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ORIGINAL ARTICLE

A Prospective Correlation Study Between Computerized Tomography of Paranasal Sinuses and Nasal Endoscopy Findings in Patients of Chronic Rhinosinusitis Undergoing Functional Endoscopic Sinus Surgery

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Abstract In order to diagnose chronic rhinosinusitis (CRS), diagnostic nasal endoscopy (DNE) and computed tomography (CT) scan both are important investigations. But both have their pros and cons, some findings are seen better in DNE and others in CT. Our study aims to correlate DNE and CT findings. 50 patients with CRS were included in this observational prospective study done at tertiary care hospital. Preoperative each patient underwent DNE and got CT scan followed by scoring using Lund Kennedy and Lund Mackay grading respectively. Functional Endoscopic Sinus Surgery (FESS) was performed and intraoperative findings were correlated with CT scan for each of them. The sensitivity of endoscopy was 93.18% and the specificity was 83.33%. Positive predictive value of DNE was 97.62% and negative predictive value was 62.50%. Most of the endoscopy positive patients of CRS were CT positive. Also, the sensitivity of CT PNS was highest for all groups of sinus disease while specificity was high for posterior group of sinuses (81.82%) and frontal sinus (89.19%). Both DNE and CT scan should be used for planning the management of CRS. DNE tells better about middle meatal secretions, condition of mucosa, polyps. But in situations where due to anatomical variation DNE is difficult, CT scan helps us. CT identifies the extent of disease, the anatomical variants and vital relations of PNS. Overdiagnosis through CT is checked by DNE.

Keywords Chronic rhinosinusitis · Diagnostic nasal endoscopy · Computed tomography scan

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Introduction

Rhinosinusitis is inflammation of the nasal cavity as well as the paranasal sinuses. If the inflammation lasts for more than 12 weeks then it is classified as CRS. It is one of the factors which hampers the quality of life of the patients involving not only functional, physical but also emotional aspects [1, 2].

According to the American Academy of Otolaryngology Head and Neck Surgery Foundation 2015 (AAOHNS-2015), CRS is diagnosed if the following symptoms are seen—mucopurulent discharge, nasal obstruction (congestion), facial pain/pressure/fullness, or decreased sense of smell. Inflammation is documented by one or more of the following findings: purulent mucus or edema in the middle meatus or anterior ethmoid region, polyps in nasal cavity or the middle meatus, and/or radiographic imaging showing inflammation of the paranasal sinuses [3].

To proceed for the surgical management of CRS, the surgeon should be thorough with the anatomy of paranasal sinuses and nasal cavity. In order to assess the anatomy, he can either do a DNE or study the Non Contrast Computed Tomography (NCCT) of the paranasal sinuses (PNS) involving axial and coronal cuts.

DNE not only gives information about the condition of nasal mucosa, nature of the secretion, anatomical variations of septum, and lateral nasal wall but also tells about the condition of osteomeatal complex and presence of areas of mucosal contact. The limitation of this procedure is difficulty in the diagnosis of localized diseases within the infundibulum, frontal recess and maxillary sinus ostium [4].

CT scan of nose and PNS (both bone and soft tissue window) is the radiological investigation of choice for CRS patients [5, 6]. It provides information about the anatomical

and pathological narrowing or variations in osteomeatal complex and also gives valuable information regarding vital structures [7]. It acts as a guide for surgical intervention as it shows the extent of disease based on opacification of the paranasal sinuses, especially the Coronal sections [8]. So, it has the advantage of being rapid, non invasive and helps in documentation and education.

In the present day scenario, both DNE and CT scan walk hand in hand for the diagnosis and management of CRS. Hence, CT scan has been well accepted mandatory investigation in the patients posted for surgical treatment of CRS which is FESS and DNE plays a key role in identifying the anatomical and structural variations along with mucosal changes around the osteomeatal complex [9].

