International Journal of Otorhinolaryngology and Head and Neck Surgery
Sharma P et al. Int J Otorhinolaryngol Head Neck Surg. 2024 Jun;10(3):310-315
http://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937

DOI: https://dx.doi.org/10.18203/issn.2454-5929.ijohns20241327

Original Research Article

A study of the prevalence of Onodi cells in a North Indian population

Preeti Sharma[1]*, Sonika Kanotra[1], Seerat Bashir[1], Yasir A. Khan[1], M. Zahid Batt[2], Qazi S. Ahmed[2], Misba M. Bhat[2], Kshitij Gupta[3]

[1]Department of E.N.T. Head and Neck Surgery, Government Medical College, Jammu, Jammu and Kashmir, India
[2]Department of Radiodiagnosis, Government Medical College, Jammu, Jammu and Kashmir, India
[3]ASCOMS, Jammu, Jammu and Kashmir, India

Received: 15 March 2024
Revised: 16 April 2024
Accepted: 23 April 2024

***Correspondence:**
Dr. Preeti Sharma,
E-mail: 567sharmapreeti@ gmail.com

ABSTRACT

Background: Onodi cells are a type of posterior ethmoid cells which extend superior and lateral to the sphenoid sinus. As these cells have a close relationship with the optic nerve and the internal carotid artery, it becomes important to be aware about their presence preoperatively to prevent injury to these vital structures. Aim of the study was to identify the presence of the Onodi cell with computed tomography (CT) scan and to determine its prevalence and gender distribution of these cells in a north Indian population.
Methods: CT scan of nose and paranasal sinuses of 300 adult patients were studied retrospectively to determine the prevalence of Onodi cells.
Results: The overall prevalence of Onodi cells was found to be 20.33%. Of this, 24 (57%) were present in males and 17 (43%) in females. Out of 61 Onodi cells, 30 (49.2%) were right-sided, 10 (16.4%) left-sided, 13 (21.3%) central and 8 (13.1%) were bilateral.
Conclusions: The presence of Onodi cell in every fifth person makes it important to have a knowledge of their presence preoperatively to prevent adverse surgical complications.

Keywords: Onodi cells, Sphenoethmoidal cell, Prevalence, Computed tomography, Pranasal sinus

INTRODUCTION

The Onodi cell is named after Dr. Adolf Onodi who first described variations in the posterior ethmoidal cells in 1910.[1] Onodi's original work did not describe a "cell" but as many as 38 variations in posterior ethmoid cell anatomy that he characterised into 12 main groups. He pointed out that the most posterior ethmoid cell could pneumatise lateral or superolateral to the sphenoid sinus so that the sphenoid sinus would lie inferior and medial to, rather than directly behind the posterior ethmoid, as was widely maintained. He also highlighted that the optic nerve could be intimately related not only to the sphenoid sinus, as was commonly maintained but also to the posterior ethmoid sinus.[2] In recognition of his work, the term Onodi cell has come to be commonly used by endoscopic surgeons to refer to the lateral or superolateral pattern of pneumatisation of the posterior ethmoid, where a bulge of the optic canal into the posterior ethmoid is apparent.[3] In 1995, Kennedy suggested that the term Onodi cell be replaced by the term sphenoethmoid cell.[4] The Onodi cells share a close relationship with the optic nerve and internal carotid artery superolaterally and to the sphenoid sinus inferomedially.[3] The optic nerve tubercle (the bulge of the medial aspect of the bone surrounding the optic foramen) can be present in the posterior ethmoids, at the junction of the posterior ethmoids and the sphenoids, or in the sphenoid sinus. Sometimes, the optic nerve can pass through an Onodi cell.[3]

Since there are many clinical implications of the Onodi cell, it becomes important for us to study its presence. First

of all, because of its close association with the optic nerve, any disease in the cell like polyps, sinusitis, mucocele or a fungal infection can cause blindness as it leads to optic neuropathy or orbital apex syndrome.[5-9] Secondly, endoscopic sinus surgery (ESS) for the management of rhinosinusitis and nasal polyps and endonasal transsphenoidal technique for the resection of pituitary adenomas is quite commonly being performed nowadays so that operating in the region of the sphenoid sinus or posterior ethmoids without any prior knowledge of the Onodi cell can have catastrophic results since there can be injury to the optic nerve or carotid artery which may lie exposed in an Onodi cell.[10,11] Thirdly, preoperative identification of the Onodi cell is necessary to prevent incomplete sphenoethmoidectomy during endoscopic sinus surgery. Lack of knowledge of the presence of the Onodi cell can make the surgeon to enter the Onodi cell instead of the sphenoid sinus and can make him believe that the sphenoid sinus has been cleared off the disease leading to inadequate resection of the sinus disease.[2,12] Also, in order to achieve complete tumour resection in the sellar and parasellar region, Onodi cells may interfere with the exposure of the edge of the sellar floor.[13] Because of the aforementioned reasons, preoperative and intraoperative identification of these cells becomes critical.

