Relationship of the optic nerve to the posterior paranasal sinuses among patients visiting a tertiary hospital of Gandaki Province of Nepal: A CT scan anatomic study

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ABSTRACT

Introduction: Functional Endoscopic Sinus Surgery (FESS) has popularly been used for the effective treatment of paranasal sinus disorders and for the removal of tissue obstructing the osteo meatal complex and the facilitation of drainage. However, almost 16% to 50% of all the complications of the FESS have orbital involvement. The complications are due to the wide variation in the anatomy of the sphenoidal and posterior ethmoidal sinuses. This study aimed to find the prevalence of types of relationships that optic nerves have with the sphenoid sinus and also the prevalence of anatomical variation in sphenoid sinus. **Methods:** This is the descriptive cross-sectional study conducted over 210 participants appearing for CT scan imaging of paranasal sinuses. CT scan of paranasal sinus was performed with 5 mm thickness and then reconstructed to 1.5 mm thickness and evaluated to find the relationship of optic nerve with the paranasal sinuses according to Delano et al. classification. Prevalence of Onodi cells and anterior clinoid process pneumatization was also evaluated for variation in sphenoid sinus. **Results:** This study found that bilateral optic nerve of Type-I was found in 82.38% people followed by Type-IV in 14.29%. While, Type-III was completely absent in the study population. Prevalence of Onodi cells was 10.95% and that of ACP pneumatization was 6.67%. **Conclusions:** Variation in relationship of Optic Nerve with paranasal sinuses found with Type-I being the most common.

Keywords: Functional endoscopic sinus surgery (FESS), optic nerve, sphenoid sinus.

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INTRODUCTION

After the introduction of trans nasal endoscopic sinus surgery in 1980s, the Functional Endoscopic Sinus Surgery (FESS) and instrumentation procedures have rapidly increased for the removal of tissue obstructing the osteomeatal complex (OMC) and the facilitation of drainage.[1] Over the last two decades, FESS has popularly been used for the effective treatment of paranasal sinus (PNS) disorders. Although the FESS is comparatively safe, it is not free from risk. Risk may include bleeding, infection, injury to the eye, optic nerve injury and may lead to blindness. This is because almost 16% to 50% of all the complications of the FESS have orbital involvement.[2] The complications are due to the wide variation in the anatomy of the sphenoidal and posterior ethmoidal sinuses.[3-5] Maxillary sinus expands to the infraorbital canal laterally until the age of four years and optic nerve may lie laterally intimate with posterior ethmoidal cells also called cells of Onodi and sphenoid sinus with greater risk of injury of the nerve.[6] This intimate close relationship of orbits to posterior paranasal sinuses imposes risks to the nearby optic nerve as a complication of FESS.[7] Therefore, surgeons need to consider and identify the close anatomical relation

between posterior paranasal sinus and orbits and orbital nerve prior to the surgery.

Based on the position of optic nerve or its relationship with the sphenoid sinus and posterior ethmoid sinuses, Delano et al. classified the optic nerve in four classes viz; type-1, type-2, type-3, and type-4.[8] The relationships can be understood well in preoperative computed tomography (CT) of the sinuses because CT scan has been accepted as the gold standard test for the detection of diseases related to paranasal sinuses.[9-11] Preoperative CT scan of paranasal sinuses when evaluated in bone window in coronal plane, the variation in anatomy of sphenoid sinus or the relationships of the optic nerve to the paranasal sinuses can be understood well and leveraged while performing FESS.

However, there is a clear gap of the knowledge regarding the prevalence of the type of variation in anatomy of the sphenoid sinus and relationships of optic nerve to the sphenoid sinus in Nepalese population. This observational study aims to fill the gap and find the prevalence of types of relationships that optic nerves have with the sphenoid sinus and also the prevalence of anatomical variation in the sphenoid sinus amongst the patients visiting the tertiary care center of Gandaki Province of Nepal.