There are various comparative studies on the imaging modalities, clinical symptomatology, anatomical variations and mucosal disease by intranasal endoscopy as well as CT scan, but a clear correlative study between pre-operative CT scan and anatomical defects as well as mucosal assessment which is found during FESS, is lacking [10].

The present study was done to correlate the CT and DNE findings.

Materials and Method

The prospective, observational study was conducted in a tertiary care hospital, included 50 patients having CRS and not responding to medical treatment for 3 months. Patients with acute rhinosinusitis, pregnant women, patients who underwent previous nasal surgery, who had clinical evidence of sinusitis of dental and traumatic origin, with chronic diseases such as cystic fibrosis, primary ciliary dyskinesia, immune deficiencies, suspected malignancy and under 20 years patients were excluded from the study.

A written and informed consent was taken from the patients and were explained about the study. A detailed history including presenting complaints with duration, past history regarding similar or other illness, any medical or surgical treatment, history of asthma or any drug sensitivity, followed by personal and family history to register any allergic predisposition, precipitating factors such as occupation, addiction or environment at home or working place, were noted.

Then a thorough general physical and local otorhinolaryngological examination alongwith routine haemogram, urine examination was done. Each patient underwent a systematic DNE and NCCT nose and PNS.

DNE was done using 4 mm 0 degree endoscope (including all three passes) after use of topical decongestant and anaesthesia. On the basis of this, each patient was given a Lund and Kennedy endoscopic score. Those patients who had zero score were categorized as negative while those who obtained any score were categorized as positive [11].

Subsequently the patients were subjected to NCCT PNS. The coronal CT PNS scan findings were reported as per the Lund and Mackay grading system. This scoring system derives a maximum score of 12 per side. Zero score for sinuses and osteomeatal complex was considered negative and score above zero as positive [12].

FESS was performed under general anaesthesia according to the Messerklinger technique. Plan of surgery was decided by preoperative findings on DNE and CT PNS. After adequate pre-operative nasal decongestion and infiltration, a 0° endoscopic examination of the nasal cavity was performed to look for landmarks, condition of mucosa, the presence of any polyps or pus. Any significant differences from the preoperative examination findings and CT PNS scan findings were documented (Fig. 1).

In cases with significant septal deviations or spurs, septoplasty was done endoscopically. Conchoplasty was done in cases wherever concha bullosa was present. Similarly hypertrophied inferior turbinates were dealt with by a partial turbinectomy or turbinoplasty. Minimum uncinectomy and middle meatal antrostomy was done in each case.

Merocel pack removal and discharge was done on postoperative day two. All the patients were prescribed oral antibiotics, nasal alkaline douching and intranasal steroid spray.

The collected data was analysed using Epi info 7.1 statistical software. To find the significance in categorical data Chi-Square test was used. Similarly if the expected cell frequency is less than 5 in 2×2 tables then the Fisher's Exact was used. In all the above statistical tools the probability value $P < 0.05$ was considered significant.

Results

Out of the 50 patients with CRS, 17 patients (34%) were female and the rest 33 (66%) were male. The age of the patients in the present study was between 20 and 70 years, maximum being in the range of 20–30 years (44%). The mean age was 39.18 ± 17.04 years (Figs. 2, 3).

Most common symptom of CRS presented in our study was nasal obstruction (80%) which was mostly accompanied by nasal discharge (56%), followed by headache (48%). Other symptoms were also seen as shown in the table. The duration of earliest presenting symptoms varied widely from 6 months to 6 year with majority of the patients suffering from their symptoms form 1 to 2 years of duration (44%). (Table 1).