Onodi cell/s are not present in all individuals and their prevalence has been reported to be as low as 7% to as high as 63.3%.[2,14] The wide variations in the prevalence of the Onodi cells is attributable to several factors viz. the differences in the definition of the Onodi cell, methods of identification, differences in the detection techniques and racial factors.[15] Identification can be done pre-operatively using computerised tomography; intraopertively during endoscopic sinus surgery or by gross anatomic cadaveric dissection.[16] Pre-operative CT scan of the paranasal sinuses acts as a roadmap for the surgeon and helps him to avoid complications**.** Research works which involved endoscopy as a method of identification of Onodi cells yielded higher prevalence than those involving CT as an identification modality.[3,17] The only way to identify the Onodi cell/s preoperatively is by studying the CT scans.

Our study aims to identify the presence of the sphenoethmoidal (Onodi cell) using computed tomography method and to determine its prevalence and gender distribution of these cells in a North Indian population.

METHODS

This was a prospective study conducted in the department of ENT and head and neck surgery**,** in collaboration with the department of radiodiagnosis and imaging, SMGS Hospital, Government Medical College, Jammu from January 2021 to June 2021 after getting approval from institutional ethical committee.

Inclusion criteria

Patients with age range of 19-60 years and patients having nasal mucosal disease such as sinusitis or nasal polyposis who required a CT-paranasal sinus were included in the study.

Exclusion criteria

Patients of age <19 or >60 years, patients having any history of trauma, surgery of the sinuses or tumour distorting the anatomy of the sinuses and pregnant females were excluded from the study.

A total of 300 patients who met the inclusion criteria were included in the study. Plain CT scan of the patients was taken using Siemens dual slice CT scanner, with slice thickness 1.5 mm, slice interval 2 mm, kvp: 130 and mas: 70.

The axial and coronal cuts were studied in each patient and the presence of Onodi cells was determined. An Onodi cell was identified as a posterior ethmoid cell present superiorly or laterally to the sphenoid, lying in close relation to the optic nerve or the internal carotid artery. The presence of Onodi cells was defined as right-sided, left-sided, bilateral or central.

The recorded data was compiled and entered in a spreadsheet (Microsoft excel) and then exported to data editor of statistical package for the social sciences (SPSS) version 2.0. Continuous variables were expressed as mean±SD and categorical variables were summarized as percentages.

RESULTS

Results are summarised in Table 1.

Table 1: Prevalence of Onodi cell (total CT scans studied=300).

Type of Onodi cell	Males (n=171)		Females (n=129)	
	Frequency (%)	Prevalence (95% CI)	Frequency (%)	Prevalence (95% CI)
Right-sided	21 (12.28)	(7.97-17.86)	9 (6.98)	(3.45-12.41)
Left-sided	3 (1.75)	(0.45-4.70)	7 (5.43)	(2.40-10.44)
Bilateral	6 (3.51)	(1.43-7.15)	2 (1.55)	(0.26-5.03)
Central	6 (3.51)	(1.43-7.15)	7 (5.43)	(2.40-10.44)
Total	36 (21.05)	(15.43-27.64)	25 (19.38)	(13.24-26.88)

The data of 300 patients with age of 19-60 years of age was analysed. Onodi cells were found to be present in 61 (20.33%) out of 300 patients. Of these, 171 (57%) were males and 129 (43%) were females. Out of a total of 61 Onodi cell, 36 (58.54%) were present in males and 25 (41.46%) in females.

Further analysis revealed that of the 61 (20.33%) Onodi cells, 30 (49.18%) were right-sided, 10 (16.39%) left - sided, 13 (21.31%) central and 8 (13.11%) bilateral (Figures 1-4). Of the 30 right-sided Onodi cells, 21 (70 %) were present in males and 9 (30%) in females while of the 10 left-sided Onodi cells, 3 (30%) were present in males and 7 (70%) in females. Of the 13 central Onodi cells, 6 (46.15%) were seen in males and 7 (53.85%) in females while out of 8 bilateral Onodi cells, 6 (75%) were present in males and 2 (25%) in females.

