International Journal of Radiology and Diagnostic Imaging

E-ISSN: 2664-4444
P-ISSN: 2664-4436
www.radiologypaper.com
IJRDI 2024; 7(3): 136-140
Received: 05-06-2024
Accepted: 10-07-2024

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Multidetector computed tomography evaluation of optic nerve canal in relation to posterior paranasal sinuses in Nepalese people

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DOI: https://doi.org/10.33545/26644436.2024.v7.i3b.407

Abstract
Objective: The aim of this descriptive cross sectional study was to assess the relationship of optic nerve canal with posterior paranasal sinuses on multidetector computed tomography of paranasal sinus performed at our tertiary level hospital.
Methodology: Study was carried out in 216 optic nerve canals of 108 participants (66 male and 42 female) who were referred for the computed tomography of paranasal sinus to the Department of Radiology, NAMS, Bir Hospital, Kathmandu. Volumetric Non Contrast CT scan of paranasal sinus was done in Philips 128 multislice CT scan machine keeping 0.65 mm axial slice thickness, 120 kV and auto mA current with multiplanar reconstruction on dedicated workstation. We included patients who were referred to our department for computed tomography of paranasal sinus and more than 16 years of age. Exclusion criteria were the patients who had undergone nasal surgery and who had history of significant trauma. Computed tomography findings of each optic nerve canal was interpreted mainly for the relationship with paranasal sinuses by two radiologists independently. Optic nerve canal was categorized into four types according to the modified DeLano *et al.* classification on coronal reconstruction. Presence of Onodi cells, bony dehiscence around optic nerve and pneumatization of anterior clinoid process were noted separately. SPSS 20 was used for entry and analysis of the collected data.
Result: Among 216 optic nerve canals of 108 patients, Type 1 canal was seen most commonly in 63.4% followed by 16.7% Type 2, 12.5% Type 3 and 7.4% Type 4 canal. Most of the canals showed bilaterally symmetrical pattern. Onodi cells, bony dehiscence around optic canal and pneumatization of anterior clinoid process were seen in 12.9%, 19.4% and 15.3% cases respectively. Presence of bony dehiscence and pneumatization of anterior clinoid process were significantly associated with Type 3 optic nerve canals (p value < 0.05).
Conclusion: CT scan is indicated for preoperative evaluation of the relationship of optic nerve canal with posterior paranasal sinus before Functional Endoscopic Sinus Surgery to avoid any unintended injury to optic nerve during surgery. Type of optic nerve canal and presence of Onodi cells, bony dehiscence and pneumatization of anterior clinoid process can be diagnosed by multidetector computed tomography, which can reduce the complications during and after surgery.

Keywords: Optic nerve canal, paranasal sinus, computed tomography

Introduction

Optic nerve canal is a bony canal through which optic nerve traverses from orbit to cranium and this canal is in close relation to posterior sinuses i.e. the posterior ethmoidal cells and sphenoid sinus [1]. It is commonly situated at superolateral position of sphenoid sinus [2]. However, this relationship is not always constant and the extent of sinus pneumatization determines the variations. Such variation in relationship between optic nerve and posterior sinuses might predispose optic nerve to get injured during Functional Endoscopic Sinus Surgery (FESS) [3].

Onodi cells are extension of posterior-most ethmoidal air cells superolateral to the sphenoid sinus, into the anterior clinoid process and their presence makes FESS more risky [4]. Sometimes, the optic nerve may lack a thin bony covering which further increases the risk of injury.

Degree of sinus pneumatization and extension of posterior sinus varies with population and ethnic group. Since prior recognition of variations in sinus pneumatization and relation with

optic nerve canal is very important prior to FESS, we need to understand the definite pattern in our population.

We conducted this study to find out the prevalence of different type of optic nerve canal according to modified DeLano's classification [5] and associated variations like optic nerve canal dehiscence and pneumatization of anterior clinoid process in Nepalese people.

Methodology

It was retrospective cross sectional study conducted at Department of Radiology & Imaging, National Academy of Medical Sciences, Bir Hospital, Kathmandu from March 1, 2023 to August 31, 2023. Patients whose Non-contrast Computed Tomography (NCCT) scan of paranasal sinuses (PNS) was performed within the study period were enrolled in the study. Volumetric NCCT scan of PNS was performed in Philips 128 multislice CT scan machine using 0.65 mm axial slice thickness, 120 kV and auto mA current with multiplanar reconstruction on dedicated workstation. Inclusion criteria were patients who were referred to our department for NCCT of PNS and more than 16 years of age. Those who had undergone nasal surgery and who had history of significant trauma were excluded from the study.

