Section: ENT

Original Research Article

ANATOMICAL VARIATIONS OF NOSE AND PARANASAL SINUSES IN CHRONIC RHINOSINUSITIS - A COMPUTED TOMOGRAPHY ASSISTED CLINICAL STUDY

Jithin.J[1], Sajilal M[2], Avinash Mohan[3], Rejee Ebenezer R[4]

[1]*Junior Resident, Department of ENT, Dr. Somervell Memorial CSI Medical College, Karakonam, Thiruvananthapuram, Kerala, India.*
[2]*Professor, Department of ENT, Dr. Somervell Memorial CSI Medical College, Karakonam, Thiruvananthapuram, Kerala, India.*
[3]*Assistant Professor, Department of ENT, Dr. Somervell Memorial CSI Medical College, Karakonam, Thiruvananthapuram, Kerala, India.*
[4]*Professor and Head, Department of ENT, Dr. Somervell Memorial CSI Medical College, Karakonam, Thiruvananthapuram, Kerala, India.*

Received *: 11/05/2025*
Received in revised form *: 09/07/2025*
Accepted *: 29/07/2025*

Corresponding Author:
Dr. Rejee Ebenezer R,
Professor and Head, Department of ENT, Dr. Somervell Memorial CSI Medical College, Karakonam, Thiruvananthapuram, Kerala, India.
Email: rejee72@gmail.com

DOI: 10.70034/ijmedph.2025.3.326

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (3); 1777-1781

ABSTRACT

Background: The objective of our study is to assess the pattern of anatomical variations of nose and paranasal sinuses in chronic rhinosinusitis and their association with severity of rhinosinusitis.

Materials and Methods: A total of 75 patients with chronic rhinosinusitis refractory to medical line of management in the age group 20 – 60 years were evaluated with CT scan of paranasal sinuses and the severity of sinusitis were assessed with Lund Mackay system of radiological staging. Presence of anatomical variations and its association with chronic rhinosinusitis involving various paranasal sinuses were assessed. The data was analysed using SPSS software.

Results: Deviated nasal septum was found to be the most common anatomical variation (94.7%), followed by concha bullosa (48%) and paradoxical middle turbinate (17.4%). Anterior ethmoids (84.6%) and maxillary sinuses (83.3%) were the most commonly involved sinuses. Concha bullosa and paradoxically curved middle turbinate were shown to have statistically significant association with chronic rhinosinusitis involving anterior group of sinuses.

Conclusion: Our study highlighted the association between anatomical variations and chronic rhinosinusitis. So in patients undergoing functional endoscopic sinus surgery for chronic rhinosinusitis, along with the sinus surgery, correction of anatomical variations of nose and paranasal sinuses will provide a better result.

Keywords: Chronic rhinosinusitis; deviated nasal septum; concha bullosa; paradoxically curved middle turbinate; paranasal sinus CT scan.

INTRODUCTION

The nose and paranasal sinus region are often characterised by various anatomical variations like deviated nasal septum, concha bullosa, paradoxically curved middle turbinate, medialised or lateralised uncinate process, pneumatised uncinate, Onodi cell, Haller's cell, pneumatised crista galli, maxillary sinus hypoplasia, etc1. Studies have shown that the prevalence of bony anatomic variations in cases of chronic rhinosinusitis is about 65%2. While many authors believe that the anatomical variations in osteomeatal complex may predispose patients to chronic rhinosinusitis3-10, its relative importance is still a matter of discussion as some studies do not show any significant correlation between anatomical variations and sinus disease11-16. Chronic rhinosinusitis sometimes does not get completely cured by medical line of management, requiring surgical intervention. Functional endoscopic sinus surgery (FESS) is the surgical intervention of choice in treatment of chronic sinusitis nowadays. The basic principle of FESS is removal of disease from the osteomeatal complex region and promoting drainage and ventilation3. While many authors have reported relief of symptoms and improvement in quality of life

after endoscopic sinus surgery17-19, few believe that the correction of anatomical variations itself will relieve the sinus pathology20. Also some studies indicate that recurrent sinusitis in patients who had undergone FESS can be due to failure in addressing the anatomic variants21. In this scenario, present study aims to assess the pattern and prevalence of anatomical variations of the nose and paranasal sinus by means of CT scan in patients with chronic rhinosinusitis, failing medical line of management, in southern part of Kerala attending a tertiary care centre. The Lund-Mackay staging system for radiological staging22 is used to determine the severity of disease. The association of anatomical variations of nose and paranasal sinuses with severity of sinus disease is also assessed to determine whether correction of these anatomical variants is needed for complete relief of symptoms in these patients.

