



## TYPES OF OPTIC NERVES : THEIR ANATOMICAL SIGNIFICANCE FOR ENDOSCOPIC NASAL SURGERY

**Dr. Santosh R. Konde**

Associate Professor, Department of Radiodiagnosis, SKNMC, Narhe, Pune 411041

**Dr. Abhijeet Pawar\***

Associate Professor, Department of Radiodiagnosis, SKNMC, Narhe, Pune 411041,  
\*Corresponding Author

**Dr. Priya Bhole**

3<sup>rd</sup> year Resident, Department of Radiodiagnosis, SKNMC, Narhe, Pune 411041

### ABSTRACT

**Aim :** To define direct anatomical relations of the sphenoid sinus, ethmoidal sinuses and optic nerve and the incidence of Type III optic nerves detected on multidetector CT with their surgical significance.

**Methods :** This retrospective, descriptive study involved 150 consecutive patients. All patients underwent computerized tomography (CT). The relationship of the optic nerve and the sphenoidal and ethmoidal sinuses was classified. The presence of dehiscence in the bone structures, forming the optic canal, was checked. Dehiscence was defined as absence of visible bone density located between the sinus and the optic nerve. Protrusion of the optic nerve into the sphenoidal sinus was defined as optic nerve surrounded by pneumatized space in at least 180° of its circumference.

**Results :** The most common type optic nerve was type I, where the optic nerve is located immediately adjacent to the lateral or superior wall of the sphenoidal sinus, without impression on the sinus wall. Dehiscence (Type II optic nerve) was documented in 110 (36.66%) optic nerves. Optic nerves were seen directly coursing through the sphenoid sinus (Type III) in 20 (6.67%) optic nerves. Type IV optic nerves were seen in 14 (4.67%) optic nerves.

**Conclusion :** Surgeons and ophthalmologists should be aware of high frequency of dehiscence of sphenoidal sinus walls when operating on patients considering the rate of dehiscence and the percentage of optic nerves seen coursing through the posterior paranasal sinuses, especially when evaluating risks and complications of surgical procedures or when diagnosing inflammatory or tumorous processes in the close vicinity of posterior paranasal sinuses.

**KEYWORDS :** Computed Tomography, Sphenoid Sinus, Optic Nerve.

### INTRODUCTION

Referred to as a “no man's land”, The ophthalmic and otorhinolaryngology branches find significant overlap in each other's specialities, the optic nerve orientation being one such overlap. Many anatomical variations of the posterior paranasal sinuses have been enumerated. These affect the choice of surgical approaches when operating within their anatomical region and can also lead to many potential complications, important including blindness or iatrogenic injury to the internal carotid artery. Anatomic or radiologic variations, especially dehiscences related to disease or previous surgery come as an important risk factor for complications of endoscopic surgery (1). A major role of imaging is to provide an idea of the normal as well as variant anatomy to the surgeon to prevent impending complications including reducing the injuries the skull base, which may lead to CSF leakage in future (2). Within the optic canal, the fibers of the optic nerve are very close to the sphenoid sinus, because of which they are exposed to mechanical or inflammatory processes, especially if there is dehiscence in the bone walls of either the optic canal or the sphenoid sinus, or if the canal wall is particularly thin (3-7). The optic nerve bulges into the superolateral wall of the sphenoid sinus which is defined as the Type II optic nerve. The prevalence of anatomical variations of posterior paranasal sinuses differs in various populations (8). The relations of the optic nerve to sphenoid and ethmoid sinuses were assessed according to DeLano et al. (1996) and were classified into four different types (assessed in axial plane)(9):

- Type 1: the nerve does not contact or impinge on either the sphenoid or posterior ethmoid cells
- Type 2: the nerve indents the sphenoid sinus, without contacting the posterior ethmoid cells
- Type 3: the nerve runs through the sphenoid sinus, and it is surrounded by the pneumatized sinus for at least 50 %
- Type 4: the nerve courses close to both the sphenoid sinus and posterior ethmoid sinus.

During Functional endoscopic sinus surgery (FESS), a detailed knowledge of all the anatomic variations of the posterior paranasal sinuses is required, along with the anatomic location of the optic nerve and the internal carotid artery with dehiscences of their walls (if present).

### PATIENTS AND METHODS

The study was performed at the Department of Radiology, Smt Kashibai Navale medical college, Narhe – Pune. Scans were performed on a multi-slice (16 slice) ACT Revolution, GE.150 CT scans were reviewed by the Consultant Senior Radiologists at our institute. Optic nerves were classified into four types as per the DeLano classification. Anatomic relations of the optic nerve and the sphenoid and ethmoid sinuses, level of sphenoid pneumatization, presence of dehiscence in the bone structures that form the optic canal, protrusion of the optic nerve into the sphenoid sinus cavity were investigated. Patients in the age group of 19 – 69 years were included in the study. The patients were further subdivided into groups of 10 years and as per sex (Table 2). This was a retrospective study of patients who had been previously referred to Department of Radiology at our institute.

The obtained scans were direct axial CT scans beginning with the frontal sinus and ending with the hard palate. Multiplanary reconstructions, created using an console to view the images in the coronal and sagittal plane. The relationship of the optic nerve and the sphenoid and ethmoidal sinuses was classified based on the criteria developed by De Lano et al. The presence of dehiscence in the neighboring bone structures, forming the optic canal, was noted. Dehiscence was defined as the absence of visible bone density located between the sinus and the optic nerve.

