ethmoid cell may contact the optic canal between the cuts of the CT
scan (Fig. 8). Descriptive statistics was used to analyze the results.

**Results**

The CT scans were from 103 males (55%) and 84 females (45%). The ages of the patients ranged between 20 to 82 years (mean 49.6 years). The CT scans included 118 paranasal sinus (63%), 50 nasopharynx (27%), 14 neck (7%) and five orbit (3%).
The demographic data is shown in Table 1. The prevalence of the Onodi cell was 49.5% (95% CI: 44-54.5%) as detected by the sagittal oblique view. The pattern of Onodi cell was classified into three patterns by axial, coronal and sagittal views. The results are shown in Table 2.

**Discussion**

Identification of Onodi cell in CT scans of the paranasal sinuses is very important to prevent optic nerve injury. The reported prevalence of Onodi cell varies according to the method of identification. Driben et al(2) and Weinberger et al(3) compared the findings from CT scans with those from endoscopic examination. They found that fewer Onodi cells were identified on CT scans than by endoscopic examination. It is possible that the gap between each CT slice will result in Onodi cells being missed.

The present study showed the prevalence of the Onodi cell at 49.5% (95% CI: 44-54.5%) which is similar to the results of the studies by Yeoh et al(7), Thanaviratananich et al(8) and Bansberg et al(9). Bansberg et al(9) studied CT scans using three views. However, when compared with the studies by CT scans in Thai patients Tantilipikorn et al(11) and Nitinavakarn et al(6) found that the prevalence were 8% because they studied only one view and two views of CT scans respectively and they used thicker slice CT scans than in the present study.

This was the first study describing the variations in the anatomical pattern of Onodi cell. The authors found that there were three patterns according to the pneumatization of the most posterior ethmoid air cell in relation to the walls of sphenoid sinus. They could be classified into three types. The most common type was the combined type.

**Conclusion**

The prevalence of the Onodi cell was 49.5% and the most common pattern was the combined type. This information should be useful for endoscopic sinus surgeons and will make them more aware of the high prevalence of Onodi cell and the variations in their anatomy.

**Potential conflicts of interest**

None

**References**

7. Yeoh KH, Tan KK. The optic nerve in the posterior ethmoid in Asians. Acta Otolaryngol 1994; 114:

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**Table 1.** Demographic data

<table>
<thead>
<tr>
<th>Demographic data</th>
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<tbody>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Male 103 (55%)</td>
</tr>
<tr>
<td>Female 84 (45%)</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Mean 49.6 yrs (range 20-82 yrs)</td>
</tr>
<tr>
<td>Diseases</td>
</tr>
<tr>
<td>Sinusitis 55 (29%)</td>
</tr>
<tr>
<td>Nasal polyp 18 (10%)</td>
</tr>
<tr>
<td>Sinonasal tumor:</td>
</tr>
<tr>
<td>Benign 5 (3%)</td>
</tr>
<tr>
<td>Malignancy 15 (8%)</td>
</tr>
<tr>
<td>Nasopharyngeal cancer 46 (25%)</td>
</tr>
<tr>
<td>Other 45 (24%)</td>
</tr>
<tr>
<td>Missing data 3 (1%)</td>
</tr>
</tbody>
</table>

**Table 2.** The patterns of Onodi cells

<table>
<thead>
<tr>
<th>Type</th>
<th>Sides (%)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior (override)</td>
<td>85 (46)</td>
<td>38.9-53.1</td>
</tr>
<tr>
<td>Lateral</td>
<td>2 (1)</td>
<td>0.3-3.9</td>
</tr>
<tr>
<td>Combine</td>
<td>98 (53)</td>
<td>45.8-60.0</td>
</tr>
</tbody>
</table>

