

Original Research Article

Study of the association between computed tomography scan of paranasal sinuses and intraoperative findings in functional endoscopic sinus surgery

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ABSTRACT

Background: Functional endoscopic sinus surgery (FESS) has become the preferred surgical modality for managing sinonasal disorders. Preoperative computed tomography (CT) is considered the gold standard imaging tool, but variations exist in its correlation with intraoperative findings. Assessing this association is essential for improving diagnostic accuracy and surgical outcomes. Objectives of the study were to evaluate the association between CT scan findings of the paranasal sinuses and intraoperative observations during FESS, and to determine the role of the Lund-Mackay (LM) score in grading disease severity.

Methods: A prospective study was conducted on 40 patients who underwent CT imaging followed by FESS. Anatomical variations, extent of sinus involvement, and histopathological findings were analyzed. Disease severity was quantified using the LM scoring system.

Results: Maxillary sinuses were the most frequently involved (92.5%), followed by ethmoidal sinuses. Ethmoidal polyps were the predominant pathology (57.5%), with antrochoanal polyps accounting for 25% of cases. A strong correlation was noted between CT and FESS findings, particularly in cases of deviated nasal septum. The LM score showed progressive increases with the number of sinuses involved, indicating its reliability in disease severity assessment. Histopathological evaluation revealed diverse pathologies, guiding individualized management.

Conclusions: CT and FESS findings show significant association in evaluating sinonasal disease. CT reliably demonstrates anatomical variations and disease extent, while the LM score provides objective severity assessment. The combined use of CT and intraoperative findings enhances diagnostic precision and optimizes treatment strategies in paranasal sinus disorders.

Keywords: FESS, Sinus surgery, Sinonasal disorders, Paranasal sinuses

INTRODUCTION

Computed tomography (CT) is the investigation of choice for pre-operative evaluation of the nasal cavity and paranasal sinuses and is the gold standard for description of inflammatory sinus disease resulting from blockage of the osteomeatal complex.¹ Subtle anatomical variations such as haller cells, paradoxical middle turbinate, and agger nasi cells can now be imaged through CT scan with increased level of clarity and accuracy.² CT scan also aids

in the diagnosis of anatomic variants that may lead to intraoperative and postoperative FESS complications and reduces the mortality and morbidity of the patients.³

To avoid complications during endoscopic sinus surgery, imaging in coronal plane is recommended as it optimally shows the osteometal unit, the relationship of skull base, ethmoid roof and the relationship of orbits to the paranasal sinuses.⁴

However, CT scan is not always accurate in detecting the disease and anatomical variants. These discrepancies though minor, need further evaluation and correlation of CT findings to that findings observed in functional endoscopic sinus surgery.⁵

The surgical treatment of sinonasal pathologies has undergone changes during the last two decades, with the introduction of functional endoscopic sinus surgery (FESS). This treatment method can remove irreversibly diseased tissue from the sinuses, preserve the intact sinus mucosa, reestablish sinus ventilation, reduce the inflammatory response, and restore mucosal glandular and ciliary clearance.⁶

As the sinuses are adjacent to important sites such as the nasolacrimal duct, orbit, optic nerve, internal carotid artery, skull base, there is a risk of serious postoperative complications with FESS, which may include nasolacrimal duct and lacrimal sac injury, orbital wall injury, visual impairment, cerebrospinal fluid rhinorrhea, and hemorrhagic complications.⁷ CT scans of the paranasal sinuses provide a roadmap for FESS. The current study was conducted to connect and analyze the CT findings with the intraoperative findings of FESS.

METHODS

This was a hospital-based, cross-sectional analytical study conducted from May 2022 to January 2024 and included a total of 40 patients.

Study population

The study population consisted of patients presenting with sinonasal pathologies that were unresponsive to medical treatment. Patients were selected based on specific inclusion and exclusion criteria.

Inclusion criteria

Inclusion criteria included patients of all age groups with sinonasal pathologies not responding to medical treatment, patients requiring functional endoscopic sinus surgery (FESS), and patients who had provided written informed consent and were willing to participate in the study.

Exclusion criteria

Exclusion criteria included patients undergoing revision endoscopic sinus surgery.

