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

Pornthep Kasemsiri MD*,
Sanguansak Thanaviratananich MD*, Warinthorn Puttharak MD**

** Department of Otorhinolaryngology, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand*
*** Department of Radiology, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand*

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*

J Med Assoc Thai 2011; 94 (9): 1122-6
Full text. e-Journal: *http://www.mat.or.th/journal*

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.

Correspondence to:
Thanaviratananich S, Department of Otorhinolaryngology, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand.
Phone: 089-714-7376
E-mail: sthanaviratananich@gmail.com

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.

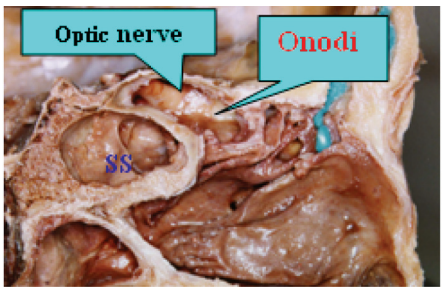

Fig. 1 An Onodi cell in a half-head cadaver

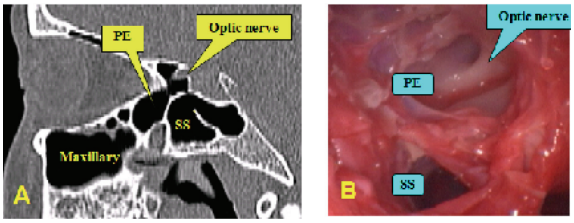

Fig. 2 CT scans of sagittal oblique view and nasal endoscopic views of the same cadaver
A: Left lateral nasal wall shows the optic nerve running through the posterior ethmoid cell which extends superiorly to sphenoid sinus
B: Endoscopic view of the Onodi cell

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, Erlangan, 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

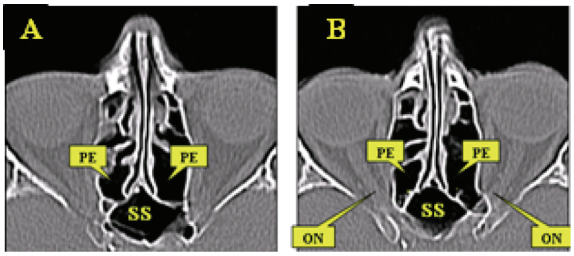

Fig. 3 Axial views at different cut level of the same patients, higher level in B
The lower slice (A) shows that the most posterior ethmoid sinus does not contact the optic canal
The higher slice (B) shows the most posterior ethmoid sinus on both sides extends lateral to sphenoid sinus and contacts optic canals. Both the air cells above the sphenoid sinus appear larger than in the lower slice. Therefore they are the combined type Onodi cells

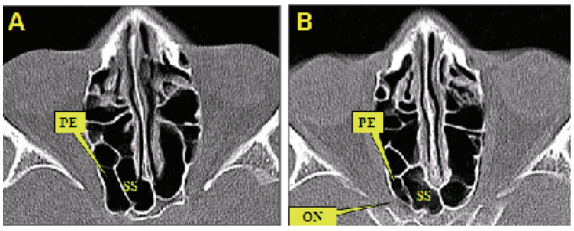

Fig. 4 Axial views shows that the right posterior ethmoid cells extend lateral to the sphenoid sinus but the air cell above the sphenoid sinus in the higher cut (B) is not larger. Therefore this Onodi cell is of the lateral type

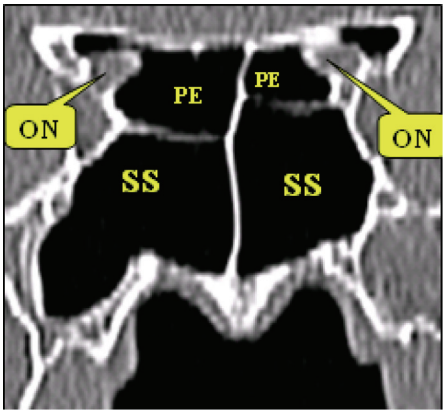

Fig. 5 This coronal view shows the optic nerves running through both the most posterior ethmoid cells. These air cells extend superior to sphenoid sinus but do not extend lateral to it. Therefore they are superior type Onodi cells