Total 108 patients fulfilling the inclusion criteria were selected for the study and optic nerve canals of both side were studied, hence we studied 216 optic nerve canals. NCCT PNS findings of each optic nerve canal was interpreted mainly for the relationship with paranasal sinuses by two radiologists independently without knowing each other's conclusion. In case of confusing findings, both the radiologists were consulted again to make them agree upon one common stand. Categorization of optic nerve canal into four types was done according to the modified DeLano *et al.* classification on coronal reconstruction (Figure 1-4). Type 1 canal is situated superolaterally to the sphenoid sinus and there is no indentation to the sinus wall. Indentation to sinus wall with less than 50% protrusion of nerve circumference is Type 2 canal, whereas, more than 50% protrusion of nerve circumference into the sinus is Type 3 canal. Type 4 canal is posteriorly displaced into ethmoidal air cells or Onodi cells. Modified DeLano's classification distinguished Type 2 & Type 3 optic nerve canals more objectively taking less or more than 50% protrusion of nerve circumference whereas Type 1 and Type 4 were kept as it was in the original classification. Presence of Onodi cells, bony dehiscence around optic nerve and pneumatization of anterior clinoid process were noted separately.

SPSS 20 was used for entry and tabulation of the collected data. Data analysis was done and presented using frequency tables, percentages and graphs. Chi- square test was used and if p-value was less than 0.05, then only it was considered to be statistically significant.

Results

We studied 216 optic nerve canals of 108 patients among which 66 (61.1%) were female and 42 (38.9%) were male. Age of patients ranged from 17 to 83 years with mean age of 42.7 years. Categorization of all the optic nerve canals assessed in our study (Table 1) showed Type 1 canal to be the most common type seen in 63.4% of the cases followed by Type 2 canal in 16.7% and Type 3 canal in 12.5% with Type 4 canal being the least common type seen only in 7.4% of the study population. The majority of canals were bilaterally symmetrical type with only 5 patients showing different types of canals bilaterally. Onodi cells were seen in 28 cases (12.9%) with right sided in 19 cases (67.9%) and left sided in 9 cases (32.1%).

Fig 1: Type 1 optic nerve canal (Arrows) situated superolaterally to sphenoid sinus bilaterally on coronal CT

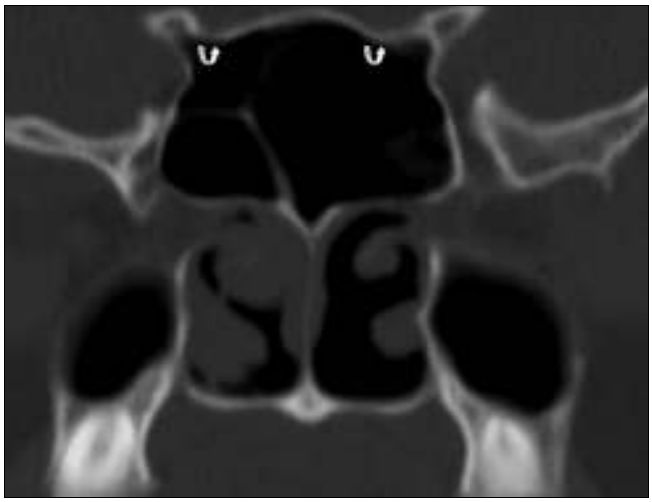

Fig 2: Type 2 optic nerve canal (curved arrows) causing <50% of indentation to sinus wall bilaterally on coronal CT

Fig 3: Type 3 optic nerve canal with bony dehiscence (arrows) and pneumatized anterior clinoid process (stars) bilaterally on coronal CT

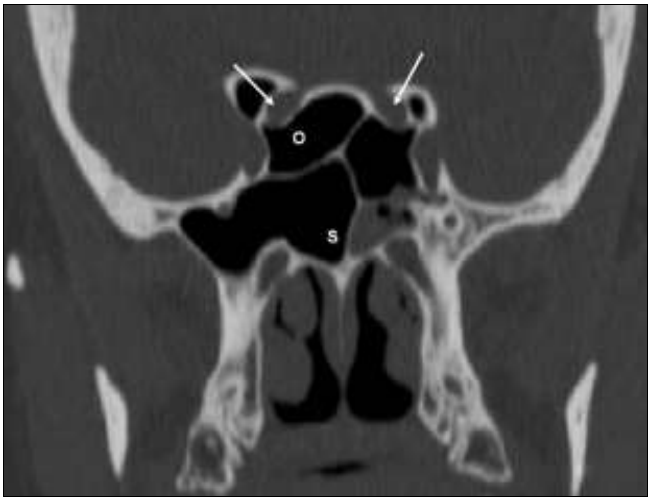

Fig 4: Type 4 optic nerve canal bilaterally (arrows) with Onodi cell (o) on right side