MATERIALS AND METHODS

The hospital based cross sectional study was conducted in Department of ENT in a tertiaty care hospital in Kerala. The study period was from December 2014 to September 2016. Study was done after obtaining clearance from institutional ethics committee.

The inclusion criteria include diagnosed cases of chronic rhinosinusitis lasting more than 12 weeks, refractory to medical line of management and requiring endoscopic sinus surgery, between the age group of 20 – 60 years. The exclusion criteria were history of previous sinus surgery, invasive fungal sinusitis or tumours in paranasal sinuses, history of facial trauma causing significant anatomical distortions and patients not willing to give consent for the study. The outcome variables were CT scan findings and radiological staging. The sample size was calculated by the formula 4pq/d2, where

p = available local prevalence rate in the target population (obtained from comparable studies)

q=100-p

d =Relative precision (17% of previous prevalence)

In this study

p = 65 (based on literature reviews, p value is calculated)

q=100-65 = 35

d= 65 x 17/100 = 11.05

Hence sample size = 4pq/d2 = 75

Eligible consecutive patients with symptoms of chronic rhinosinusitis, not getting relieved with medical line of management and requiring functional endoscopic sinus surgery were enrolled into the study according to inclusion and exclusion criteria. After taking detailed history and clinical examination, computed tomography (plain study) images of paranasal sinuses are taken.

All CT scans were obtained with SIEMENS Somatom Emotion 16 slice CT scanner. Both axial and coronal sections were taken with slice thickness of 1 mm at 2.2 mm interval. The scans thus generated were evaluated in detail to look for any anatomical variations in nose and paranasal sinus regions.

The severity of sinusitis was scored according to Lund-Mackay radiological staging system. The pattern and prevalence of anatomical variations in chronic rhinosinusitis and also the association between these variations and severity of chronic rhinosinusitis were statistically evaluated.

Data collected were entered in Microsoft excel and analysed using SPSS software. Prevalence of anatomical variations is estimated as percentage.

Association between rate of anatomic variations and severity of chronic rhinosinusitis is analysed using Chi square test. The p value was calculated. The statistical significance was set at $p< 0.05$.

RESULTS

This study included totally 75 patients with chronic rhinosinusitis of which 32 were males (42.7%) and 43 were females (57.3%). The mean age was 34 ranging from 20 to 60 years.

The most common presenting complaint was headache (53.3%) followed by unilateral or bilateral nasal obstruction (28%), nasal discharge (10.7%), facial pain (5.3%) and postnasal drip (2.7%) (Fig. 1)

Among the various anatomical variations of nose and paranasal sinuses studied, nasal septal deviations were the most common (94.3%). Of which 45.3% had deviation of nasal septum to right side, 40% had deviation to left side and 9.3% had ‘S’ shaped deviation of nasal septum. Pneumatisation of middle turbinate (concha bullosa) is the second most common anatomical variation (48%) with 21.3% having right sided, 16% having left sided and 10.7% having bilateral concha bullosa. Next commonest anatomical variation was paradoxically curved middle turbinate (17.4%) (Table 1). The various other anatomical variations noted were those of the uncinate process (medialised uncinate, lateralised uncinate and pneumatised uncinate), presence of Onodi cell, Haller’s cell and maxillary sinus hypoplasia.

Anterior ethmoid sinus and maxillary sinus were found to be most commonly involved in chronic rhinosinusitis.

