

Study of Diagnostic Accuracy of Cone Beam Computed Tomography for Detection of Pathological and Anatomical Variations in Chronic Sinusitis Patients

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ABSTRACT

Background: Cone-beam computed tomography (CBCT) was developed because of studies demonstrating its value in enhancing vision of the nasal cavity, lateral nasal wall, osteomeatal complex, and sinuses prior to functional endoscopic sinus surgery (FESS).

Objective: The aim of the current work was to detect paranasal sinus diseases and anatomical variants in patients with chronic sinusitis identified prior to sinus surgery by CBCT and intraoperative during FESS.

Patients and Methods: This study included a total of 30 patients with chronic sinusitis scheduled for FESS, attending at Department of Otolaryngology, Head and Neck Surgery, Zagazig University Hospitals.

Results: The current research demonstrated consistent findings between CBCT and FESS in patients with chronic rhinosinusitis. Statistically significant ($P < 0.001$) agreement was found between CBCT and FESS in the diagnosis of nasal deviation and concha bullosa. For nasal polyp and OMC blockage, the correlation between CBCT and FESS was statistically significant ($P < 0.001$). The sensitivity and NPV of CBCT with respect to FESS were both 100%, and the agreement between the two methods for detecting infundibulum thickening was statistically significant ($P < 0.001$). Exceptions include nasal deviation and a thickened infundibulum, but otherwise, specificity is very good (67 percent and 70 percent respectively). Additionally, PPV was quite high except for nasal deviation, which was just 70%.

Conclusion: It could be concluded that CBCT and FESS yield similar results when examining the paranasal sinuses. Diagnostic sinus endoscopy for the evaluation of chronic rhinosinusitis syndrome (CRS) is not always appropriate, but CBCT would be a suitable option due to its high accuracy, reduced costs, and lower radiation doses.

Keywords: Cone Beam Computed Tomography, Chronic Sinusitis

INTRODUCTION

Worldwide, millions of people suffer from chronic rhinosinusitis. Objective and subjective criteria are included in the consensus recommendations used to clinically characterize chronic rhinosinusitis. After 12 weeks of nasal obstruction, drainage, facial pain/pressure, and hyposmia/anosmia, as well as objective evidence of sinusitis on nasal endoscopy or sinus computed tomography, the American Academy of Otolaryngology—Head and Neck Surgery recommends a diagnosis of chronic rhinosinusitis syndrome (CRS) ⁽¹⁾.

Chronic rhinosinusitis can be diagnosed with the help of a thorough patient history, a standard otolaryngoscopic examination, and radiographic imaging. The most reliable method for seeing this area is computerized tomography (CT). Before functional endoscopic sinus surgery, CT can be used to see the sinuses, nasal cavity, and lateral nasal wall in detail. While CT has many potential benefits, its widespread use is limited by concerns over cost and radiation exposure. Because of these benefits, using CBCT in dentistry is highly recommended. Furthermore, the precise function of CBCT in the field of otolaryngology is still up for debate. Compared to conventional CT, cone beam (CBCT) has fewer drawbacks ⁽²⁾.

Cone-beam computed tomography emerged from studies with this aim (CBCT). In CBCT, the voxels can be utilized to precisely quantify maxillofacial features from a variety of angles because

they are isotropic, unlike in medical CT. Reconstructed CBCT images have the same resolution and quality in the axial, sagittal, and coronal planes. CBCT's higher resolution and lower radiation exposure to patients make it the method of choice for maxillofacial imaging ⁽³⁾.

In the oral and maxillofacial area, CBCT can be used for a wide variety of procedures it is usually utilized for evaluation of lesions of mandibular condyle among cases who had or maxillofacial trauma or disorders of temporomandibular joint; for individuals undergoing orthodontic treatment and implant planning; olfactory and airway examination; for the evaluation of nasal mucosal thickness; the diagnosis of sinusitis; the finding of nasal septal deviation, concha hypertrophy; prior to functional endoscopic sinus surgery (FESS) to assess sinus diseases and anatomical variances ⁽¹⁾.

It was demonstrated that CBCT may be preferred to CT for detecting anomalies in the mandibular region and paranasal sinuses due to its lower patient radiation dosage and higher resolution. CT remains the optimum imaging modality for this purpose. Few studies have, to the authors' knowledge, compared the results of CBCT and FESS to determine whether there is concordance between the two ⁽⁴⁾.

