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ORIGINAL ARTICLE

The Variations in Deviation of Nasal Septum and their Impact on Maxillary Sinus Volume and Occurrence of Sinusitis

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Abstract To study the effect of variations in deviation of the nasal septum and their impact on maxillary sinus volume and occurrence of sinusitis. This prospective observational study was conducted in the department of ENT, Head &Neck surgery GMC Jammu from August 2021 to November 2022. 130 patients (90 males, 40 females), with age range of 18–47 years with DNS were included in the study. Grade of DNS was classified according to Mladina's classification and volume of maxillary sinus was calculated using geometric formula by performing 256 slice CT Scan. In our study mean age of the males was 32.8 ± 6.99 years and females was 33.7 ± 7.26 years with Male: Female ratio of 9:4.Patients with grade 1 DNS had mean maxillary sinus volume of 9.9 ± 1.97 cu mm while patients with grade 7 DNS had mean maxillary sinus volume of 3.8 ± 1.47 cu mm. Thus, with the increasing grade of DNS, the OMC blockage increased towards the side of DNS and so the occurrence of maxillary sinusitis. The study showed that with high grade DNS, the maxillary sinus volume decreases on the side of septum deviation and there is association of blocked OMC with increasing grade of DNS. The incidence of maxillary sinusitis findings on the side of septum deviation was significantly increased.

Keywords Maxillary sinus volume · Deviated nasal septum (DNS) · Ostiomeatal complex (OMC) · Sinusitis

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Introduction

Nasal septal deviation is defined as "deviation of the bony and cartilaginous septum to one or both sides". As the deviation suggests some sort of growth disjunction, septal deviation further complicates the growth theories of the septum [1]. Nasal septal deviation is commonly presented in Indian population and is associated with an increased prevalence of paranasal sinusitis. It appears to be one of many possible factors that might lead to the development of sino nasal pathologies [2].Despite the fact that difference in maxillary sinus volume is related to sinusitis considered as common belief, there are only a few studies that associate deviated nasal septum with the sinus volume and aetiology forsinusitis [3].

Sinusitis is one of the most common diseases of the nose and paranasal sinuses. Sinusitis affects 1 in 7 adults resulting in about 50 million individuals diagnosed with sinusitis every year world over [4]. Many historical references to the paranasal sinuses exist.The earliest such reference can be dated back to the works of Galen, who described the presence of the ethmoid air cells. Later descriptions of the maxillary sinuses by Leonardo da Vinci (1489), the sphenoid sinuses by Giacomo Berengario da Carpi (1521), and the frontal sinuses by Coiter (16th century) introduced early anatomists and scholars to the presence of these craniofacial air cells. The first modern and accurate descriptions of the paranasal sinuses can be traced to the works of the late 19th century Austrian anatomist, Emil Zuckerkandl. His detailed study and illustrations of the paranasal sinuses set the standard for generations of anatomists and physicians. Countless 19th and 20th century anatomists, radiologists and surgeons have further contributed to advancing the knowledge of sinus anatomy. The introduction of computed tomography (CT) and the wider use of it in the last 20 years have further contributed to the physician's

ability to appreciate nuances of paranasal sinus anatomy and accurate disease correlation [5].

CT is the radiological investigation of choice in evaluating the paranasal sinuses of a patient with sinusitis. In the study entitled we have related deviated nasal septum (DNS) with occurrence of sinusitis and its effect on volume of the maxillary sinus. Efforts have been made to compare each possible variable in our study with other previous studies.

Methods

This prospective observational study was conducted in the department of ENT, Head & Neck surgery, from August 2021 to November 2022. One hundred and thirty patients (90 males, 40 females), with the range of 18–47 years with nasal septaldeviations were included in the study. The study involved patients with deviated nasal septum and having symptoms of headache, PNS tenderness, nasal obstruction and recurrent upper respiratory tract infections. The grade of DNS was classified according to Mladina's classification [6] and volume of maxillary sinus was calculated using geometric formula by performing 256 slice CT Scan.

Calculation of Volume by Geometric Formula

For the calculation of the volume, maximum AP [length], maximum vertical [height] and maximum horizontal diameter [breadth] was taken Fig. 1a and b. The following formula was used [7].