Association between anatomical variations and chronic rhinosinusitis were assessed and statistically there was no significant association between deviation of nasal septum with chronic rhinosinusitis in this study. But there is statistically significant association of right concha bullosa with right maxillary (p value = 0.039) and right frontal chronic rhinosinusitis (p value = 0.041). There is also statistically significant correlation between right concha bullosa and osteomeatal complex blockade (p value = 0.002) (Table 2). Left concha bullosa also showed statistically significant association with chronic left maxillary rhinosinusitis (p value = 0.005) and left osteomeatal complex blockade (p value = 0.014) (Table 3). Also there is statistically significant

association of right paradoxical middle turbinate with chronic right maxillary (p value = 0.047) and frontal rhinosinusitis (p value = 0.038) and also with right osteomeatal complex blockade (p value = 0.005) (Table 4). Left paradoxically curved middle turbinate also showed statistically significant association with left osteomeatal complex blockade (p value = 0.005) (Table 5).

Table 1: Frequency of paradoxical middle turbinate

Paradox middle turb	Frequency	Percent
Right	6	8
Left	5	6.7
Bilateral	2	2.7

Table 2: Association between right concha bullosa and chronic sinusitis as per Lund-Mackay radiological staging

	Rt max			Rt ant eth			Rt frontal			Rt OMC	
	0	1	2	0	1	2	0	1	2	0	2
Rt Concha bullosa (Total 24)	1	7	16	1	13	10	11	9	4	5	19
p value	0.039			0.153			0.041			0.002	

Table 3: Association between left concha bullosa and chronic sinusitis as per Lund-Mackey radiological staging

	Lt max			Lt ant eth			Lt frontal			Lt OMC	
	0	1	2	0	1	2	0	1	2	0	2
Lt Cocha bullosa (Total 20)	1	6	13	2	13	5	12	7	1	8	12
p value	0.005			0.501			0.426			0.014	

Table 4: Association between right paradoxical middle turbinate and chronic sinusitis as per Lund-Mackay radiological staging

	Rt max			Rt ant eth			Rt frontal			Rt OMC	
	0	1	2	0	1	2	0	1	2	0	2
Rt paradox middle turb (Total 8)	0	1	7	0	4	4	2	6	0	0	8
p value	0.047			0.287			0.038			0.005	

Table 5: Association between left paradoxical middle turbinate and chronic sinusitis as per Lund-Mackay radiological staging

	Lt max			Lt ant eth			Lt frontal			Lt OMC	
	0	1	2	0	1	2	0	1	2	0	2
Lt paradox middle turb (Total 7)	0	2	5	0	4	3	3	3	1	1	6
p value	0.100			0.209			0.064			0.005	

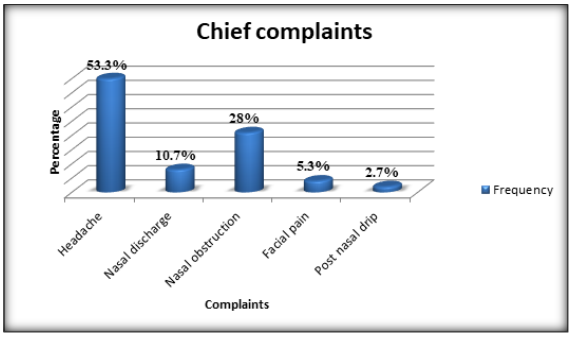

Figure 1: Frequency of chief complaints

DISCUSSION

The etiopathology of chronic rhinosinusitis is often regarded as a complex interplay of various factors affecting nose and paranasal sinuses, which include both host and environmental components. The association of anatomical variations of nose and paranasal sinuses with chronic rhinosinusitis is a matter of debate among various authors.