On DNE, deviation of nasal septum was seen in 32 patients (64%). Spur was seen in 11 patients. During the first pass inferior turbinate hypertrophy was identified in

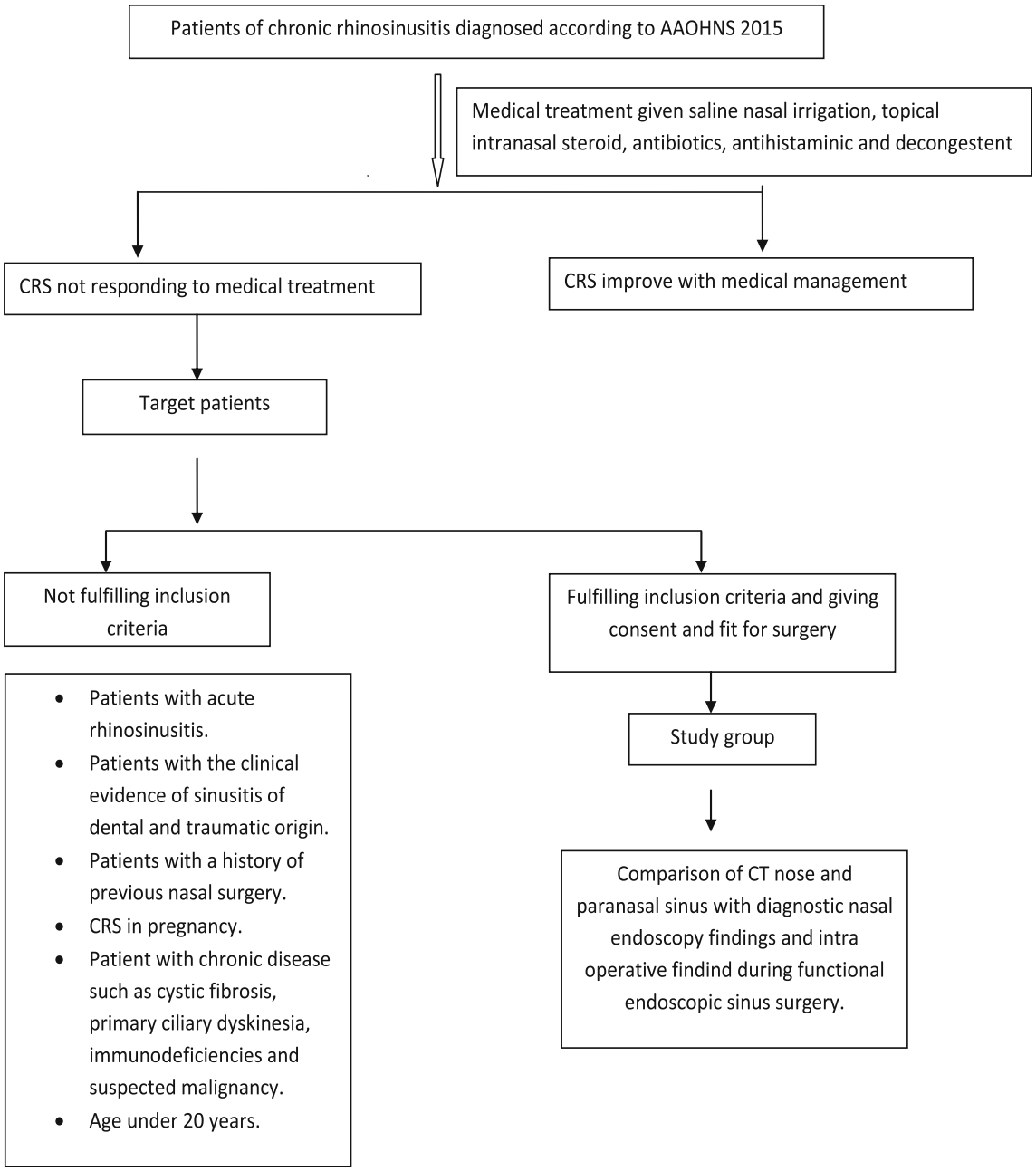

Fig. 1 Flowchart of the study

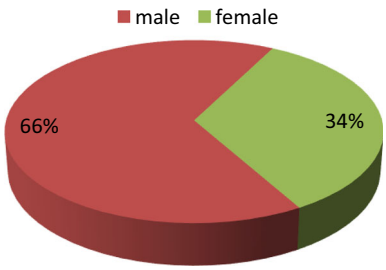

Fig. 2 Pie diagram showing sex distribution of study population

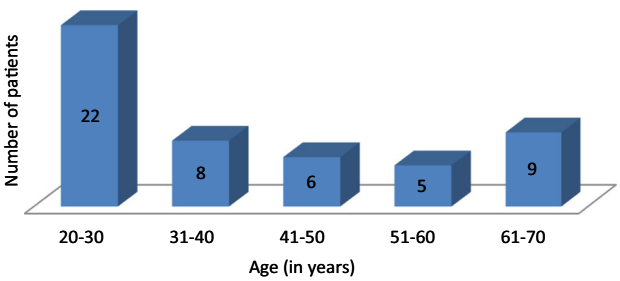

Fig. 3 Bar diagram showing age distribution of study population

Table 1 Clinical presentation of study population

Symptoms	Frequency	Percentage
Nasal obstruction	40	80
Nasal discharge	28	56
Headache	24	48
Post nasal drip	18	36
Sneezing	6	12
Nasal bleed	4	8
Cough	4	8
Anosmia/Hyposmia	3	6
Facial pain	1	2

30% patients. Unilateral polyp was noted in 6 patients, while bilateral polyps were seen in 10 patients. During the third pass, pneumatized middle turbinate or concha bullosa was seen in 28% of patients and paradoxically curved middle turbinate was seen in 14%. An accessory ostium was seen in 13 patients (26%).

The Osteomeatal complex was found to be blocked on CT scans of 39 patients (78%), among which 16 patients showed OMC blockage bilaterally (32%) and 23 unilaterally (46%). Maxillary sinus involvement was seen in the CT scan of 40 patients (80%), out of which, bilateral complete opacification was seen in only 6 patients, while bilateral partial opacification was seen in 14 patients. In the remaining 18 patients unilateral maxillary sinus involvement was seen, which was either complete or partial. Anterior group of ethmoid sinuses were involved in 36 patients (72%), unilateral or bilateral. Posterior ethmoid opacification was seen in 21 patients (42%) while sphenoid sinus involvement, complete or partial, unilateral or bilateral was seen in 28% of the patients. Involvement of the frontal recess or frontal sinuses was seen in 34% patients. Presence of anatomical variants like haller cells was seen in about 10%, agger nasi in 30% and onodi cells were seen in 16% of the study population.