The demographic data is shown in Table 1. The prevalence of the Onodi cell was 49.5% (95% CI: 44-54.5%) as detected by the sagittal oblique view. The pattern of Onodi cell was classified into three patterns by axial, coronal and sagittal views. The results are shown in Table 2.
ความชุกและรูปแบบทางกายวิภาคของ Onodi cell ในผู้ป่วยคนไทย

พรเทพ เกษมศิริ, สงวนศักดิ์ ธนวัฒนานิจ, วีรทร พุทธรักษ์

ที่มา:

Onodi cell เป็นความแปรปรวนของเอ็ธมอยด์ไซนัสที่อยู่หลังลูกชิ้นซึ่งมีการยื่นออกไปด้านข้าง และหรือ ด้านบน ต่อ สฟีนอยด์ไซนัส และอยู่ในสภาวะที่ หากมีการอักเสบหรือระบุตำแหน่งของ Onodi cell ในภาพรูปที่ไม่ชัดเจน จะทำให้เกิดอันตรายขึ้น ซึ่งการใช้ภาพถ่ายเอกซเรย์คอมพิวเตอร์ช่วยชัดเจนในการประเมินความแปรปรวนของ Onodi cell แต่ยังไม่มีการศึกษาเรื่องความแปรปรวนทางกายวิภาคของ Onodi cell

วัสดุและวิธีการ:

เป็นการศึกษาแบบพรรณนาโดยเก็บข้อมูลย้อนหลังจากภาพถ่ายเอกซเรย์คอมพิวเตอร์, หลังโพรงจมูก, คอ และตา ในท่า axial, coronal, sagittal และ sagittal oblique (ตัดขนานกับเส้นประสาทตา) โดยทำที่โรงพยาบาลศรีนครินทร์, ระหว่างวันที่ 1 มกราคม พ.ศ. 2547 ถึงวันที่ 30 พฤศจิกายน พ.ศ. 2549 และได้มีการตรวจสอบความแม่นยำระหว่างรังสีแพทย์และแพทย์โรคจมูกในการแปลผล Onodi cell ก่อนทำการศึกษาจริง พบว่ามีค่า kappa เก่ากว่า 0.74 ซึ่งการแปลผล Onodi cell รังสีแพทย์และแพทย์โรคจมูกจะแตกกันอย่าง ภาพประกอบด้วยแบบอิสระที่ 2 ทาน ความแม่นยำไม่ตรงกันจะนำภาพถ่ายนั้นมาอ่านใหม่ ร่วมกันอีกครั้ง

ผลการศึกษา:

มีภาพถ่ายเอกซเรย์คอมพิวเตอร์ (ภาพไซนัส 374 ข้าง) ซึ่งจากภาพที่ทำตามท่า常年 ความแปรปรวน (Sagittal oblique view) ตรวจพบ Onodi cell 185 ข้าง (49.5%; 95% CI: 44.4-54.5) ในขณะนั้น Onodi cell แบบที่พบได้แบ่งเป็น 3 แบบ แบ่งตามการยื่นออกในตามบลัดสฟีนอยด์ไซนัสหลัง 46% (95% CI: 38.9-53.1) แบบที่สอง มีการยื่นออกไปตามช่องของสฟีนอยด์ไซนัสหลัง 1% (95% CI: 0.3-3.9) แบบที่สามมีการยื่นออกไปในแบบที่รวมกันอย่าง Onodi cell ที่ยื่นออกไปตามช่องของสฟีนอยด์ไซนัสหลัง 53% (95% CI: 45.8-60.0)

สรุป:

ความชุกของ Onodi cell จากภาพถ่ายเอกซเรย์คอมพิวเตอร์พบ 49.5% (95% CI 44.4-54.5) และลักษณะการยื่นออกไปด้านที่สุดคือ แบบที่ได้ไปตามห้อง และยื่นออกไปตามช่องของสฟีนอยด์ไซนัสหลัง 53% (95% CI: 45.8-60.0) ซึ่งจากข้อมูลนี้เป็นประโยชน์ต่อแพทย์ผู้ทำการผ่าตัด