The most common anatomical variation noted in the study is presence of deviated nasal septum. 94.7% of the study subjects had deviated nasal septum either right sided, left sided or 'S' shaped deviation. The result is almost similar to studies done by Rashid Al Abri et al which showed an 80% prevalence of deviated nasal septum among 360 subjects with chronic rhinosinusitis,[23] and of Peres Pinas et al where 80% of his 110 study subjects with chronic rhinosinusitis had deviated nasal septum.[24]

The second most common anatomical variation found in our study is concha bullosa, in 48% of study subjects. This is supported by studies done by Mohannad Al Qunah et al who reported a prevalence of concha bullosa as 51% among 65 paediatric patients with chronic rhinosinusits.[25] Similarly Y K Maru and V Gupta reported 42.6% among 61 cases of chronic rhinosinusitis.[26]

Paradoxically curved middle turbinate was found in 17.4% of study subjects. It is found to be in accordance with studies done by Ahmet Kayguzuz et al (13.8% of 65 study subjects with chronic

rhinosinusitis)16 and Kim et al (19.5% of 113 children with chronic rhinosinusitis).[14]

The other anatomical variations observed in the study are medialised uncinate (2.66%), lateralised uncinate (4%), pneumatised uncinate (1.33%), Onodi cell (5.33%), Haller cell (8%) and hypoplasia of maxillary sinus (1.33%). Out of the 75 study subjects, 7 had either of the uncinate process variations (9.33%) and this is higher than that reported by Asruddin et al,[27] (2%), and is lower than that reported by Wanamaker et al6(45%). The prevalance of pneumatised uncinate process in our study (1.33%) is comparable to the findings by Bolger et al,[2] (2.5%) and by Arslan et al,[28] (2%) but higher than that found by Krzeski et al,[29] (0.96%). The prevalence of medialised and lateralised uncinate process were lower than those found in studies of Krzeski et al (medial deviation of uncinate in 8.6% and lateral deviation in 9.55%),[29] and Cagici et al (medial deviation in 12% and lateral deviation in 4%).[30] The prevalence pattern of Onodi (5.33%) and Haller's cell (8%) were almost similar to those seen in study done by Ahmet Kaygusuz et al who found prevalence of 9.2% of Onodi cells and 13.8% of Haller cell in 65 patients with chronic rhinosinusitis.[16]

In our study the paranasal sinuses most commonly involved were anterior ethmoid (84.6%) and maxillary (83.3%). This is similar to studies done by Enema Job Amodu et al in 60 patients with chronic rhinosinusits the maximum prevalence is found in maxillary sinuses (81.7%) and ethmoid sinuses (68.3%).[3]

On evaluating the association between anatomical variations and chronic rhinosinusitis, deviated nasal septum did not show any statistically significant association with chronic rhinosinutis. Studies done by Kim et al and Ahmet kayagusuz et al also showed that there is no significant association between chronic rhinosinusitis and deviation of nasal septum.[14,16] Stallman et al also concluded that there is no statistical relationship between deviation of nasal septum and presence of any sinus disease.[12]

Concha bullosa was found to have statistically significant association with osteomeatal complex blockade resulting in chronic sinusitis involving anterior group of sinuses. Similar association was also found in studies done by Calhaun et al,[5] and Scribano et al.[32] G L Fadda et al, in their retrospective study on CT scan findings of 200 patients with chronic sinusitis, also found statistically significant association between concha bullosa and maxillary sinusitis.[4]

Paradoxically curved middle turbinate also showed statistically significant association with osteomeatal complex blockade and chronic sinusitis involving anterior group of sinuses. Similar conclusions were also made from studies done by Tonai and Baba.[33]

Uncinate process variations studied did not show any statistically significant association with chronic rhinosinusitis. Isha Preet Tuli et al from their prospective study done on 50 patients with chronic rhinosinusitis also concluded that bony anatomical variations of the uncinate do not influence the occurrence of rhinosinusitis.[34]

All cases with Haller's cell (6 patients) had chronic maxillary sinusitis, but a statistically significant association could not be made. Stackpole and Edelstein had demonstrated that higher the number of Haller's cells, greater is the chances of maxillary sinus inflammation.[35]

CONCLUSION

Chronic rhinosinusitis is a debilitating health condition and among the various predisposing factors, anatomical variations of nose and paranasal sinuses have also been found to play a major role. In our study the prevalence of the disease was found to be similar in all age groups without any sex preponderance. Among the anatomical variations evaluated, concha bullosa and paradoxically curved middle turbinate are found to have statistically significant association with osteomeatal complex blockade leading to chronic rhinosinusitis. Also the presence of Haller cells is associated with chronic maxillary sinusitis, though a statistically significant correlation couldn't be made in this study due to its relatively low prevalence among study subjects.