Correlation Between Endoscopy Score and CT Score

Out of the total, 42 patients (84%) had abnormal endoscopic findings while 44 (88%) patients had disease in CT scan. Out of 8 patients having normal endoscopy, 3 patients had abnormal CT. But one patient who was CT scan negative was found to be endoscopic positive for CRS and this patient was showing oedematous mucosa at osteomeatal complex on nasal endoscopy. Five patients were both endoscopy and CT negative for CRS indicating no disease. The sensitivity of endoscopy was 93.18% and the specificity was 83.33%. Positive predictive value of DNE was 97.62% and negative predictive value was 62.50%. Most of the endoscopy positive patients of CRS were CT positive. There was significant association in diagnosis of CRS on basis of endoscopic score and CT score (Table 2).

Deviated nasal septum was seen in 20 patients on CT PNS while in 32 patients during DNE. Similarly for bony spur, concha bullosa and paradoxical middle turbinate significant association was seen as shown in table (Table 3).

Intra-operative FESS Findings Correlation with CT Findings

The osteo meatal complex (OMC) occlusion was present in 37 patients intra operatively (20-unilateral, 17-bilateral). Comparing this to CT scan findings, 39 patients had shown OMC blockage. While bilateral middle meatal antrostomy (MMA) was performed in 17 patients as compared to CT PNS in which bilateral OMC occlusions seen in 16 patients. Unilateral MMA was carried out in 20 patients as opposed to unilateral OMC blockage detected in 23 patients on CT PNS.