All selected patients underwent a thorough clinical evaluation including detailed history taking and physical examination. Relevant preoperative laboratory investigations were performed for each patient. Prior to surgery, diagnostic nasal endoscopy (DNE) under topical anesthesia was carried out using a zero-degree rigid endoscope. All patients subsequently underwent a

contrast-enhanced CT scan of the paranasal sinuses using a Siemens Somatom Emotion 6-slice third-generation spiral CT scanner. High-resolution axial and coronal images were obtained with a slice thickness of 3 mm. CT scans were evaluated and scored using the Lund-Mackay CT classification system.

An experienced radiologist analyzed the CT images in detail and completed an objective assessment questionnaire, documenting findings such as septal deviation, concha bullosa, sinus involvement, mucosal thickening, narrowing or partial obstruction of the osteomeatal complex (OMC), and the presence of nasal polyps or masses.

FESS was performed under general anesthesia following the Messerklinger technique. The surgical approach and extent of surgery were planned based on findings from the DNE and CT scan. Prior to initiating surgery, nasal decongestion and infiltration were performed. A zero-degree endoscope was used to examine the nasal cavity intraoperatively, evaluating anatomical landmarks, mucosal condition, and the presence of any pathology such as polyps or purulent secretions. Any intraoperative findings differing significantly from preoperative CT or DNE findings were carefully documented.

Statistical analysis

Descriptive analysis was performed for all collected data. Findings were summarized in terms of frequencies and proportions where appropriate. Interrater reliability was assessed using Cohen's Kappa coefficient. Agreement ranged from 90% to 100% across the five sinus regions. Chi-square tests were performed to assess the association between CT-detected anatomical variations and FESS findings.

RESULTS

Demographic profile

Out of the 40 patients enrolled in the study with sinonasal pathology, 62.5% were males and 37.5% were females. The average age of the participants was 36.75 years, with a median age of 37.5 years. The youngest participant was 24 years old, while the oldest was 54 years old. The standard deviation was 8.7845 years, suggesting a moderate degree of variability in age distribution. The interquartile range, representing the middle 50% of values, extended from 29 to 42.75 years.

Age distribution

The highest number of participants, accounting for 22.5% of the total sample, were within the age group of 36 to 40 years. Both the 26–30 and 31–35-year age groups had seven individuals each, representing 17.5% of the sample per group. Five individuals (12.5%) belonged to the 21–25 age group, while four participants each (10%) fell into the

41–45, 46–50, and 51–55 age brackets. Overall, a majority of the study participants, approximately 57.5%, were between the ages of 26 and 40.

Presenting symptoms

Among the various signs and symptoms reported by participants, nasal obstruction was the most frequently observed, affecting 80% of the study population. Nasal discharge was the second most common symptom, seen in 77.5% of individuals. Smell disturbances were noted in 67.5% of the patients, and headaches were reported by 62.5%. Postnasal drip was present in 45% of cases, while cough was reported in 37.5%. Sneezing was experienced by 35% of the patients, and facial pain was the least common symptom, affecting 27.5% of the individuals (Table 1).

Table 1: Distribution of signs and symptoms in patients (n=40).

Signs and symptoms	Frequency (N)	Percentage (%)
Nasal obstruction	32	80.0
Nasal discharge	31	77.5
Smell affected	27	67.5
Headache	25	62.5
Postnasal dripping	18	45.0
Cough	15	37.5
Sneezing	14	35.0
Facial pain	11	27.5

Sinus involvement on CT

The maxillary sinus was the most frequently involved sinus group, affected in 92.5% of the participants. Ethmoidal sinus involvement was present in 77.5% of patients, while the sphenoidal and frontal sinuses were involved in 57.5% and 47.5% of cases respectively. The osteomeatal complex (OMC) showed involvement in 70% of the patients based on CT findings. Regarding the number of sinuses affected, 12.5% of patients had involvement of a single sinus, 27.5% had two sinuses involved, 30% had three sinuses affected, and another 30% had all four sinuses involved (Figure 1).

Laterality of sinus involvement

Bilateral sinus involvement was the most common pattern and was observed in 62.5% of participants. Right-sided sinus involvement was seen in 22.5% of the cases, whereas left-sided involvement was the least common, found in only 15% of the study population.

Interrater reliability between CT and FESS

To assess diagnostic agreement between preoperative CT scans and intraoperative FESS findings, Cohen's Kappa coefficient was utilized. There was excellent agreement

between the two diagnostic methods across all five sinus groups, maxillary, ethmoidal, sphenoidal, frontal, and osteomeatal complex. Agreement rates ranged from 90% to 100%, and the corresponding Cohen's Kappa values varied from 0.752 to 1.000, indicating substantial to perfect agreement. All values were statistically significant with a p-value less than 0.001, demonstrating a high level of interrater reliability (Table 2 and Figure 2).