Maximillary Sinus volume

$$= 1/3 \times \text{maximum length} \times \text{maximum breadth} \times \text{maximum height}$$

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Statistical Analysis

All the collected data was entered in the Microsoft excel sheet and then analysed using computer software Microsoft excel SPSS version 22 for window. The qualitative data and quantitative data were reported as proportions and mean (sd) respectively. X^2-test was used to test the significance of association for qualitative variables and unpaired student t-test was used to test the significance between quantitative variables and ANOVA with Post. A p-value less than 0.05 was considered as significant. All *p*-values were two tailed.

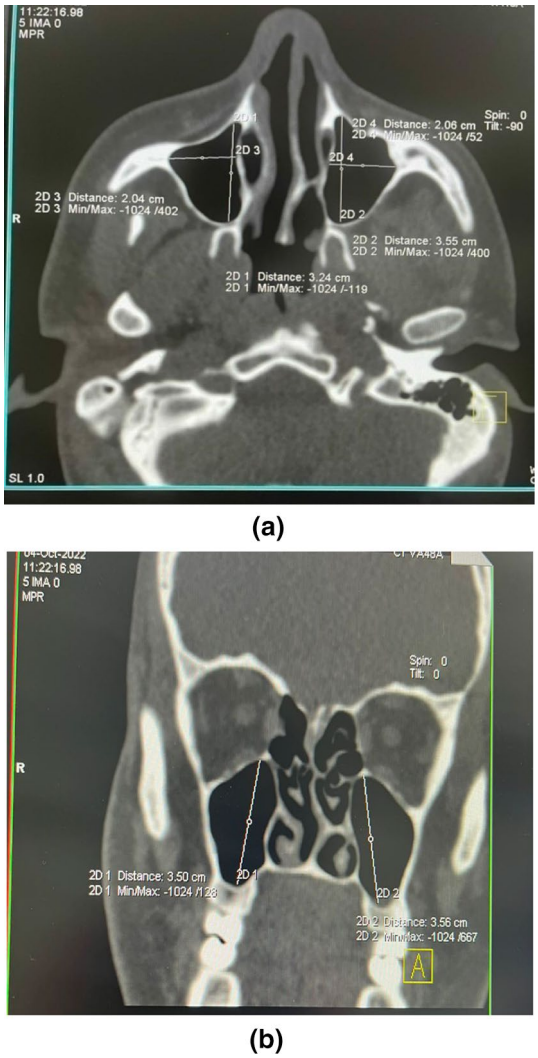

Fig. 1 **a**: Axial CT Scan: depicting calculation of maximum length & breath of maxillary sinus. **b** Coronal: CTscan depicting calculation of maximum height of maxillary sinus

Results

The study included a total of 130 cases which included 90(69.23%) males and 40 (13.77%) females. The mean age among males was 32.8 ± 6.99 years and females was 33.7 ± 7.26 years respectively(Table 1).The most common symptom in the study was headache seen in 92(70%) cases followed by nasal obstruction, PNS tenderness and URTI in 84 (64.6%), 42 (32.3%) and 33(25.3%) cases, respectively.The highest number of cases with headache was seen with Grade 7 DNS followed by Grade 5,6,3 (Table 2).

In subjects with Grade 7 DNS, 76% had ipsilateral maxillary sinusitis followed by Grade 6 (68%), Grade 5(64.28%), Grade 3 (50%), Grade 2 (38.4%) while the Grade 1 the occurrence was only 27.2%. This finding suggests increase

Table 1 Classification of grades of DNS according to Mladina's classification

Type I	Midline septum or mild deviations in vertical or horizontal plane, which do not extend throughout the vertical length of the septum
Type II	Anterior vertical deviation
Type III	Posterior vertical deviation (OM and middle turbinate area)
Type IV	'S' septum—posterior to one side and anterior to other side
Type V	Horizontal spur on one side with or without high deviation to the opposite side
Type VI	Type V with a deep groove on the concave side
Type VII	Combination of more than one type, in Types II–VI. The side of thedeviation is marked L (Left) or R (Right). In type IV whichever side is anterior deviation ismarked L or R

Table 2 Showing association of DNS and signs and symptoms

Grade of DNS	Nasal obstruction	Headache	URTI	PNS tenderness	Total number
Grade 1	11	6	0	0	11
Grade 2	7	12	2	4	13
Grade 3	2	5	2	0	6
Grade 4	0	0	0	0	0
Grade 5	2	17	4	9	28
Grade 6	11	15	4	4	16
Grade7	51	37	21	25	56
Total no	84	92	33	42	130

Chi. Sq. (χ^2)=29.9 and *P value=0.0005

*=Grade 1 & Grade 2 Clubbed and Grade 3, Grade 4 & Grade 5 Clubbed for purpose of calculation of Chi. Sq. (χ^2) in order to meet the Cochran criteria

in incidence of OMC blockage with increasing grade of DNS and so is the increase in chance of maxillary sinusitis (Table 3) and (Fig. 2).