This study was aimed to evaluate if CBCT is an effective approach for assessing the paranasal sinuses in individuals with chronic rhinosinusitis by comparing its findings to those of functional endoscopic sinus surgery (FESS).

SUBJECTS AND METHODS

This study included a total of 30 patients with chronic sinusitis scheduled for FESS, attending at Department of Otolaryngology, Head and Neck Surgery, Zagazig University Hospitals.

Inclusion Criteria: Patients having chronic sinusitis for more than three months and whose symptoms had not improved with medication.

Exclusion Criteria : Patients < 18 years, pregnant women, ineligible surgical patients, traumatic cases, osteomyelitis, and infiltrating tumors, and patients unwilling to undergo endoscopic sinus surgery.

All patients were subjected to:

- 1- Complete history taking.
- 2- General and local examination.
- 3- Standardized preoperative lab work and cone beam CT nasal and paranasal (axial, coronal, sagittal).
- 4- Surgery through (FESS) operation was done under GA, with endoscopic detection of pathologies and anatomical variations.
- 5- Timeline. Three months were almost duration of the study for collection and preparation of cases, 2 months for FESS and comparison between CBCT and FESS.

Ethical Consideration

This study was ethically approved by Zagazig University's Research Ethics Committee. Written informed consent of all the participants or the relatives was obtained. The study protocol conformed to the Helsinki Declaration, the ethical norm of the World Medical Association for human testing.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 24 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Chi square test (χ^2) to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean \pm SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value < 0.05 was considered significant.

RESULTS

In the present study, the mean age was 28.6 years and the participant's gender was typically matched (Table 1).

Table (1): Study participants demographic data

		Mean	SD
Age (years)		28.6	± 7.2
		N	%
Gender	Female	15	50
	Male	15	50

Table (2) shows the frequency and correlation between CBCT and FSSS finding, and showed statistical insignificant between them.

Table (2): Comparison of CBCT and FSSS finding

	CBCT		FESS		P Value
	N	%	N	%	
Mucosal thickening	30	100	30	100	-
Nasal deviation	24	80	26	86.7	0.48
Concha bullosa	9	30	13	43.3	0.28
Nasal polyp	16	53.3	18	60	0.6
Ostemeatal complex obstruction	22	73.3	24	80	0.54
Infundibulum thickening	20	66.7	23	76.7	0.39
Hypertrophic ethmoid bulla	17	56.9	19	63.3	0.6
Uncinate process variation	19	63.3	18	60	0.39
large agar nasi cell	18	60	17	56.7	0.39
Haller cell	18	60	17	56.7	0.39

Chi square test

In patients with chronic rhinosinusitis, CBCT and FESS findings were consistent. For mucosal thickening, a correlation coefficient of 1 was found between CBCT and FESS (maximum). A statistically significant (P0.001) agreement was found between CBCT and FESS in the detection of nasal deviation and concha bullosa. For nasal polyp and OMC blockage, the correlation between CBCT and FESS was excellent and statistically significant (P0.001). A statistically significant (P0.001) agreement was found between CBCT and FESS for infundibulum thickness (Table 3).