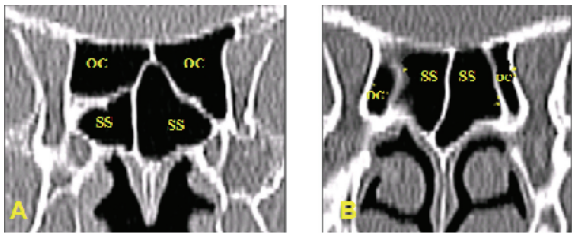

Fig. 6 These Coronal views demonstrate two types of Onodi cell, superior type (A, right) and combined type (A, left). Bilateral lateral type of Onodi cells are demonstrated in B

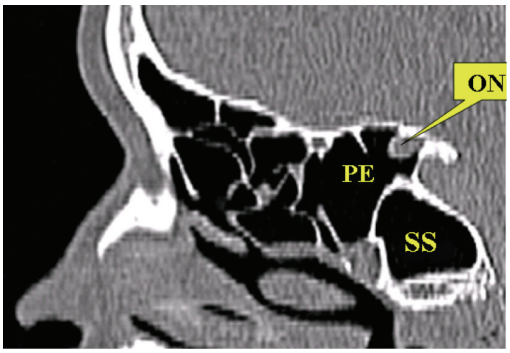

Fig. 7 Sagittal view shows right Onodi cell

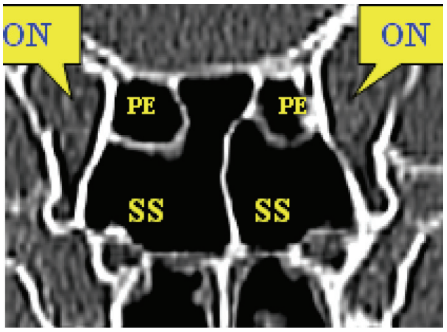

Fig. 8 This coronal view shows extension of Onodi cells superior to the sphenoid sinus without making contact with the Optic nerve

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%).

Table 1. Demographic data

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

Table 2. The patterns of Onodi cells

Type	Sides (%)	95% CI
Superior (override)	85 (46)	38.9-53.1
Lateral	2 (1)	0.3-3.9
Combine	98 (53)	45.8-60.0

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 Weinbeger 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: 44.4-54.5%) 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

1. Stammberger HR, Kennedy DW. Paranasal sinuses:anatomic terminology and nomenclature. The Anatomic Terminology Group. Ann Otol Rhinol Laryngol Suppl 1995; 167: 7-16.
2. Driben JS, Bolger WE, Robles HA, Cable B, Zinreich SJ. The reliability of computerized tomographic detection of the Onodi (Sphenoethmoid) cell. Am J Rhinol 1998; 12: 105-11.
3. Weinberger DG, Anand VK, Al-Rawi M, Cheng HI, Messina AV. Surgical anatomy and variations of the Onodi cell. Am J Rhinol 1996; 10: 365-70.
4. Arslan H, Aydinlioglu A, Bozkurt M, Egeli E. Anatomic variations of the paranasal sinuses: CT examination for endoscopic sinus surgery. Auris Nasus Larynx 1999; 26: 39-48.
5. Unal B, Bademci G, Bilgili YK, Batay F, Avci E. Risky anatomic variations of sphenoid sinus for surgery. Surg Radiol Anat 2006; 28: 195-201.
6. Nitinavakarn B, Thanaviratananich S, Sangsilp N. Anatomical variations of the lateral nasal wall and paranasal sinuses: A CT study for endoscopic sinus surgery (ESS) in Thai patients. J Med Assoc Thai 2005; 88: 763-8.
7. Yeoh KH, Tan KK. The optic nerve in the posterior ethmoid in Asians. Acta Otolaryngol 1994; 114:

329-36.
8. Thanaviratananich S, Chaisiwamongkol K, Kraitrakul S, Tangsawad W. The prevalence of an Onodi cell in adult Thai cadavers. Ear Nose Throat J 2003; 82: 200-4.
9. Bansberg SF, Harner SG, Forbes G. Relationship of the optic nerve to the paranasal sinuses as shown by computed tomography. Otolaryngol Head Neck Surg 1987; 96: 331-5.
10. Batra PS, Citardi MJ, Gallivan RP, Roh HJ, Lanza DC. Software-enabled CT analysis of optic nerve position and paranasal sinus pneumatization patterns. Otolaryngol Head Neck Surg 2004; 131: 940-5.
11. Tantilipikorn P, Churojana A, Chiewwit P, Phuttharak W, Lerdlum S, Aeumjaturapat S, et al. The accuracy of limited CT in the evaluation of chronic rhinosinusitis and for endoscopic sinus surgery: a multicenter study. Siriraj Med J 2009; 61: 3-7.