Dehiscence was labelled when bony coverage around the optic nerve was absent. We observed bony dehiscence in 42 optic nerve canals (19.4%) with 20 bilaterally (in 10 patients), 13 in right side only and 9 in left side only. Bony dehiscence was most commonly seen (57.1%) in Type 3 canal followed by in 23.8% in Type 2 and 14.2% cases in type 4 canals and least common in Type 1 canal (only 4.7%) (Figure 5). 56% cases with bony dehiscence were male and 44% were female. Presence of bony dehiscence was found to be statistically significant with Type 3 optic nerve canal (p value< 0.01).

We found pneumatization of anterior clinoid process in 22 patients around 33 optic nerve canals (15.3%) - 18 bilateral in 9 patients, 8 in left side only and 7 in right side only). Type 3 optic nerve canal was associated with 26 cases (78.8%) of pneumatized anterior clinoid process, whereas, Type 4 and Type 2 canals were associated with 12.1% and 9.1% cases of pneumatized anterior clinoid process respectively (Figure 6). Pneumatization of anterior clinoid process was not seen in any case of Type 1 canal. Occurrence of pneumatized anterior clinoid process was found to be statistically significant with presence of Type 3 optic nerve canals (p value< 0.01).

Table 1: Distribution of Types of Optic nerve canals

Optic nerve canal	Right	Left	Total	Percentage
Type 1	70	67	137	63.4
Type 2	17	19	36	16.7
Type 3	13	14	27	12.5
Type 4	8	8	16	7.4
Total	108	108	216	100

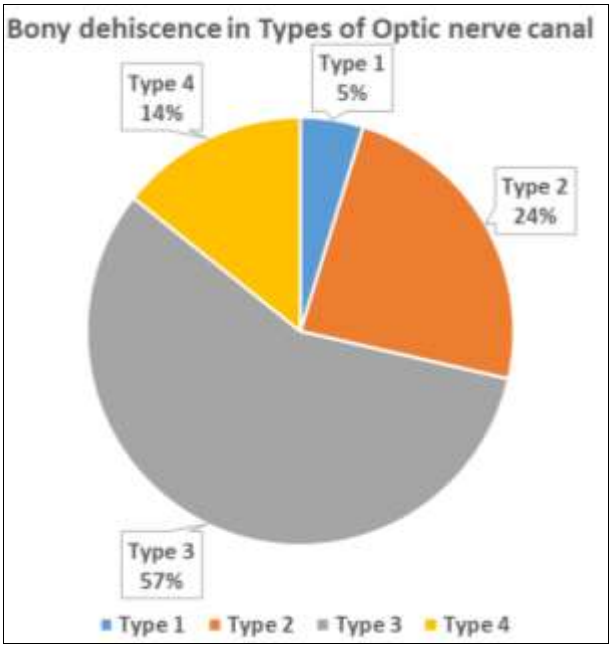

Fig 5: Distribution of bony dehiscence in different types of canals (Pie chart)

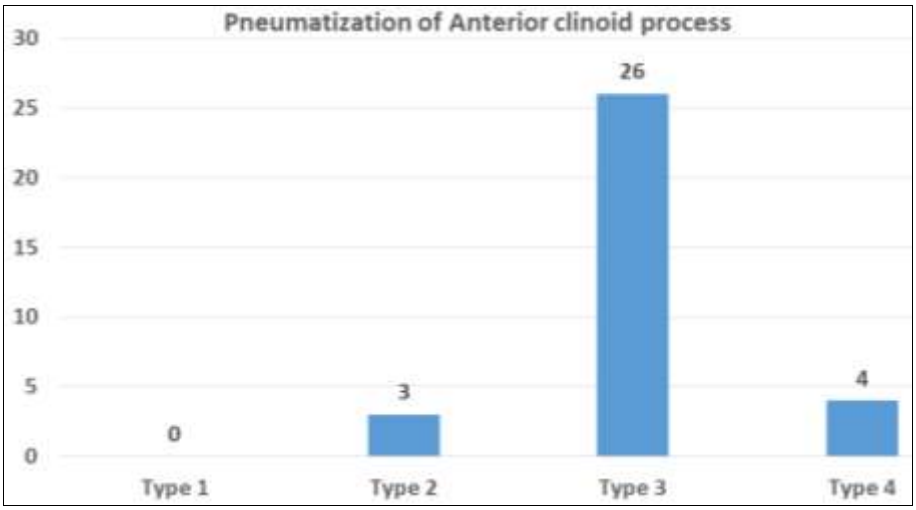

Fig 6: Distribution of pneumatization of anterior clinoid proces in different types of canals (Bar diagram)