Table 2: Inter-rater reliability between CT scan and FESS findings for sinus involvement.

Sinus	Agreement (%)	Cohen's Kappa (κ)	Z-value	P value
Maxillary	100	1.000	6.32	<0.001
Ethmoid	90	0.752	4.91	<0.001
Sphenoid	95	0.899	5.72	<0.001
Frontal	100	1.000	6.32	<0.001
OMC	95	0.886	5.64	<0.001

Types of sinonasal pathologies identified

Ethmoidal polyps were the most frequently diagnosed pathology, found in 57.5% of cases. Antrochoanal polyps were observed in 25% of the patients. Fungal rhinosinusitis accounted for 7.5% of cases, while inverted papilloma was seen in 5%. Angiomatous polyps and nasal masses were each found in 2.5% of the study population.

Detailed side-specific sinus involvement

On the right side, the frontal sinus was the most commonly involved, found in 60% of patients. The left side also showed highest involvement of the frontal sinus, with 80% of individuals affected. The maxillary sinus was the second most involved sinus on both sides, with 27.5% of patients on the right and 52.5% on the left. The anterior ethmoidal sinus was more commonly involved than the posterior ethmoidal sinus on both sides, with the right and left anterior ethmoidal sinuses affected in 37.5% and 50% of patients respectively. The posterior ethmoidal sinus showed involvement in 55% of right and 67.5% of left sides. The sphenoidal sinus was the least involved, with 7.5% on the right and 5% on the left (Table 3).

OMC involvement severity

OMC involvement was observed in 60% of the patients on the right side and in 50% on the left side. The severity of OMC disease was scored on a scale from 0, indicating no abnormality, to 2, indicating total opacification. This analysis showed a slightly greater disease burden on the right side.

Concordance of CT and FESS for anatomical variations

When comparing CT scan findings to intraoperative FESS results, Onodi cells were found to be positive in 30 patients

by both diagnostic methods. Deviated nasal septum was observed in 29 patients by both CT and FESS. Uncinate process variations were negative in both diagnostic techniques for 32 cases, and only 8 cases showed concordant positive findings. These results indicate a strong concordance between the two diagnostic modalities in identifying certain anatomical variations (Table 4).

Correlation of anatomical variations between CT scan and FESS findings

The concordance between preoperative CT scans and intraoperative FESS findings for anatomical variations was assessed using chi-square tests (Table 5). Significant associations were found for Onodi cells ($\chi^2=19.444$, $p<0.05$), Agger Nasi cells ($\chi^2=31.512$, $p<0.05$), Haller cells ($\chi^2=30.616$, $p<0.05$), deviated nasal septum ($\chi^2=11.649$, $p<0.05$), uncinat

($\chi^2=40.000$, $p<0.05$), and Concha Bullosa ($\chi^2=32.308$, $p<0.05$).

There was strong agreement between CT and FESS, with most patients showing matching positive or negative findings. No positive findings were observed for paradoxical middle turbinate and septal cells, so statistical analysis was not applicable for these.

Heatmap compares CT findings with intraoperative FESS results for anatomical variations (Figure 3). CT showed poor detection for Agger nasi, Haller, Onodi cells, uncinat process, paradoxical middle turbinate, and septal cells, which were more frequently identified during FESS. Concha bullosa was also underestimated (CT: 2, FESS: 24). Deviated nasal septum showed good concordance (CT: 4, FESS: 5). Overall, CT scans tend to underestimate anatomical variations compared to intraoperative findings, with FESS remaining more reliable.