Figure 3 and Table 4 depicts the relationship between grade of DNS and MSV,subjects with Grade 1 DNS had maximum mean maxillary sinus volume that was 9.9 ± 1.97 cu mm followed by grade 2 with volume of 9.3 ± 2.39 cu mm followed by grade 3 having volume 7.2 ± 2.66 cu mm, grade 5, 6 & 7 having mean MSV 7.1 ± 2.98 cu mm, 5.3 ± 1.805 cu mm, 3.8 ± 1.47 cu mm respectively. Grade 7 had minimum mean maxillary sinus volume i.e. 3.8 cu mm. (Table 4) and Fig. 4

Discussion

Nasal septum deviation (NSD) is diagnosed by an otorhinolaryngology, but it is usually not specified on the basis of visual measurement. As a consequence, diagnosing the disease may differ substantially; its clinical effects are assessed among observers, including its precise location, quantification of deviations, and clinical assessment of its effects. The maxillary sinus is very important in the maxillofacial area because it is anatomically close to other structures and it has the largest volume between the paranasal sinuses. For the maintenance of normal physiology, the paranasal sinuses requires adequate ventilation. Any obstruction that affects the osteomeatal complex can alter the physiology of the sinuses.

A total of 130 cases which included 90(69.23%) males and 40 (13.77%) females were enrolled in the study. The mean age among males was 32.8 ± 6.99 years and females was 33.7 ± 7.25 years.The most common symptom was headache followed by nasal obstruction, PNS tenderness and recurrent URTI. In a study done by Shoib et al. [8] headache was

Table 3 Showing association between Grade of DNS and Ipsilateral maxillary sinusitis

Grade of DNS	Total number of patients n(%)	Ipsilateral maxillary sinusitis		Significance	
		(+) n(%)	(−) n(%)	(χ^2)-value	p-value
Grade 1	11(8.46)	3(27.27)	8(72.73	14.73	0.012
Grade 2	13(10.0)	5(38.4)	8 (61.6)		
Grade 3	6(4.61)	3(50.0)	3(50.0)		
Grade 4	0	0	0		
Grade 5	28(21.54)	18(64.28)	10(35.72)		
Grade 6	16(12.31)	11 (68.75)	5(31.25)		
Grade 7	56 (43.08)	43 (76.78)	13(23.22)		

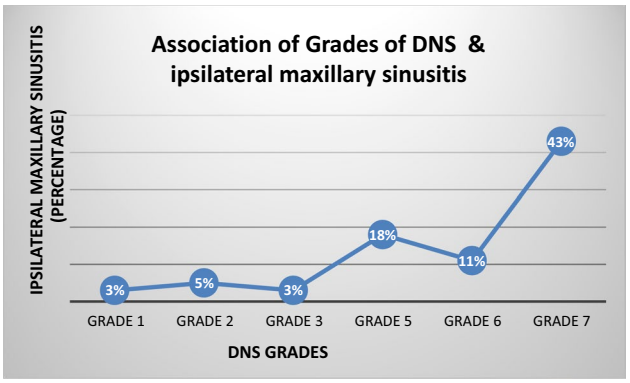

Fig. 2 Figure showing association of grades of DNS with ipsilateral maxillary sinusitis