Figure 1: NCCT scan of paranasal sinuses shows central Onodi cell (white arrow).

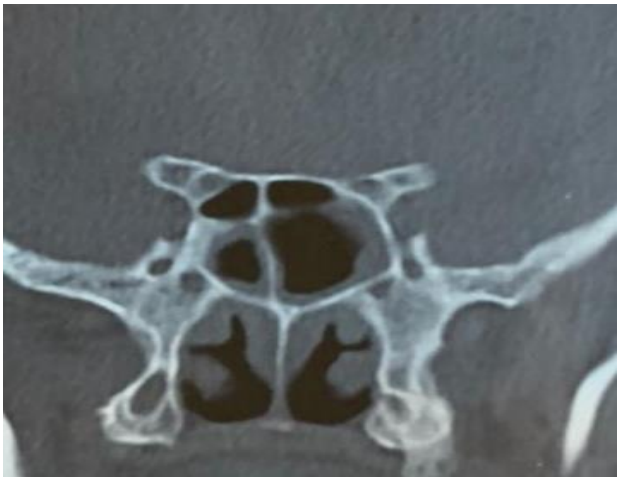

Figure 2: NCCT scan of paranasal sinuses shows bilateral Onodi cells (white arrows).

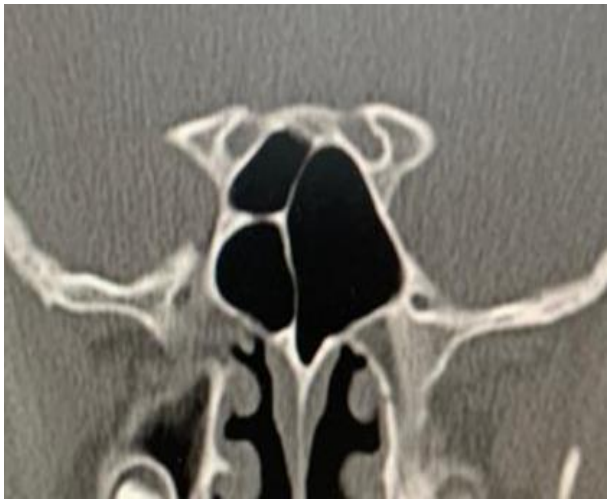

Figure 3: NCCT scan of paranasal sinuses shows right-sided Onodi cell (white arrow).

DISCUSSION

Embryologically, the primitive ethmoidal cells appear in the fourth month of intrauterine life as extensions of the nasal mucosa of the middle, superior and supreme meatuses and their development continues till puberty. On the other hand, the primitive sphenoid sinus develops from the posterosuperior portion of the recessus terminalis and it attains its adult size by the age of 10 or 12 years.[18] The embryological development of sphenoid bone occurs from two chondral ossification centres. The upper ossification centre merges with the ethmoid and the lower ossification centre forms the sphenoid sinus.[12]

Anatomically, the ethmoid cells are grouped into two categories: an anterior and a posterior group. The cells lying anterior to the basal lamella of the middle turbinate and draining into the middle meatus are called the anterior ethmoid complexes. The cells lying posterior to the basal lamella of the middle turbinate and draining into the superior meatus or sphenoethmoidal recess are called the posterior ethmoid complexes. The ethmoid cells show pneumatization into the surrounding bones. Pneumatization of the posterior ethmoidal cells laterally and superiorly to the sphenoid sinus leads to the formation of the Onodi cells also known as the sphenoethmoid cell.[2,3] The terms Onodi cell and the sphenoethmoid cell will be used interchangeably in our study.