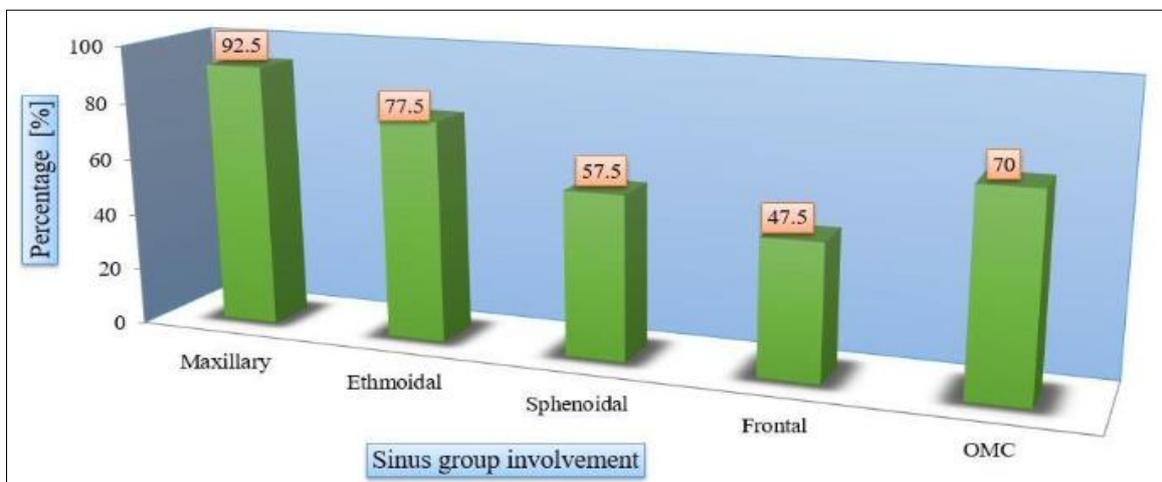


Figure 1: Distribution graph of the patients according to their sinus involvement.

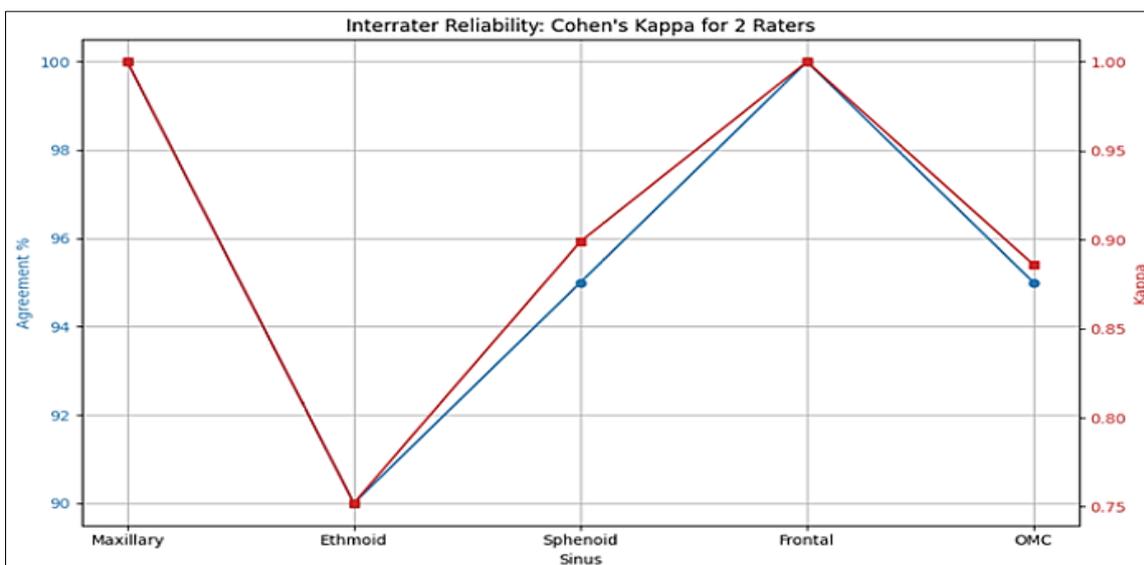


Figure 2: Distribution graph of the patients according to sinus involvement in CT scan and FESS assesments (red – CT, blue- FESS).