Based on our study, in patients with chronic rhinosinusitis CT scan of paranasal sinuses is an important diagnostic tool in detecting anatomical abnormalities which is an important predisposing factor for chronic rhinosinusitis. Careful evaluation of anatomical variations by CT scan is necessary in patients of chronic rhinosinusitis especially those undergoing endoscopic surgery. Correction of anatomical variations detected is very important for cure of the disease.

REFERENCES

1. Lund VJ. Anatomy of the nose and paranasal sinuses. In Kerr AG, Gleeson M, editors. Scott-Brown's Otolaryngology-Basic Sciences. 6th ed. Reed Educational and Professional Publishing Ltd; 1997. p.5/19-30
2. Bolger WE, Butzin CA, Parsons DS. Paranasal sinus bony anatomic variations and mucosal abnormalities: CT analysis for endoscopic sinus surgery. Laryngoscope. 1991;101: 56-64
3. Dua K, Chopra H, Khurana AS and Munjal M. CT scan variations in chronic sinusitis. Ind J Radiol Imag. 2005;15(3): 315-320.
4. Fadda GL, Rosso S, Aversa S, Petrelli A, Ondolo C, Succo G. Multiparametric statistical correlations between paranasal sinus anatomic variations and chronic rhinosinusitis. Acta Otorhinolaryngol Ital. 2012;32(4): 244-251
5. Calhoun KH, Waggenspack GA, Simpson CB, Hokanson JA, Bailey BJ. CT evaluation of the paranasal sinuses in symptomatic and asymptomatic populations. Otolaryngol Head Neck Surg. 1991;104(4): 480-483
6. Wanamaker HH. Role of Haller's cell in headache and sinus disease: a case report. Otolaryngol Head Neck Surg. 1996;114(2): 324-327
7. Jorissen M, Hermans R, Bertrand B, Eloy P. Anatomical variations and sinusitis. Acta Otorhinolaryngol Belg. 1997;51(4): 219- 226
8. Liu X, Han D, Zhou B. Relationship between anatomic variations of nasal sinus and chronic sinusitis. Zhonghua Er Bi Yan Hou Ke Za Zhi 1998 Jun;33(3): 149-152