Thus, the Onodi cell is the posterior-most ethmoidal air cell lying superior or lateral to the sphenoid sinus lying in close relation to the optic nerve or the internal carotid artery. The Onodi cell may grow into the body of the upper sphenoid bone, surrounding the optic nerve canal and extending into the sella turcica. Hence, the sphenoid sinus may lie posterior, medial, and/or inferior to the Onodi cell. If the posterior ethmoidal cell overrides the bilateral sphenoid sinus in a central location comparative to the usual superolateral location, it is known as central a Onodi cell.[19] The central Onodi cell has at least one

endoscopically identified optic nerve bulge.[19] The Onodi cells share a close relationship with the optic nerve and internal carotid artery superolaterally and to the sphenoid sinus inferomedially.[6] The optic nerve tubercle (the bulge of the medial aspect of the bone surrounding the optic foramen) can be present in the post ethmoids, at the junction of the posterior ethmoids and the sphenoids, or in the sphenoid sinus. Sometimes, the optic nerve can pass through an Onodi cell.[3]

One of the most sinister complications of functional endoscopic sinus surgery is blindness caused by injury to the optic nerve. Among the factors responsible for this complication, apart from lack of surgeon's experience, poor visualisation due to bleeding and loss of anatomic orientation during surgery; the vast anatomic variations in the anatomy of the area have also been implicated.[5]

Since the endoscopic sinus surgery for clearing sinonasal disease and endonasal sellar surgery for resecting pituitary adenomas are becoming popular, more concern has arisen to define Onodi cells and their variations.[20] As Onodi cell has close relationship with the optic nerve and the internal carotid artery, it becomes important to be aware about its presence beforehand to prevent injury to these vital structures and for this, pre-operative CT scan of the paranasal sinuses is the only method.

The wide variations in the prevalence of the Onodi cells is attributable to several factors viz. the differences in the definition of the Onodi cell, methods of identification, differences in the detection techniques and racial factors.[15]

The definition used by most studies is consistent with the International Conference on sinus disease i.e. a posterior ethmoid cell that is lateral and superior to the sphenoid sinus and intimately associated with the optic nerve.[4] Using this definition, Weinberger et al found the incidence of Onodi cells to be 8% with CT scan and 14% in cadaveric specimens.[11] However, another general description of the Onodi cell has been used by Kainz et al i.e. a posterior ethmoid cell that extends into the sphenoid bone with the optic nerve either adjacent to or impinging upon the cell and they reported 42% and 51% respectively using endoscopic dissection in cadavers.[3,17]

Using CT examination, the reported prevalence of Onodi cell in various studies has ranged from as low as 7% to as high as 65.3% (Table 2).[2,14] On the other hand, cadaveric studies have reported the prevalence of Onodi cells to be in the higher range of 14% to 60% (Table 3). Shin et al analysed 162 patients for prevalence of Onodi cells and found a good corelation between the CT and intraoperative findings, being 32.7% and 33.3% respectively.[13] The higher prevalence reported by Tomovic et al has been attributed by the authors to be due to the difference in their definition of the Onodi cell not requiring optic nerve protrusion or dehiscence but just being a posterior ethmoid cell that lies superior to the ethmoid sinus.[14] They did not find any gender age or ethnic variations. Driben et al used both CT scans and endoscopic dissection on the same cadaveric specimens and found that the computerised tomography was not able to predict reliably the presence of the Onodi cell, being seen in only 7% compared to 39% with anatomic dissection.[2]

Table 2: Comparison of studies on prevalence of Onodi cell in CT scan.

S. no.	Authors	Country	Sample size	Prevalence (%)
Asians				
1	Aibara et al[25]	Japan	200	7
2	Tan et al[22]	Malayasia	102	19.65
3	Shin et al[13]	S. Korea	162	32.7
4	Kasemsiri et al[20]	Thailand	187	49.5
5	Tomovic et al[14]	USA	6	83.3
6	Ali et al[21]	India	201	42.8
7	Present study, 2024	N. India	300	19.38
Non-Asians				
1	Weinberger[11]	USA	76	8
2	Jones et al[26]	UK	200	8
3	Driben et al[2]	USA	41	7
4	Arslan et al[27]	Turkey	200	12
5	Basic et al[28]	Croatia	212	10.4
6	Tomovic et al[14]	USA	164	61.8
7	Turna et al[29]	Turkey	5832	13.5
8	Senturk et al[30]	Brazil	618	52.7

Table 3: Comparison of studies of Onodi cell by endoscopy.