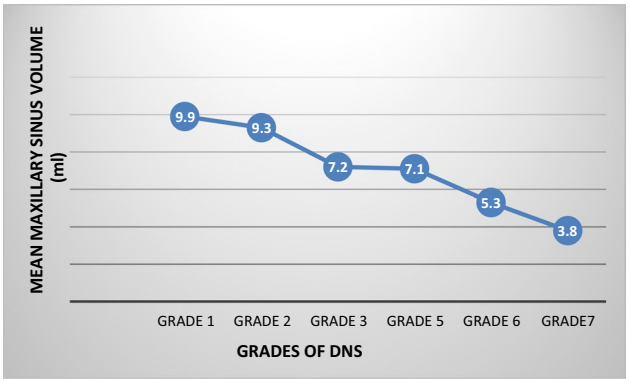

Fig. 3 Showing association between grades of DNS &mean maxillary sinus volume

Table 4 Comparison of mean maxillary sinus volume with different grades

Grades	N	Mean ± Std. deviation	Significance	
			F- value	*P* value
1	11	9.9 ± 1.97813	30.877	< 0.0001
2	13	9.3 ± 2.39444		
3	6	7.2 ± 2.66490		
5	28	7.1 ± 2.98028		
6	16	5.3 ± 1.80579		
7	56	3.8 ± 1.47624		
Total	130	7.1 ± 3.12562		

Fig. 4 **a**: CT scan showing Grade 1 DNS with equal maxillary sinus volume bilaterally. **b**: CTscan showing grade 7 DNS with decreased ipsilateral MSV and ipsilateral maxillary sinusitis

seen in 186 patients (93%), nasal obstruction in 178patients (89%), nasal discharge in 126 patients (63%),facial pain in 95 patients (47.5%), fever in 55 patients(27.5%), halitosis in 20 patients (10%), cough in 17patients (8.5%), fatigue in 6 patients (3%). In another studyconducted by Singh et al. [9] headache was the predominantsymptom seen in 80% of patients, nasal blockage was seenin 76.66%, nasal discharge in 43.33%, facial pain in 40%patients. Jadia et al. [10] in their study reported nasal obstruction as the most common symptom followed by headache.

The maximum number ofcases in our study had Grade 7 DNS followed by Grade 6 and then Grade 5, 3, 2 and 1 in the decreasing order. However a studyconducted by Jadia et al. [10]. maximum number ofcases had Grade 3 DNS followed by Grade 4and 5 having equal proportion of each. In the present study we found out that 76.78% subjects with grade 7 DNS had ipsilateral maxillary sinusitis while in subjects with grade 1only 27.2% had ipsilateral maxillary sinusitis. However in a study done by Sumaily et al. [11] where Grade 3 and 4 DNS showed 40.5% of the caseswith OMC blockade. Other studies by Sarmishtha et al. and Mishram et al.

also concluded that DNS is a key factor for the development of sinusitis. Thus our finding suggest increase in incidence of OMC blockage with increasing grade of DNS (Table 3) and thus increase in the occurrence of maxillary sinusitis with increasing DNS.

In our study the maxillary sinus volume ranged from 2.08–35.75 cu mm (calculated using geometric formula) and the mean sinus volume was maximum for grade 1(9.9 ± 1.97 cu mm), followed by grade 2 (9.3 ± 2.39 cu mm).Grade 7 had minimum mean maxillary sinus volume of 3.8 ± 1.47.

Ariji et al. [12] concluded thatthe transverse and anteroposterior widths of the maxillarysinus on axial CT are convenient indices for its size and foundthe average volume to be 9.61 cu mm. In another study by Uchida et al. [13] the sinus volume was found to be 7.69 ± 1.54 cu mm. In the study conducted by Jadia et al. [10] the maxillary sinus volume for the cases was seen maximum in range of 9.1–10 cu mm by software and in the range of 8.1–9 cu mm for geometric analysis and cases with Grade 2 DNS showed maximum cases in volume range of 11.1–12 cu mm followed by 9.1–10 cu mm. It was concluded that higher grades of DNS had reduced sinus volumes. Kapusus et al. found that mild and moderate septal deviations did not affect MSV while severe deviation had significantly decreased MSV on ipsilateral side. Thus, the maxillary sinus volume is affected by the degree of septal deviation on the side of the deviations.

Conclusion

In the study we found definite association between grade of DNS and volume of maxillary sinus.Thus sever and moderate deviations of nasal septum prevent sufficient development of maxillary sinuses on the same time we found that osteomeatal complex blockage increases with increase in grades/severity of DNS. Thusdeviated of nasal septum of higher grades can be associated with significant sinonasal disease. This study brings to light various presentations of DNS implicated in causation of chronic sinusitis which will influence the treatment decisions and also reduce the morbidity caused by it.

Declarations

Conflict of interest All authors declare that they have no conflict ofinterest.

Ethical Approval All procedures performed in studies involvinghuman participants were in accordance with the ethical standards ofthe institution.

Informed Consent Informed consent was obtained from all individual/participants included in the study.

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