METHODS

This descriptive observational study with a sample size of 210 participants was conducted at Pokhara Academy of Health Sciences (PoAHS), Kaski between March 2024 and August 2024. Sample size of 186 was needed based on previous literature about anatomical variation of sphenoid sinus with the prevalence of Onodi cells in 14% of patients and an error of 5%.[12] All the patients between the ages of five years and above coming for CT scan of PNS in the radiology department of PoAHS were included in the study, provided they did not meet the exclusion criteria of the study. Exclusion criteria included prior sinus surgery, head and neck surgeries, Sino-nasal tumors, nasal polyps, and cervical arthroplasty. The study was started after the ethical clearance (Ref. No: 216/080) from the Institutional Review Committee of Pokhara Academy of Health Sciences, Kaski. A written consent was achieved from the participants about the use of image for research and study purposes keeping the identity of the patient confidential.

CT protocol: Demographic data of the patients coming for CT scan of PNS was collected. The scan was done in supine position with head stabilization from hard palate to above the end of frontal sinuses. Scan was done by Philips Incisive 128 CT scanner with parameters of 120 KVp, 100-150 mAs and slice thickness of 5 mm with 1.5 mm reconstruction. Reconstructed images in axial, sagittal and coronal sections were studied by Radiologist in CT console with DICOM viewer soft-ware (INTELLI SPACE). Images were studied in Bone window (WW: 2500, L: 400).

Variation in anatomy of sphenoid sinuses was noted in terms of presence or absence of Onodi cells, and also the presence or absence of Anterior Clinoid Process (ACP) pneumatization. Similarly, the types of optic nerve or the relationships of optic nerve with the sinuses were also noted following the criteria of Delano et al. Those types are; Type-1 means optic nerve adjacent to the sphenoidal sinus. Type-2 represents indentation of sphenoidal sinus, type-3 means optic nerve traversing sphenoidal sinus, and type-4 means adjacent to sphenoidal and posterior ethmoidal air cells.[8] The study was susceptible to measurement bias because diagnosis may vary from one radiologist to another. To address this measurement bias, three registered Radiologists were blinded to one another and were asked to evaluate the image in coronal plane in bone window and the most common diagnosis was accepted. For the analysis of the data, statistical software STATA 15.1 was used.

RESULTS

Age-specific and sex-specific distribution of the 210 participants in the sample delineates that 210 participants included 59% males and almost 41% females. The greatest percentage of patients were between the age of 21 years and 40 years representing 31.43%. (Table 1)

Table 1: Age and sex distribution of the participants (N=210)

Characteristics	Category	Frequency	Percentage
Age (years)	1 to 20 years	31	14.76%
	21 to 40 years	66	31.43%
	41 to 60 years	64	30.48%
	61 to 80 years	36	17.14%
	more than 80 years	13	6.19%
Sex	Male	124	59.05%
	Female	86	40.95%

After the evaluation of CT scan image, Onodi cells were present bilaterally in almost 10.95% of the patients, while 18.57% people had Onodi cells present in either right or left side. The study also has shown that 13.33% people had ACP pneumatization on right side while only 8% people had the pneumatization on left side (Table 2).

Table 2: Distribution of Anatomical variation in sphenoid sinus (N=210)

Variations in sphenoid sinus n(%)		Right n(%)	Left n(%)	Bilateral
Onodi cells	Absent	171(81.43%)	171(81.43%)	187(89.05%)
	Present	39(18.57%)	39(18.57%)	23(10.95%)
The Anterior clinoid process (ACP) pneumatization	Absent	182(86.67%)	193(91.90%)	196(93.33%)
	Present	28(13.33%)	17(8.10%)	14(6.67%)

CT image has shown that optic nerve of type-1 was in highest prevalence of 47.62% and 85.24% on right side and left side respectively. Second common type of optic nerve relationship was of type-4. The results has shown that optic nerve of type-3 was not seen as shown in Table 3.