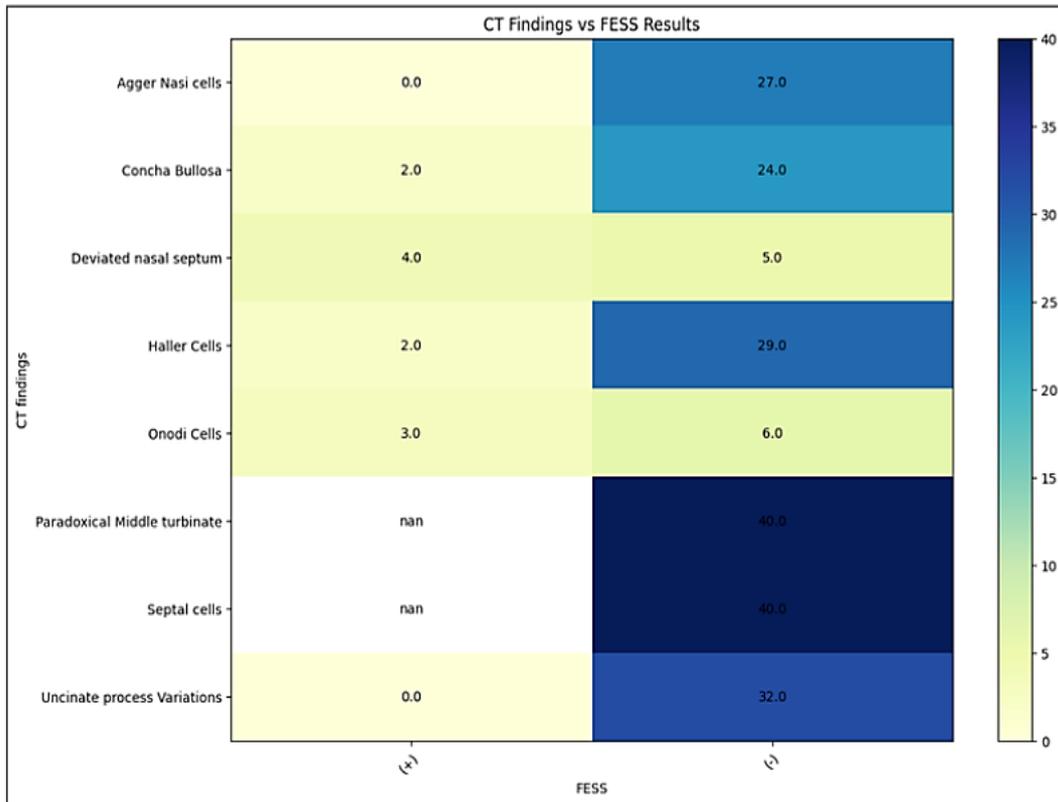


Figure 3: Heatmap for CT findings versus FESS results for anatomical variations.

Table 3: Lund-Mackay CT scores for sinuses (n=40).

Sinus	Right side 0 (%)	Right side 1 (%)	Right side 2 (%)	Left side 0 (%)	Left side 1 (%)	Left side 2 (%)
Frontal	24 (60.0)	11 (27.5)	5 (12.5)	32 (80.0)	4 (10.0)	4 (10.0)
Maxillary	11 (27.5)	21 (52.5)	8 (20.0)	12 (30.0)	20 (50.0)	8 (20.0)
Anterior ethmoidal	15 (37.5)	18 (45.0)	7 (17.5)	20 (50.0)	15 (37.5)	5 (12.5)
Posterior ethmoidal	22 (55.0)	14 (35.0)	4 (10.0)	27 (67.5)	9 (22.5)	4 (10.0)
Sphenoid	19 (47.5)	18 (45.0)	3 (7.5)	30 (75.0)	8 (20.0)	2 (5.0)

Table 4: Correlation of FESS findings with CT scan results for anatomical variations.

Anatomical variation	FESS positive/CT (+)	FESS positive/CT (-)	FESS negative/CT (+)	FESS negative/CT (-)
Onodi cells	30	3	1	6
Agger Nasi cells	11	0	2	27
Haller cells	9	2	0	29
Deviated nasal septum	29	4	2	5
Uncinate process variations	8	0	0	32
Concha bullosa	14	2	0	24
Paradoxical middle turbinate	0	0	0	40
Septal cells	0	0	0	40

Table 5: CT scan versus FESS findings for anatomical variations.

Anatomical variation	FESS negative/CT negative	FESS negative/CT positive	FESS positive/CT negative	FESS positive/CT positive	Chi-square (χ^2)	P value	Significance
Onodi cells	6	3	1	30	19.444	<0.05	Significant
Agger Nasi cells	27	0	2	11	31.512	<0.05	Significant
Haller cells	29	2	0	9	30.616	<0.05	Significant
Deviated nasal septum	5	4	2	29	11.649	<0.05	Significant
Uncinate process variations	32	0	0	8	40.000	<0.05	Significant
Concha Bullosa	24	2	0	14	32.308	<0.05	Significant
Paradoxical middle turbinate	40	0	0	0	—	—	Not applicable
Septal cells	40	0	0	0	—	—	Not applicable

DISCUSSION

The present study included 40 subjects, with a male predominance of 62.5% compared to 37.5% females. Similar male dominance has been reported by Handanakere et al (76.66% males, 23.33% females), Rathor et al (61.8% males, 38.2% females), and Padmalatha et al (52% males, 48% females).⁸⁻¹⁰ In terms of age distribution, the majority of cases (22.5%) were in the 36–40-year range. Padmalatha et al. also noted that most patients were between 20–40 years, with 48% in the third and fourth decades.