### RESULTS

Number of ON	Number	Percentage(%)
Type 1	156	52%
Type 2	110	36.66%
Type 3	20	6.67%
Type 4	14	4.67%

**Table 1: Classification as per optic nerve type**

TYPES OF NERVES	MALE	FEMALE
I	15-25	33
	26-35	20
	36-45	19
	46-55	7
	56-65	10
	>65	8

II	15-25	21	8
	26-35	16	2
	36-45	15	6
	46-55	11	14
	56-65	7	4
III	>65	4	2
	15-25	4	0
	26-35	8	0
	36-45	2	0
	46-55	0	0
IV	56-65	2	0
	>65	2	0
	15-25	3	0
	26-35	0	3
	36-45	2	0
	46-55	2	2
	56-65	2	0
	>65	0	0

Table 2: Classification as per age and sex



Fig 1: Type I optic nerve:

The nerve is not in contact with either the sphenoid or posterior ethmoid cells



FIG 2: Type II optic nerve:

The nerve is seen indenting the sphenoid sinus with a dehiscent inferomedial wall, without contacting the posterior ethmoid cells



Fig 3: Type III optic nerve

The nerve is seen coursing through the sphenoid sinus, and is surrounded by the pneumatized sinus in more than 180 degree of its extent.



Fig 4A



Fig 4B



Fig 4C



Fig 4D

Fig 4 (A-D) : The course of the optic nerve through the sphenoid sinus and the ethmoid air cells can be demonstrated(Posterior to anterior).

As per our study, Type I was the most common type of optic nerves found followed by Type II, III, IV in descending order of incidence. While Type I optic nerve is considered safe for performing FESS as there is bony wall between the nerve and the posterior paranasal sinuses, it formed just half of the percentage of the nerves. Dehiscent superolateral walls of the optic nerves were found in more than one third of the patients. This necessitates a pre-operative CT scan for every patient. Also the surgeon has to be extremely vigilant about the injury that may be caused to the optic nerves during the surgery. Also the types of optic nerves were not necessarily same on same side (different types on both sides in a significant number of patients).

**CONCLUSION:**

The indentation, protrusion or the course of optic nerve through the sphenoid sinus, bone dehiscence over the nerve and pneumatization of the anterior clinoid process are anatomic configurations that predispose to optic nerve injury during surgical intervention in this region. Our results show that anatomical configurations are very common. Axial scans with Coronal and Sagittal reformations are required for visualisation of the position of the optic nerve. It is essential in preoperative planning to ensure the safety and efficiency of paranasal sinus surgery. Due to prevalence of endoscopic sinus surgeries preoperative knowledge of the anatomy of sinuses and its variants should be known. The most important sinus to be well evaluated for optic nerve and carotid artery relation is the sphenoid sinus along its superior and lateral walls.

To reduce the risks of surgery, care must be taken in evaluating the pre-operative CT-scans and recognizing anatomical variations. These will guide surgeons for the surgical plan and the limits of dissection intraoperatively in the sphenoid sinus.

**Discussion:**

Several anatomic variations of the ethmoid and sphenoid sinuses increase the risk for injury to adjacent structures during endoscopic sinus surgery. Inadvertent injury to these structures can result in uncontrollable bleeding, hematoma formation with proptosis, diplopia caused by extraocular muscle injury and stretching of the optic nerve resulting in blindness, injury to skull base with resultant pneumocephalus or cerebrospinal fluid leakage. Damage of the optic nerve is a serious complication of Functional endoscopic sinus surgery. Protrusion of the optic canal into the sphenoid and/or ethmoid sinuses has considerable clinical importance.

In the present study, we found 43.3% nerves in the second and the third categories which are considered the most critical for the potential risk of injury of Optic Nerves due to no intervening bony wall between them increasing the risk of injury to the nerve. DeLano et al.(9) reviewed 150 CT scans – 300 nerves, which all were intimately related

to the sphenoid sinus. Only 3 % were in contact with the posterior ethmoid cells (PEC). They reported – type 1 – 76 %, type 2 – 15 %, type 3 – 6 % and type 4 – 3 %. Our study found a higher percentage of Type II, III and IV optic nerves.

#### References:

1. Stankiewicz JA, Lal D, Connor M, Welch K. Complications in endoscopic sinus surgery for chronic rhinosinusitis: a 25-year experience. *Laryngoscope* 2011; 121:2684-701.
2. El Kammash T, Enaba M, Awadalla A. Variability in sphenoid sinus pneumatization and its impact upon reduction and complications following sellar region surgeries. *The Egyptian Journal of Radiology and Nuclear Medicine* 2014; 45:705-14.
3. Patt BS, Manning SC. Blindness resulting from orbital complications of sinusitis. *Otolaryngol Head Neck Surg* 1991; 104:789-90.11.
4. Sato H, Tsukuda M, Mochimatsu I, Furukawa M, Sawaki S. Sinusitis associated with disorders of visual acuity. *ORL J Otorhinolaryngol Relat Spec* 1994; 56:302-4.12.
5. Postma GN, Chole RA, Nemzek W. Reversible blindness secondary to acute sphenoid sinusitis. *Otolaryngol Head Neck Surg* 1995; 112:742-6.13.
7. Remm WH, Rhoton AL. Microsurgical anatomy of the sellar region. *J Neurosurg* 1975; 43:288-98.
8. Al-Abri R, Bhargava D, Al-Bassam W, Al-Badaai Y, Sawhney S. Clinically significant anatomical variants of the paranasal sinuses. *Oman Med J* 2014; 29:110-3.
9. Delano MC, Fun FY, Zinreich SJ. Relationship of the optic nerve to the posterior paranasal sinuses: a CT anatomic study. *AJNR Am J Neuroradiol* 1996; 17:669-75.