ความชุกและรูปแบบทางกายวิภาคของ Onodi cell ในผู้ป่วยคนไทย

พรเทพ เกษมศิริ, สงวนศักดิ์ ธนาวิรัตนานิจ, วรินทร พุทธรักษ์

ภูมิหลัง: *Onodi cell เป็นความแปรปรวนของเอ็ธมอยด์ไซนัสที่อยู่หลังสุดซึ่งมีการยื่นออกมาด้านข้าง และหรือ ด้านบนต่อ สฟีนอยด์ไซนัส และอยู่ชิดเส้นประสาทตาหากมีการอักเสบหรือระบุตำแหน่งของ Onodi cell ในการผ่าตัดไม่ชัดเจนจะทำให้เกิดอันตรายต่อเส้นประสาทตา ปัจจุบันได้มีการใช้ภาพถ่ายเอกซเรย์คอมพิวเตอร์เข้ามาช่วยในการประเมินความแปรปรวนของ Onodi cell แต่ยังไม่มีการศึกษาถึงความแปรปรวนทางกายวิภาคของ Onodi cell*

วัตถุประสงค์: *เพื่อประเมินความชุกและความแปรปรวนทางกายวิภาคของ Onodi cell*

วัสดุและวิธีการ: *เป็นการศึกษาแบบพรรณนาโดยเก็บข้อมูลย้อนหลังจากภาพถ่ายเอกซเรย์คอมพิวเตอร์ไซนัส, หลังโพรงจมูก, คอ และตา ในท่า axial, coronal, sagittal และ sagittal oblique (ตัดขนานกับเส้นประสาทตา) โดยทำที่โรงพยาบาลศรีนครินทร์ ระหว่างวันที่ 1 มกราคม พ.ศ. 2547 ถึงวันที่ 30 พฤศจิกายน พ.ศ. 2549 และได้มีการทดสอบความแม่นยำระหว่างรังสีแพทย์และแพทย์โรคจมูกในการแปลผล Onodi cell ก่อนทำการศึกษาจริง พบว่ามีค่า kappa เท่ากับ 0.74 ซึ่งการแปลผล Onodi cell รังสีแพทย์และแพทย์โรคจมูกจะแยกกันอ่านภาพถ่ายเอกซเรย์อย่างเป็นอิสระต่อกัน หากแพทย์ทั้ง 2 ท่าน อ่านภาพถ่ายใดไม่ตรงกันจะนำภาพถ่ายนั้นมาอ่านใหม่ร่วมกันอีกครั้ง*

ผลการศึกษา: *มี 187 ภาพถ่ายเอกซเรย์คอมพิวเตอร์ (ภาพไซนัส 374 ข้าง) ซึ่งจากภาพถ่ายท่าด้านข้างตามแนวเส้นประสาทตา (Sagittal oblique view) ตรวจพบ Onodi cell 185 ข้าง (49.5%; 95% CI: 44.4-54.5) ลักษณะของ Onodi cell แบ่งออกได้เป็น 3 แบบ แบบแรกมีการยื่นขึ้นไปด้านบนต่อสฟีนอยด์ไซนัสพบ 46% (95% CI: 38.9-53.1) แบบที่สอง มีการยื่นออกไปด้านข้างต่อต่อสฟีนอยด์ไซนัสพบ 1% (95% CI: 0.3-3.9) แบบสุดท้ายมีทั้งยื่นไปด้านบนร่วมกับยื่นออกไปด้านข้างต่อสฟีนอยด์ไซนัสพบ 53% (95% CI: 45.8-60.0)*

สรุป: *ความชุกของ Onodi cell จากภาพถ่ายเอกซเรย์คอมพิวเตอร์พบ 49.5% (95%CI 44.4-54.5) และลักษณะการยื่นตัวที่พบมากที่สุดคือ แบบที่ยื่นไปด้านบน และยื่นออกไปด้านข้างต่อสฟีนอยด์ไซนัสพบ 53% (95% CI: 45.8-60.0) ซึ่งจากข้อมูลนี้เป็นประโยชน์ต่อแพทย์ผู้ทำการผ่าตัด*