S. no.	Authors	Country	Sample size	Percentage (%)
Asians				
1	Yeoh et al[17]	Singapore	102 cadaver half heads	51
2	Thanaviratananich et al[16]	Thailand	65 cadaver half heads	60
3	Shin et al[13]	S. Korea	162 Live surgeries	33.3
Non-Asians				
1	Kainz et al[3]	Austria	52 cadaver half heads	42
2	Weinberger et al[11]	USA	44 cadaver half heads	14
3	Driben et al[2]	USA	21 cadaver whole heads	39

Regarding ethnic variations, some studies have reported higher prevalence in the Asian population (Table 2).[21,22] Using CT scans, Ali et al from India found the prevalence of Onodi cells in 42.8% cases.[22] However, a Malayasian study reported it to be 19.65 %, a finding consistent with the present study i.e.19.38%.[23] In a study on the anatomical variations of the optic nerve in the sphenoid sinus by Kanotra et al, the authors having compared various studies among different ethnic groups concluded that the discrepancy in results even in persons of the same ethnicity precluded a definite conclusion about the role of ethnicity in these variations.[24] The same seems to be true in case of Onodi cells since a look at Tables 2 and 3 shows the variable results. When studied by the more sensitive method of endoscopy, the prevalence was 42% in Europeans and 39% among Americans while among Asians, the prevalence was found to be 51% in Singapopre, 60% in Thailand and 33.3% in South Korea.[2,3,13,16,17] Tomovic et al reported the prevalence to be 57% in African American population, 62.7% in the Hispanic population, 73.1% of the white population and 83.3% of the Asian cohort studied.[14]

A study conducted by Tan et al showed a prevalence of 19.6% Onodi cells where they found 33.33% each were right-sided, left-sided and bilateral.[23] The overall prevalence of 20.5% in our study was almost consistent with his result but in our study, we found 48.78% right-sided, 17.07 % left-sided, 12.20% bilateral and 21.95% central Onodi cells which was not consistent.

CT evaluation should ideally be done in all three planes (axial, coronal and sagittal) although Unal et al in their study on risky anatomic variations of sphenoid for surgery suggested axial planes to be the most preferable method to detect an Onodi cell.[25] However, Tomovic et al concluded coronal and axial cuts to be useful.[14] We found coronal cuts to be an important tool for evaluating Onodi cells.

Ali et al conducted an imaging analysis of the Onodi Cells by cone-beam computed tomography and found the prevalence to be 42.8% in Indian subjects.[22] Tomovic et al studied the prevalence of the Onodi cells by HRCT which gave a 65.3% yield.[14] On the contrary, our evaluation of the Onodi cells by studying CT PNS showed the prevalence to be 20.5%. This difference in the results make us to conclude that CBCT and HRCT are better imaging modalities than CT but the availability and feasibility of CT in our institute made us to choose this modality for our study.

Limitations

Limitations of this study include the small sample size and the absence of endoscopic examination to validate the existence of the Onodi cells. Also, our study was focussed on one particular geographical area and the results cannot be generalised to reflect a universal outcome. Thus, further research will be required to address these issues.

CONCLUSION

The prevalence of the Onodi cells in our study of 300 CT scans was 20.50%. The presence of Onodi cell in at least one in five of our patients makes it mandatory to look for these cells preoperatively and in view of the higher prevalence seen by endoscopic examination by several authors, to be vigilant about their presence while performing endoscopic sinus and skull base surgery even if not recognised on CT scan. This will go a long way to prevent deleterious consequences resulting from injury to the vital structures in its vicinity.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Onodi A. The Optic Nerve and the Accessory Sinuses of the Nose. William Wood. 1910.
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(2):105-12.
3. Kainz J, Stammberger H. Danger areas of the posterior rhinobasis: an endoscopic and anatomical-surgical study. Acta Otolaryngol. 1992;112:852-61.
4. Kennedy DW. International conference on sinus disease: Terminology, Staging, Therapy. Ann Otol Rhinol Laryngol. 1995;104(167):7-16.
5. Huang EI, Kuo CL, Lee LW. A 16-Year Study on Incidence and Progression of Diseased