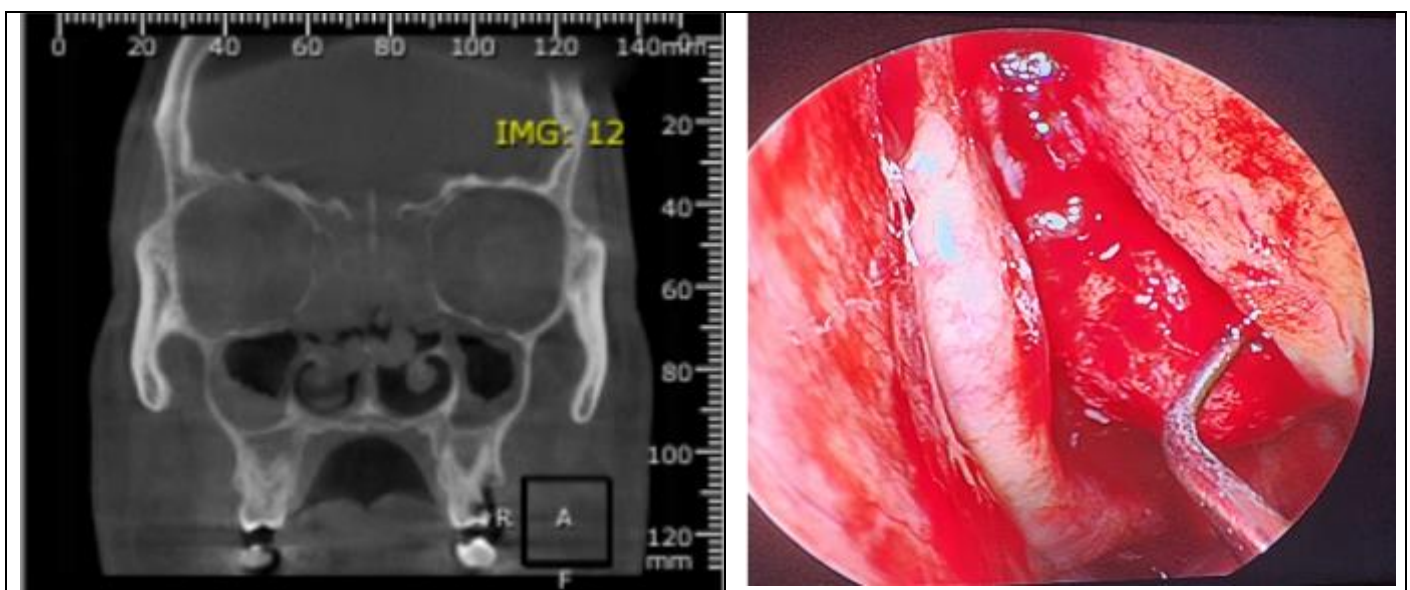
Table (3): Agreement between CBCT and FESS

	CBCT	FESS	Kappa Coefficient	P Value
	N(%)	N(%)		
Mucosal thickening	30(100)	30(100)	1	
Nasal deviation	24(80)	26(86.7)	0.76	0.001
Concha bullosa	9(30)	13(43.3)	0.72	0.001
Nasal polyp	16(53.3)	18(60)	0.86	0.001
Ostemeatal complex obstruction	22(73.3)	24(80)	0.82	0.001
Infundibulum thickening	20(66.7)	23(76.7)	0.76	0.001
Hypertrophic ethmoid bulla	17(56.9)	19(63.3)	0.75	0.001
Uncinate process variation	19(63.3)	18(60)	0.8	0.6
large agar nasi cell	18(60)	17(56.7)	0.87	0.3
Haller cell	18(60)	17(56.7)	0.73	0.3

The sensitivity and NPV of CBCT and FESS were 100%, with excellent accuracy in all finding. High specificity was found except for nasal deviation and infundibulum thickening (67% and 70% respectively). Also, there was high PPV except for nasal deviation (70%) (Table 4).

Table (4): Diagnostic performance of CBCT compared with FESS

	Sen%	Spe%	PPV%	NPV%	ACC%
Mucosal thickening	100	100	100	100	100
Nasal deviation	100	67	92	100	93.3
Concha bullosa	100	81	70	100	86.7
Nasal polyp	100	86	89	100	93.3
Ostemeatal complex obstruction	100	75	92	100	93.3
Infundibulum thickening	100	70	87	100	90
Hypertrophic ethmoid bulla	100	92	94	80	88
Uncinate process variation	91	86	91	90	90
large agar nasi cell	91	90	93	93	93
Haller cell	91	80	87	86	86