Bilateral complete maxillary sinus opacification was seen in 40 patients on CT PNS and in 38 patients intra-operatively. Overall involvement of maxillary sinuses as seen on CT PNS was 80% showing good correlation with intra-operative finding. CT PNS had shown a right side involvement in 8 patients and left side in 10 patients. While intra-operatively, right and left side involvement was seen in 7 and 11 patients respectively.

Table 2 Correlation between endoscopy score and CT score in CRS patients (n = 50)

	CT score positive	CT score negative	Total	p-value
Endoscopy positive	41	1	42	0.00001
Endoscopy negative	3	5	8	
Total	44	6	50	

Table 3 Comparative findings in CT scan PNS and DNE in relation to anatomical variant

	Diagnostic nasal endoscopy finding		Computed tomography findings		*p*-value
	Present	%	Present	%	
Deviated nasal septum	32	64	20	40	0.0276
Septal spur	11	22	7	14	0.4348
Mass or polyp nasal cavity	16	32	27	54	0.0433
Inferior turbinate hypertrophy	12	24	11	22	1
Concha bullosa	14	28	25	50	0.0403
Paradoxical middle turbinate	7	14	17	34	0.0350
Agger nasi	4	8	15	30	0.0108
Accessory maxillary ostium	13	26	3	6	0.0140

Anterior ethmoid was involved in 72% patients on CT PNS scan, whereas 70% patients underwent anterior ethmoidectomy. Similarly, 17 patients had positive intra-operative posterior ethmoid involvement, correlating with CT PNS scan, while 2 patients showed false negative results. Unilateral or bilateral frontal sinus involvement was seen in 17 patients on CT PNS as compared to 14 patients who had positive intra-operative findings. 12 patients had positive intra-operative sphenoid sinus involvement, correlating with CT PNS scan positive finding seen in 14 patients. Polyps were detected in 16 patients on CT PNS while intraoperatively in 27 patients (Table 4).

The most common anatomical variant visualized in both CT PNS and intra-operatively was concha bullosa, which had positive correlation in 21 patients (42%). Agger nasi cell was seen in 14% patients intra-operatively as compared to 30% in CT PNS. Similarly, Haller cell was encountered intra-operatively in 4% of the patients while in CT PNS it was seen in 10%. Onodi cell was observed during FESS in 8 and 16% in CT PNS.

Discussion

For functional sinuses, the drainage of osteo-meatal complex and posterior group of sinuses should be present. In CRS, there is sinonasal inflammation which hampers the adequate drainage of these sinuses. For diagnosing CRS adequate documentation of the inflammation apart from patient reported sinonasal symptoms is required. AAOHNS-2015 has emphasized on this objective confirmation of sinonasal inflammation either by direct visualization or by CT scan [3].

In the present study 66% were males and 34% were females. A similar male preponderance was also found in the study of Lee et al. [13], with 75% of the patients being male. 44% of the patients belonged to age group 20–30 years and had symptoms for 1–2 years of duration.

As discussed earlier, most common symptoms of CRS we came across was nasal obstruction (80%) and nasal discharge (56%). Kirtane et al. [14] also observed that the commonest complaint was nasal discharge (78.1%), followed by headache (68.7%) and nasal obstruction (68.7%).

Stammberger and Hawke have shown that CT scan of PNS provides an anatomic road map to identify presence of anatomical variants, the site and severity of disease and obstruction [15]. In our study, the sensitivity of endoscopy

Table 4 Correlation between pre-operative CT PNS scan findings and intra-operative endoscopic findings in CRS patients

Parameters	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Osteo meatal complex	89.19	53.85	84.62	63.64	80.00
Maxillary sinus disease	92.11	58.33	87.50	70.00	84.00
Anterior ethmoid sinus disease	85.71%	60.00	83.33	64.29	78.00
Posterior ethmoid sinus disease	88.24	81.82	71.43	93.10	84.00
Frontal sinus disease	92.86	89.19	76.47	97.06	90.20
Sphenoid sinus disease	92.86	89.19	76.47	97.06	90.20

was 93.18% and the specificity was 83.33%. Positive predictive value of DNE was 97.62% and negative predictive value was 62.50%.