Sphenoethmoidal (Onodi) Cell. BioMed Res Int. 2020;2410415.
6. Ogata Y, Okinaka Y, Takahashi M. Optic neuropathy caused by an isolated mucocele in an Onodi cell. Oto-Rhino-Laryngologia. 1998;60(6):349-52.
7. Kitagawa K, Hayasaka S, Shimizu K, Nagaki Y. Optic neuropathy produced by a compressed mucocele in an Onodi cell. Am J Ophthalmol. 2003;135(2):253-4.
8. Yoshida K, Wataya T, Yamagata S. Mucocoele in an Onodi cell. Oto-Rhino-Laryngologia. 1998:60(6);349-52.
9. Fukuda Y, Chikamatsu K, Ninomiya H, Yasuoka Y, Miyashita M, Furuya N. Mucocele in an Onodi cell with simultaneous bilateral visual disturbance. Auris Nasus Larynx. 2006;33(2):199-202.
10. Stammberger HR, Kennedy DW. Paranasal sinuses: anatomic terminology and nomenclature. The Anatomic Terminology Group. Ann Otol Rhinol Laryngol Suppl. 1995;167:7-16.
11. Weinberger DG, Anand VK, Al-Rawi M. Surgical anatomy and variations of the Onodi cell. Am J Rhinol. 1996;10:365-70.
12. Yanagisawa E, Weaver EM, Ashikawa R. The Onodi (sphenoethmoid) cell. Ear Nose Throat J. 1998;77(08):578-80.
13. Shin J, Hong YK, Jaun S. The Onodi cell: An obstacle to sellar lesions with a Transsphenoidal approach. Otolaryngol H N Surg. 2011;145:1040.
14. Tomovic S, Esmaeili A, Chan NJ, Choudhry OJ, Shukla PA, Liu JK, et al. High-resolution computed tomography analysis of the prevalence of Onodi cells. Laryngoscope. 2012;122(7):1470-3.
15. Chmielik LP, Chmielik A. The prevalence of the Onodi cell -Most suitable method of CT evaluation in its detection. Int J Ped Otolayngol. 2017;202-5.
16. Thanaviratananich S, Chaisiwamongkol K, Kraitrakul S, Tangsawad. The prevalence of an Onodi cell in adult Thai cadavers. Ear, Nose, Throat J. 2003;82(3):200-4.
17. Yeo KH, Tan KK. The optic nerve in the posterior ethmoid in Asians. Acta otolryngol. 1994:329-36.
18. Cherla DV, Tomovic S, Liu JK, and Eloy J A. The central Onodi cell. A previously unreported anatomic variation. Allergy Rhinol. 2013;4(1):49-51.
19. Schwartz T, Anand V. Endoscopic Pituitary Surgery: Endocrine, Neuro-Ophthalmologic and Surgical Management. Thieme. 2012.
20. Kasemsiri P, Thanaviratananich S ,Puttharak W. The prevalence and pattern of Onodi cell in adult Thai cadavers. J Med Assoc Thai. 2011;94(9):1122-26.
21. Ali IK, Sansare K, Karjodkar F, Saalim M. Imaging analysis of Onodi cells on Cone-Beam Computed Tomography. International Arch Otolaryngol. 2020;24(3)319-22.
22. Tan KL, Harvinder S. Prevalence of Onodi cells in hospital raja permaisuri bainun, ipoh, Malaysia. Med J Malaysia. 2010;65(2):101-2.
23. Kanotra S, Bashir S, Sharma P. Anatomical Variations of the Optic Nerve in the Sphenoid Sinus-Do Ethnic variations Matter. Ind j Otolayngol H N Surg. 2023;75(3)1943-9.
24. 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.
25. Aibara R, Kawakita S, Yumoto E, Yanagihara N. Relationship of Onodi cell to optic neuritis–radiological anatomy on coronal CT scanning. Nippon Iibiinkoka Gakkai Kaiho. 1997;100:663-70.
26. Jones NS, Strobl A, Holland I. A study of the CT findings in 100 patients with rhinosinusitis and 100 controls. Clin Otolaryngol. 1997;22:47-51.
27. 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.
28. Basic N, Basic V, Jukic T. Computed tomographic imaging to determine the frequency of anatomical variations in pneumatization of the ethmoid bone. Eur Arch Otorhinolaryngol. 1999;256:69-71.
29. Turna O, Ayber MD, Karagoz Y. Anatomical variations of the Paranasal Sinus region: evaluation with multidetector CT. Istanbul. 2014;15(2):104-9.
30. Senturk M, Guler I, Azgin I, Sakarya EU, Ovet G, Alatas N, et al. The role of Onodi cells in sphenoiditis: results of multiplanar reconstruction of computed tomography scanning. Brazilian J Otolaryngol. 2017;83:88-93.

Cite this article as: Sharma P, Kanotra S, Bashir S, Khan YA, Batt MZ, Ahmed QS, et al. A study of the prevalence of Onodi cells in a North Indian population. Int J Otorhinolaryngol Head Neck Surg 2024;10:310-5.