Table 3: Optic nerve types based on relationship with sphenoid sinus (N=210)

Optic nerve type	Right optic nerve		Left optic nerve		B/L Optic Nerve	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Type-1	100	47.62%	179	85.24%	173	82.38%
Type-2	5	2.38%	8	3.81	7	3.33%
Type-3	0	0	0	0	0	0
Type-4	105	50%	23	10.95%	30	14.29%
Total	210	100%	210	100%	210	100%

Variation in anatomy of sphenoid sinus across sex as tabulated 4 has shown that prevalence of presence of onodi cells and ACP pneumatization was almost twice in percentage in males as compared to females as per Table 4.

Table 4: Variation in sinuses across sex (N=210)

Variation in sinuses		Sex	
		Male	Female
Right onodi cells	Absent	96(77.42%)	75(87.21%)
	Present	28(22.58%)	11(12.79%)
Left onodi cells	Absent	100(80.65%)	71(82.56%)
	Present	24(19.35%)	15(17.44%)
Right ACP pneumatization	Absent	103(83.06%)	79(91.86%)
	Present	21(16.94%)	7(8.14%)
Left ACP pneumatization	Absent	112(90.32%)	81(94.19%)
	Present	12(9.68%)	5(5.81%)

DISCUSSION

This study found that almost 11% people had onodi cells on bilateral side while only about 7% had ACP pneumatization on both the sides. The presence of onodi cells was almost similar in percentage (14%) when compared to the previous literature of Kaya et al. However, another literature reported that there was presence of Onodi cells in 22.6% of the patients. About the ACP pneumatization, this study found the prevalence of 7% only, while Kaya et al. and another researchers Ravindra et al. and Devika et al. found the ACP pneumatization prevalence to be 21% and 25% respectively.[12,13] The possible reason of this variation may be due to the sample size of this study. Sample size of this study was almost twice as compared to other studies and so overestimation might have been the case in previous literature while less chances of error in this one. However, this study also admits the fact that further research is needed with a bigger sample size and lesser error.

Previous literature has mixed types of result interpretation about the prevalence of the type of optic nerve. When this study examined the optic nerve and categorized it as per the Delano et al. classification. This study found that the most common type was type-1 optic nerve followed by type-4 optic nerve with the prevalence being 82% followed by 14%. The pattern was similar to the findings of other literature which reported similar patterns.[14] In contrast, some research reported different patterns of prevalence of types and reported that type-1 is the most common followed by type-2 then type-3, and finally type-4.[15] Surprising finding of this study is that not even a single case with type-3 optic nerve was seen in this study.

This variation in the result amongst studies conducted before calls for a large observational study with little or no bias. Furthermore, study should be done across ethnicity as well.

The limitation of the study was that the sample was collected at a single center and ethnicity was not taken into account because of which the sample may not be population representative of Pokhara. Furthermore, this was simply a descriptive study. There still remains a gap and further study is needed with a large sample size to find the association using regression analysis.

CONCLUSIONS

As per the diagnosis from CT scan about the relationship of optic nerve with paranasal sinuses, the most common was Type-I followed by Type-IV and Type-II respectively. Results of this study would help surgeons in decision making and would guide while performing FESS. This study provides the foundation for further research to understand the factors associated with the variation in optic nerve.

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AUTHORS' CONTRIBUTION

RP contributed to the definition of intellectual content, data acquisition, manuscript editing, and manuscript review. MM contributed to the design, literature search, data analysis, statistical analysis, manuscript preparation

editing, and review. AB contributed to concepts, design, the definition of intellectual content, literature search, data acquisition, and manuscript editing. LPL contributed in the literature search, data analysis, statistical analysis, manuscript editing, and review. DB contributed in literature search, data acquisition, manuscript preparation, editing, and review. MT contributed to manuscript preparation, editing, and review. RMB also contributed in manuscript preparation, editing, and review. TRB contributed in the design, literature search, data acquisition, and manuscript review.

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