Chakraborty et al., in 2019 conducted a comparative study between CT and DNE mainly focusing on anatomical variations and pathological finding of nose and PNS. The association of the two was found to be significant. DNE sensitivity was 78.08% and specificity was 66.67%. They concluded that endoscopy can be helpful in prediction of the various sinus involvement and reduce the burden on CT [16].

Again a high correlation was found between Lund-Mackay overall CT and Lund-Kennedy Endoscopy Score in the study by Deosthale et al. (2017). The sensitivity and specificity of DNE in comparision to CT scan were 94 and 75%. They concluded that CT scan should be done in those patients whose DNE is negative and have clinical symptoms [17].

Maxillary Sinus involvement being the most common finding, was seen in the CT scan of 80% patients. This correlated well with the study of Lloyd et al. [18] where the most common site of involvement was found to be maxillary sinus (83%) followed by anterior ethmoid (63%), posterior ethmoid (60%). CT scans had a sensitivity of 92.11% in detecting maxillary sinus disease, although specificity came out to be 58.33%. with an overall accuracy of 84%. Thus, CT cannot differentiate CRS from other diseases involving the maxillary sinuses. Kaluskar et al. [19] in their study had also shown similar figures of 90% sensitivity for maxillary sinus disease, in their comparative study between radiological and surgical findings.

For the anterior ethmoid group of sinuses, the sensitivity was 85.71% but with a specificity of 60%. Overall accuracy of CT scans for the anterior ethmoids was found to be 78% with a high positive predictive value of 83.33%. The study by Handanakere et al. [21] shows a sensitivity of 91% and a specificity of 88.9% for the anterior ethmoid group.

Good correlation was seen in our study with respect to the disease in posterior ethmoid group and the sphenoid sinus showing a sensitivity 88.24 and 92.86%, and specificity 81.82 and 89.19% respectively. This makes CT scan important tool to diagnose disease in the posterior ethmoids and sphenoid sinuses as they are not seen in DNE. For disease in the frontal sinus CT scan showed a better sensitivity (92.86%) and specificity (89.19%) with overall accuracy is 90.20%. Kaluskar et al. [19] in their study had also shown high sensitivity for the frontal recess (88%) and posterior ethmoids (92%). However, Handanakere et al. [20] in their study found a poor correlation for frontal sinus disease with a sensitivity of only 66.7% but a high specificity of 96.3%. Similarly Tandon et al. [21] in their study observed fair to moderate agreement between CT scans and intra operative findings for posterior ethmoids and frontal sinus.

To identify polyps CT PNS scan was not found to be the preferred investigation. In our study CT PNS had a sensitivity of only 70% and specificity of 62%. This was in line with the results obtained by Handanakere et al. [20] which showed a sensitivity of 78.5% for nasal polyps and 73.9% for sinus polyps.

Therefore, from the results of our study we could infer that the sensitivity of CT PNS was highest for all groups of sinus disease while specificity was high for posterior group of sinuses and frontal sinus.

Conclusion

DNE can prove to be a better diagnostic modality compared to CT scan when conditions like middle meatal secretions, condition of mucosa, polyps are looked for. However, in some cases it was not possible to pass the endoscope beyond certain point due to anatomical variations, CT scan was helpful in those cases. It also provides baseline pictures which serve as documentation for treatment outcomes in follow up and can either support or refute CT scan findings thereby reducing over-diagnosis of CRS.

In our study, CT scan findings correlated well with the intraoperative ones. CT scans and DNE both are essential pre-operative diagnostic tools for patients of CRS and both are complementary to each other in detecting type and extent of pathology.

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Declarations

Conflict of interest Authors declare that we have no potential conflict of interests.