In the current study, nasal obstruction (80%) and nasal discharge (77.5%) were the most prevalent symptoms. A considerable proportion of patients (67.5%) also reported a compromised sense of smell, highlighting the olfactory impairment often associated with sinonasal disease. Tandon et al observed chronic nasal discharge as the most common complaint (79.5%), followed by nasal obstruction (77.5%).¹¹ In contrast, Sheetal et al reported headache (90%) as the predominant symptom, followed by nasal discharge (80%).¹²

The distribution of paranasal sinus involvement in the present study provides important insights. The maxillary sinuses were most frequently affected, with 92.5% of patients showing maxillary sinus pathology. This high prevalence is often attributed to proximity to dental infections, structural abnormalities, and inflammatory processes extending from adjacent nasal structures. Zojaji et al similarly reported maxillary sinus involvement as the most common (82%), followed by the ethmoid sinuses (54%), while frontal (20%) and sphenoid (25%) sinuses were least affected.¹³ Kumari et al also observed a similar trend, with maxillary sinus involvement in 80% of cases, followed by anterior ethmoid (45%), posterior ethmoid (35%), sphenoid (28.3%), and frontal sinuses (12.5%).¹⁴

In the present study, ethmoidal polyps were the most common pathology, accounting for 57.5% of cases. Antrochoanal polyps were the next most frequent finding

(25%), followed by angiomatous polyps (2.5%) and nasal masses such as carcinoma (2.5%). These findings highlight the anatomical diversity and potential differential diagnoses encountered in sinonasal pathology. Kanwar et al reported final diagnoses of non-specific inflammation suggestive of sinusitis (57.1%), inflammatory polyps (24.1%), antrochoanal polyp (7.6%), fungal sinusitis (6.5%), and poorly differentiated carcinoma (4.3%).¹⁵ Similarly, Kushwah et al observed non-specific inflammatory disease (64%), inflammatory polyp (14%), angiofibroma (8%), inverted papilloma (6%), fungal sinusitis (4%), and mucocele (2%), along with poorly differentiated carcinoma (2%).¹⁶

The extent of disease in the present study was assessed using the Lund-Mackay (LM) scoring system, which quantifies sinus opacification and structural changes on CT imaging.¹⁷ When only one sinus was involved, the mean LM score was low (2.2 ± 1.1), reflecting mild disease. Involvement of two sinuses nearly doubled the score (3.8 ± 1.7), indicating moderate severity. With three sinuses affected, the mean score rose sharply to 8.2 ± 2.5 , suggesting significant disease progression. When all four sinuses were involved, the mean score peaked at 12.7 ± 5.2 , denoting severe disease with widespread functional compromise. This correlation between the number of involved sinuses and LM score highlights the utility of LM scoring in assessing disease severity and guiding appropriate treatment planning.

The limitations found in our study are as follows. The study included a relatively small sample size of 40 subjects, which may limit the generalizability of the findings to larger populations. As it was conducted at a single center, the results may not fully represent variations in clinical practice or patient characteristics seen in multi-center studies. The study primarily focused on the agreement between CT findings and FESS observations, without evaluating other outcomes such as postoperative complications, long-term follow-up, or patient-reported measures. In addition, the interpretation of CT scans and intraoperative findings is subject to inter-observer

variability, which could affect the reliability of the results. While the findings are consistent with previous studies, larger multi-center research with long-term follow-up is required to strengthen the evidence and enhance clinical applicability.

CONCLUSION

Our study demonstrated a strong correlation between CT findings and surgical observations during FESS, confirming the accuracy of CT in assessing disease extent and anatomical variations. The Lund-Mackay score proved effective in quantifying sinusitis severity, with higher scores corresponding to greater sinus involvement. The study also highlighted the prevalence and pattern of sinus involvement, underscoring the importance of bilateral assessment. Histopathological evaluation revealed diverse pathologies, providing valuable guidance for individualized treatment planning. Overall, both CT and FESS showed high reliability in diagnosing sinonasal conditions, with deviated nasal septum demonstrating good sensitivity. These findings emphasize that the combined use of CT imaging and FESS significantly enhances diagnostic precision and optimizes treatment outcomes in paranasal sinus disorders.