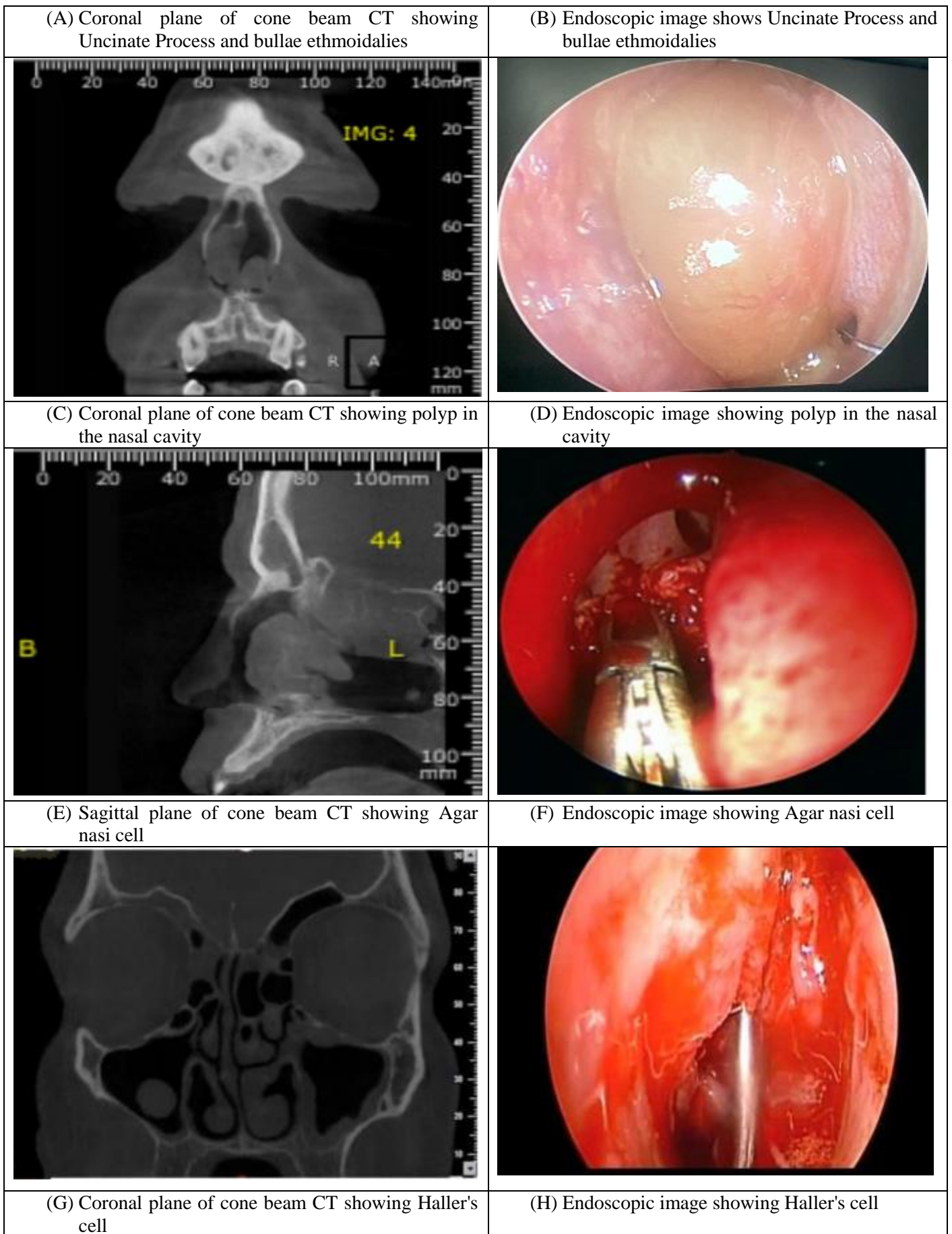


Figure (1): Comparative illustrations of cone beam CT versus Endoscopic images

DISCUSSION

Pathological changes and anatomical variants in the nasal cavity and paranasal sinuses have been extensively researched. Numerous anatomical variants contribute to chronic sinusitis by altering the mucociliary transport pattern and producing blockage in the ostiomeatal complex (OMC). Septal deviation is the most distinctive anatomical feature among the participants⁽⁵⁾.

Cone beam computed tomography (CBCT) is the best option among the common imaging modalities for considering the sinus condition during diagnosis and therapy planning, as it permits full or partial 3D observation of the structure, unlike 2D imaging which is limited by the possibility of superimposition with other structures⁽⁶⁾.

CBCT's voxels are isotropic, allowing for precise measurement of craniofacial structures from a variety of viewing angles, unlike those of medical CT. Images reconstructed from CBCT scans in the axial, sagittal, and coronal planes have the same resolution and quality. When it comes to maxillofacial imaging, CBCT is preferable to CT because of its higher resolution and lower radiation dosage to the patient⁽³⁾.

The correlation between CBCT and FESS has not been studied. In patients with chronic rhinosinusitis, however, numerous prior investigations have examined the agreement between CT findings and surgical methods.

In order to investigate if CBCT can replace CT in paranasal sinus diseases diagnosis, the current study evaluated the agreement between CBCT and FESS findings.

Since CBCT scans expose patients to less radiation than CT and may be reconstructed in many planes, they are frequently utilized for detecting anatomical variants in the sinonasal region⁽⁷⁾. Bone anatomy in the sinonasal region can also be described with the aid of CBCT scans⁽⁸⁾.

Our results were consistent with those of other studies which found that mucosal thickening was the most common abnormality, concha bullosa was the least common, and there was full agreement between CBCT and FESS results.