References

1. Snow V, Mottur-Pilson C, Hickner JM et al (2001) Principles of appropriate antibiotic use for acute sinusitis in adults. Ann Intern Med 134:495–497
2. Bhattacharyya N et al (2001) Chronic rhinosinusitis: is the nose really involved? Am J Rhinol 15:169–173
3. Rosenfeld RM, Piccirillo JF, Chandrasekhar SS et al (2015) Clinical practice guideline: adult sinusitis. Otolaryngol Head Neck Surg 152(S2):s1–s39
4. Benninger MS, Ferguson BJ (2003) Adult chronic rhinosinusitis definitions. Classification diagnosis and pathophysiology and epidemiology. Otolaryngol Head Neck Surg 129(3):S1–S32.
5. Mafee MF, Tran BH, Chapa AR (2006) Imaging of rhinosinusitis and its complications: plain film, CT, and MRI. Clin Rev Allergy Immunol 30:165–186

6. Melhem ER, Oliverio PJ, Benson ML et al (1996) Optimal CT evaluation for functional endoscopic sinus surgery. Am J Neuroradiol 17:181–188
7. Chavan A, Maran R et al (2018) Diagnostic evaluation of chronic nasal obstruction based on nasal endoscopy and CT Scan paranasal sinus. Indian J Otolaryngol Head Neck Surg 71(Suppl 3):1948–1952
8. Bhattacharyya N, Fried MP (2003) The accuracy of computed tomography in the diagnosis of chronic rhinosinusitis. Laryngoscope 113:125–129
9. Benninger MS (2008) Rhinosinusitis, Chap 113. In: Gleeson M, Browning GG, Burton MJ et al (eds) Scott Brown's otorhinolaryngology and head neck surgery, vol 2, 7th edn. Hodder Arnold, Great Britain, pp 1439–1449
10. Tegnoor MS, George JW, George W, Joshi R (2017) Comparative study between diagnostic nasal endoscopy and computed tomography of PNS in sino nasal diseases. Int J Otorhinolaryngol Head Neck Surg 3(4):972–978
11. Psaltis AJ, Li G, Vaezeafshar R, Cho KS et al (2014) Modification of the Lund-Kennedy endoscopic scoring system improves its reliability and correlation with patient-reported outcome measures. Laryngoscope 124(10):2216–2223
12. Lund VJ, Mackay IS (1993) Staging in rhinosinusitis. Rhinology 107:183–184
13. Drake-Lee AB (1991) The value of medical treatment in nasal polyps. Clin Otolaryngol Allied Sci 16(3):237–239
14. Kirtane MV (1991) Functional endoscopic sinus surgery (A preliminary study). Indian J Otolaryngol 43:126–129
15. Stammberger H, Hawke M et al (1993) Essentials of functional endoscopic sinus surgery, 1st edn, pp 12–25.
16. Chakraborty P, Jain RK (2019) Nasal Endoscopy as an Effective Alternative for CT-Scan in diagnosing chronic rhinosinusitis: a clinical study and review of literature. Indian J Otolaryngol Head Neck Surg 71(Suppl 3):1734–1738. https://doi.org/10.1007/s12070-017-1085-6
17. Deosthale NV, Khadakkar SP, Harkare VV et al (2017) Diagnostic accuracy of nasal endoscopy as compared to computed tomography in chronic rhinosinusitis. Indian J Otolaryngol Head Neck Surg 69(4):494–499. https://doi.org/10.1007/s12070-017-1232-0
18. Lloyd GA (1990) CT of the paranasal sinuses: study of a control series in relation to endoscopic sinus surgery. J Laryngol Otol 104(6):477–481
19. Kaluskar SK, Patil NP (1992) Value of CT in the evaluation of chronic sinus disease. IJLO Head and Neck Surg 4:188–192
20. Handanakere SS, Devasanudra CR (2016) Clinical study of correlation between preoperative CTscan findings with intraoperative findings in cases of chronic rhinosinusitis. Indian J Ana Surg Head Neck Brain 2(2):49–52
21. Prakash A, Raj A, Wadhwa V, Tandon S, Rathore PK (2017) Correlation of computed tomographic findings and intraoperative findings in patients with chronic sinusitis. Clin Rhinol An Int J 10(2):78–85