Discussion

In this study, we assessed optic nerve canals on multidetector computed tomography of paranasal sinuses and categorized the canals in 4 types according to modified DeLano classification. Type 1 optic nerve canal (63.4%) was the most commonly seen in our study followed by Type 2 canal (16.7%) and Type 3 canal (12.5%). Type 4 canal was seen only in 7.4% of the study population, hence, it was the least common type. In their landmark study in 1996, DeLano *et al.* found that Type 1 was the most common (76%) and Type 4 the least common (3%) type of optic nerve canal with Type 2 and Type being 15% & 6% respectively. Dahal P *et al.* had conducted similar study in Nepal in 2023 and showed that Type 1 (65.4%) was the

commonest type of optic nerve canal followed by Type 2 (16.9%), Type 4 (9.1%) and Type 3 (8.6%) [6]. Sapci *et al.* found 64% Type 1 canal followed by 22% Type 2 canal with 7% each Type 3 & Type 4 canal in their study in Turkish population [7]. Itagi *et al.* also showed Type 1 (60%) was the most common type of optic nerve canal followed by Type 2 (15%), Type 3 (14%) and Type 4 (11%) in Indian population. So, finding of our study turned out to be similar to that of several other studies which had been conducted in different parts of the world.

We observed bony dehiscence around optic nerve in 19.4% of the cases and Type 3 optic nerve canals were most commonly associated (57.1%) with bony dehiscence. Efendic *et al.* observed that bony dehiscence was seen in 25% in their study with older people affected more commonly than the younger ones [8]. Bony dehiscence was seen in 17.5% canals in previous study done by Itagi *et al.* in India and in 21.3% in a study done by Dahal *et al.* in Nepal. In both of these studies, Type 3 optic nerve canals was the most commonly associated type with presence of bony dehiscence. So, finding of our study regarding bony dehiscence around optic nerve was similar to that of several previous studies.

Onodi cells were present in 12.9% of cases in our study with right sided predominance. In a Brazilian study conducted by Dias *et al.*, Onodi cells were seen in 7.92% [9]. Driben *et al.* observed presence of Onodi cells in 7% of the cases in their study based on 41 computed tomography scans [10] and Dua *et al.* showed 6% incidence in Indian population [11]. However, Thanaviratananich *et al.* conducted a study on 65 Thai cadavers unlike on computed tomography scans and showed very high (60%) incidence of Onodi cells [12]. But Thirunavukarasu P *et al.* observed that Onodi cells were present in 11.9% of computed tomography scans in Indian population [13]. So, it has been concluded that prevalence of Onodi cells varies in different population and although these cells can be detected by computed tomography, its sensitivity is less than that of cadaveric dissection.

Pneumatization of anterior clinoid process (PACP) was seen in 15.3% of the cases in our study. It was also most commonly associated with Type 3 optic nerve canals in 78.8%. Heskova G et.al showed that PACP was seen in 26.5% patients in their study [14]. PACP was seen in 20.9% cases in a study done by Dahal P *et al.* in Nepal and in 15% cases in another study done by Itagi *et al.* in India. Both of these studies showed PACP was seen most commonly in Type 3 optic nerve canals. So, our observation of PACP prevalence of 15.3% and its commonest association with Type 3 optic nerve canal was similar to the findings of other previous studies.

Conclusion

Preoperative evaluation of the relationship of optic nerve canal with posterior paranasal sinus is mandatory to avoid any unintended injury to optic nerve during Functional Endoscopic Sinus Surgery (FESS). Among the 4 types of optic nerve canals, Type 1 canal was the most common type (63.4%) in Nepalese population followed by Type 2 (16.7%), Type 3 (12.5%) & Type 4 (7.4%) canal. Though Type 3 & Type 4 optic nerve canals are not much common, their presence must be reported in computed tomography of paranasal sinuses as optic nerves are more vulnerable to injury in these two types. Onodi cells were seen in 12.9% cases. Bony dehiscence around optic nerve was seen in 19.4% and pneumatization of anterior clinoid process was seen in 15.3% of study samples. Both of these conditions were significantly associated with presence of Type 3 optic nerve canals.

Conflict of interest

No conflict of interest involved. No funding agency present.

Limitation

Results of our study might not be the true reflection of the condition of general population since it was primarily hospital-based study.

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How to Cite This Article
Bhattarai S, Adhikari BBS, Prasad Pant HP. Multidetector computed tomography evaluation of optic nerve canal in relation to posterior paranasal sinuses in Nepalese people. International Journal of Radiology and Diagnostic Imaging. 2024;7(2):136-140.