The practically perfect agreement between CBCT and FESS in this study for mucosal thickening may be explained by the findings of various previous studies.

For instance, **Amodu et al.**⁽⁹⁾ found that nearly all CT scans (98%) showed mucosal thickening in at least one or two sinuses. **Rege et al.**⁽¹⁰⁾ revealed that mucosal thickening was the most common abnormality found on CBCT pictures of asymptomatic patients, accounting for 66% of all abnormalities studied.

Ritter et al.⁽¹¹⁾ found that mucosal thickening was the most frequently reported CBCT finding,

occurring in 56.3% of patients in whom pathological lesions were observed.

Khojastepour et al.⁽¹²⁾ assessed the CBCT images of 281 rhinoplasty patients. 61.7% of people had mucosal thickening.

Therefore, CBCT pictures are quite helpful for diagnosing paranasal sinus mucosal thickness. Consensus for OMC blockage was nearly perfect in our study.

Consistent with previous research, **Agius**⁽¹³⁾ and **Pokharel et al.**⁽¹⁴⁾, found that CBCT and FESS pathology findings agree with one another to a high degree.

Woo et al.⁽¹⁵⁾ evaluated CBCT's potential role in preoperative evaluation of endoscopic sinus surgery. After evaluating the before and after of paranasal sinus surgery, they concluded that CBCT was a helpful tool for preoperative evaluation and diagnosis. Their findings, like ours, supported the strong correlation between the outcomes of the surgery and CBCT.

In patients with chronic rhinosinusitis, we found that CBCT and FESS findings were consistent. For mucosal thickening, a correlation coefficient of 1 was found between CBCT and FESS (maximum). Good and statistically significant ($P < 0.001$) agreement was seen between CBCT and FESS in the detection of nasal deviation and concha bullosa. For nasal polyp and OMC blockage, the correlation between CBCT and FESS was excellent and statistically significant ($P < 0.001$). When comparing CBCT and FESS for infundibulum thickness, there was a strong correlation between the two methods ($P < 0.001$).

These results were nearly agreed with the findings of **Nikkerdar et al.**⁽³⁾, with the exception that they found the least agreement between CBCT and FESS for infundibulum thickness (0.552).

Zojaji et al.⁽⁴⁾ found that 42 patients with chronic rhinosinusitis had their CBCT scans analyzed, and the results showed that CBCT and endoscopy agreed on all parameters except for infundibulum thickening ($\kappa = 0.59$). Consistent with our findings, the kappa coefficients for mucosal thickening, nasal polyp, and OMC blockage were all > 0.8 in the current study.

This study differed mostly from **Zojaji et al.**⁽⁴⁾ in its approach since FESS was not viewed as the gold standard for the diagnosis of rhinosinusitis by those authors. To be utilized as the industry standard, FESS must improve upon its flaws and inaccuracies.

Detecting pathological alterations in the paranasal sinuses using CBCT and FESS was found to have a strong association in the present study's findings. In addition, CBCT has been described as the "gold standard" for sinus examination **Hodez et al.**⁽¹⁶⁾ Patients with chronic rhinosinusitis may benefit from using CBCT as an effective alternative to CT for evaluating their paranasal sinuses prior to surgery.

The sensitivity and NPV of CBCT and FESS were 100%, with excellent accuracy in all findings. High specificity was found except for nasal deviation and infundibulum thickening (67% and 70% respectively). Also, there was high PPV except for nasal deviation (70%). **Nikkerdar et al.** ⁽³⁾ agreed with our finding as regard to high specificity except nasal deviation, and infundibulum thickening (66% and 62%). Unlike our finding of higher sensitivity, they reported higher sensitivity except for concha bullosa (74%).

Zojaji et al. ⁽⁴⁾ found that Most results, with the exception of infundibulum thickness and septal deviation, had sensitivity, specificity, PPV, NPV, and accuracy of CBCT >80%.

Comparisons of CBCT and CT results for the detection of pathological alterations in the paranasal sinuses will require bigger sample sizes in future research.

CONCLUSION

It could be concluded that CBCT and FESS yield similar results when examining the paranasal sinuses. Diagnostic sinus endoscopy for the evaluation of chronic rhinosinusitis syndrome (CRS) is not always appropriate, but CBCT would be a suitable option due to its high accuracy, reduced costs, and lower radiation doses.

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Competing interests: Nil.

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