9. Kantarci M, Karasen RM, Alper F. Remarkable anatomic variations in paranasal sinus region and their clinical importance. Eur J Radiol. 2004;50: 296-302
10. Luo X, Liang C, Xu K, Tang S, Ren X, Liu D. Influence of nasal septal deviation on incidence of bilateral sinusitis. Lin Chung Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 2012;26(17): 777-780
11. Earwaker J. Anatomic variants in sinonasal CT. Radiographics. 1993;13: 381-415
12. Stallman JS, Lobo JN, Som PM. The incidence of concha bullosa and its relationship to nasal septal deviations and paranasal sinus disease. Am J Neuroradiol. 2004; 25: 1613-1618
13. Lerdlum S, Vachiranubhap B. Prevalance of anatomic variation demonstrated on screening sinus computed tomography and clinical correlation. J Med Assoc Thai. 2005;88(4): S110- S115
14. Kim HJ, Jung Cho M, Lee JW, Tae Kim Y, Kahng H, Sung Kim H, Hahm KH. The relationship between anatomical variations of paranasal sinuses and chronic sinusitis in children. Acta Otolaryngol. 2006;126(10): 1067- 1072
15. Azila A, Irfan M, Rohaizan Y, Shamim AK. The prevalence of anatomical variations in osteomeatal unit in patients with chronic rhinosinusitis. Med J Malaysia. 2011;66(3): 191- 194.
16. Ahmet kaygusuz, Mehmet Haksever, Davut Akduman, Sundus Aslan, Zeynep Sayar. Sinonasal anatomical variations: Their relationship with chronic rhinosinusitis and effect on the severity of disease- a computerised tomography assisted anatomical and clinical study. Indian J Otolaryngol Head Neck Surg. 2014 July-Sept;66(3): 260-266
17. Palmer JN, Kennedy DW. Medical management in functional endoscopic sinus surgery failures. Curr Opin Otolaryngol Head Neck Surg. 2003 Feb;11(1): 6-12.
18. Soler ZM, Mace J, Smith TL. Symptom-based presentation of chronic rhinosinusitis and symptom specific outcomes after endoscopic sinus surgery. Am J Rhinol. 2008 May-Jun; 22(3): 297-301
19. Bhattacharyya N. Clinical outcomes after endoscopic sinus surgery. Curr Opin Allergy Clin Immunol. 2006 Jun;6(3): 167-171
20. Osama G, Abdel Naby Awad, Abd El-Rehim A, Abd El-Karim, Mostafa S Hamad. Role of surgical septal correction in subjective improvement of chronic rhinosinusitis. The Egyptian Journal of Otolaryngology. 2014;30: 196–200
21. Kristen L Baugnon, John M DelGaudio, Patricia A Hudgins. Functional endoscopic sinus surgery- postoperative findings and complications. Head and Neck Imaging. 5th ed. Elsevier, 2011; chap 5.
22. Valerie J Lund, Julian Rowe-Jones. Surgical management of Rhinosinusitis. In Gleeson M, Browning GG, Burton MJ et al., editors. Scott-Brown's Otolaryngology, Head and neck surgery. 7th ed. London: Edward Arnold Publishers Ltd; 2008. p.1478- 1499
23. Rashid Al-Abri, Deepa Bhargava, Wameedh Al-Bassam, Yahya Al-Badaai, Sukhpal Sawhney. Clinically Significant Anatomical Variants of the Paranasal Sinuses. Oman Medical Journal. 2014;29(2): 110-113.
24. Perez Pinas, Sabate J, Carmona A, Catalina Herrera CJ, Jimenez Castellanos J. Anatomical variations in the human paranasal sinus region studied by CT. Journal of Anatomy. 2000;197: 221-227
25. Mohannad Al-Qudah. The relationship between anatomical variations of the sino-nasal region and chronic sinusitis extension in children. International Journal of Pediatric Otorhinolaryngology. 2008;72: 817 - 821.
26. Maru YK, Gupta V. Anatomical variations of the bone in sinonasal CT. Indian J Otolayngol Head Neck Surg. 2001;53(2): 123-128
27. Asruddin, Yadav SPS, Yadav RK, Singh J. Low dose CT in chronic sinusitis. Indian J Otolaryngol. 1999–2000;52: 17–22
28. 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.
29. Krzeski A, Tomaszewska E, Jakubczyk I, Galewicz-Zielinska A. Anatomic variations of the lateral nasal wall in the computed tomography scans of patients with chronic rhinosinusitis. Am J Rhinol. 2001;15(6): 371–375
30. Cagici CA, Yilmaz M, Erkan AN, Yilmazer C, Ozluoglu L. Concurrence of paranasal sinus mucosal thickening and Anatomic Variation. Turk Arch Otolaryngol. 2006;44(4): 211–217.
31. Enema Job Amodu, Ayotunde James Fasunla, Aliu Oyebamiji Akano, Abiodun Daud Olusesi. Chronic rhinosinusitis: correlation of symptoms with computed tomography scan findings. The Pan African Medical Journal. 2014;18: 40
32. Scribano E, Ascenti G, Loria G, Cascio F, Gaeta M. The role of the ostiomeatal unit anatomic variations in inflammatory disease of the maxillary sinuses. European Journal of Radiology. 1997 May;24(3): 172-174.
33. Tonai A, Baba S. Anatomic variations of the bone in sinonasal CT. Acta Otolaryngol Suppl. 1996;525: 9–13
34. Isha Preet Tuli, Subhabrata Sengupta, Sudeep Munjal, Santosh Prasad Kesari, Suvamoy Chakraborty. Anatomical Variations of Uncinate Process Observed in Chronic Sinusitis. Indian J Otolaryngology Head and Neck Surgery. 2013 April–June; 65(2): 157–161
35. Stackpole AS, Edelstein DR. The anatomic relevance of the Haller cell in sinusitis. Am J Rhinol. 1997;11: 219–223.