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REFERENCES

- Duvoisin B, Landry M, Chapuis L, Krayenbuhl M, Schnyder P. Low-dose CT and inflammatory disease of the paranasal sinuses. *Neuroradiology*. 1991;33:403-6.
- Mendiratta V, Baisakhiya N, Singh D, Datta G, Mittal A, Mendiratta P. Sinonasal Anatomical Variants: CT and Endoscopy Study and Its Correlation with Extent of Disease. *Indian J Otolaryngol Head Neck Surg*. 2016;68(3):352-8.
- Chaitanya CS. Computed tomographic evaluation of diseases of paranasal sinuses. *Int J Rec Sci Res*. 2015;6(7):5081-6.
- Zinreich SJ. Imaging of chronic sinusitis in adults: X-ray, computed tomography, and magnetic resonance imaging. *J Allergy Clin Immunol*. 1992;90(3 Pt 2):445-51.
- Sheetal D, Devan PP, Manjunath P, Martin P, Satish kumar K, Sreekantha, et al. CT PNS – Do We Really Require Before FESS? *J Clin Diagnost Res*. 2011;5(2):179-81.
- Subspecialty Group of Rhinology, Editorial Board of Chinese Journal of Otorhinolaryngology Head and Neck Surgery; Subspecialty Group of Rhinology, Society of Otorhinolaryngology Head and Neck Surgery, Chinese Medical Association. [Chinese guidelines for diagnosis and treatment of chronic rhinosinusitis]. *Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi*. 2019;54(2):81-100.
- ZM X, Y L. Indications and complications of endoscopic nasal surgery. *Chin arch otolaryngol head neck surg*. 2014; 21(07):349–51.
- Handanakere SS, Devasanudra CR. Clinical study of correlation between preoperative CT scan findings with intraoperative findings in cases of chronic rhinosinusitis. *Indian J Anat Surg Head Neck Brain*. 2016;2(2):49-52.
- Khale A, Baviskar S, Khan S, Baviskar P. Correlation between Pre-Operative CT Scan and Intra Operative Endoscopic Findings in Functional Endoscopic Sinus Surgery. *GJMEDPH*. 2023;11(6).
- Padmalath M, Garudadri S. A study on correlation between CT findings and the endoscopic findings in Functional Endoscopic Sinus Surgery of chronic rhinosinusitis. *Int J Radiol Diagnost Imag*. 2021;4(3):118-24.
- Tandon S, Rathore PK, Raj A, Prakash A, Wadhwa V. Correlation of Computed Tomographic Findings and Intraoperative Findings in Patients with Chronic Sinusitis. *Clin Rhinol Int J*. 2017;10(2):78-85.
- Sheetal D, Devan PP, Manjunath P, Martin P, Satish kumar K, Sreekantha, et al. CT PNS – Do We Really Require Before FESS? *J Clin Diagnost Res*. 2011;5(2):179-81.
- Zojaji R, Mirzadeh M, Naghibi S. Comparative Evaluation of Preoperative CT scan and Intraoperative Endoscopic Sinus Surgery Findings in Patients with Chronic Rhinosinusitis. *Iran J Radiol*. 2008;5(2):77-82.
- Kumari A, Kaur A, Mathur M, Singh J, Mohi JK, Haq S. Comparison between preoperative computed tomography scan of paranasal sinuses and operative findings in functional endoscopic sinus surgery (FESS) in chronic sinusitis. *Int J Med Res Rev*. 2016;4(12):2147-55.
- Kanwar SS, Mital M, Gupta PK, Saran S, Parashar N, Singh A. Evaluation of paranasal sinus diseases by computed tomography and its histopathological correlation. *J Oral Maxillofac Radiol*. 2017;5:46-52.
- Kushwah APS, Bhalse R, Pande S. CT evaluation of diseases of Paranasal sinuses & histopathological studies. *Int J Med Res Rev*. 2015;3(11):1306-10.
- Okushi T, Nakayama T, Morimoto S, Arai C, Omura K, Asaka D, et al. A modified Lund–Mackay system for radiological evaluation of chronic rhinosinusitis. *Auris Nasus Larynx*. 2013;40(6):548-53.

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