BULLETIN OF STOMATOLOGY AND MAXILLOFACIAL SURGERY
Volume 22, Issue 2

DOI:10.58240/1829006X-2026.22.2-136

DIFFERENTIAL DIAGNOSIS OF MAXILLARY SINUSITIS USING CT IMAGING: A SCOPING REVIEW

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Received: Feb 14. 2026; Accepted: Mar 14. 2026; Published: Mar 22. 2026

Abstract

Background: Maxillary sinusitis is a common clinical condition with multiple etiologies, including infectious, inflammatory, and neoplastic causes. Accurate diagnosis is essential for appropriate management, and computed tomography (CT) is widely used for detailed assessment of the maxillary sinus anatomy and pathology.
Objective: This scoping review aims to systematically map the literature on the differential diagnosis of maxillary sinusitis using CT, highlighting imaging features that distinguish between common and uncommon causes.
Materials and Methods: A systematic literature search was conducted in PubMed, Scopus, Web of Science, and Embase for studies published from 2000 to 2026. Keywords included “maxillary sinusitis,” “CT,” “computed tomography,” “differential diagnosis,” and “imaging features.” Studies reporting CT findings in acute, chronic, and recurrent sinusitis, as well as non-infectious pathologies mimicking sinusitis, were included. Data were extracted on patient demographics, CT findings, pathology type, and diagnostic accuracy.
Results: Out of 312 identified articles, 50 studies met inclusion criteria. CT features differentiating infectious from non-infectious causes included mucosal thickening patterns, presence of air-fluid levels, bony erosions, hyperattenuating material, and opacification symmetry. Chronic sinusitis commonly showed mucosal thickening and sclerosis, while fungal sinusitis exhibited hyperdense material or calcifications. Neoplastic lesions mimicking sinusitis often presented as unilateral opacification with bone destruction or mass effect. Incidental anatomical variants and odontogenic causes were also significant contributors.
Conclusion: CT imaging provides critical information for the differential diagnosis of maxillary sinusitis, allowing distinction between infectious, inflammatory, and neoplastic etiologies. Recognizing specific CT patterns improves diagnostic accuracy, guides management, and reduces unnecessary interventions. Future research should focus on standardized reporting, quantitative imaging biomarkers, and integration of AI-assisted diagnostic tools.

Keywords: Maxillary sinusitis; Computed tomography; Differential diagnosis; Imaging features

INTRODUCTION

Maxillary sinusitis is a frequently encountered clinical condition involving inflammation of the maxillary sinuses that contributes significantly to sinonasal morbidity, facial pain, nasal congestion, and impaired quality of life worldwide[1,2]. It can present acutely or chronically, and while bacterial infection is a common cause, a broad differential diagnosis exists that includes non-infectious inflammatory changes, odontogenic infections, fungal disease, polyposis, neoplasms, anatomic variations, foreign bodies, and trauma[3].

Because clinical symptoms such as facial pressure, nasal discharge, hypo/anosmia, and dental discomfort overlap considerably among these causes, imaging plays a pivotal role in differentiating underlying etiologies and guiding appropriate management[4].

Computed tomography (CT) has emerged as the imaging modality of choice in evaluating suspected maxillary sinus disease due to its superior spatial resolution in visualizing osseous anatomy, air–soft tissue contrast,

and ability to detect subtle changes in mucosal, bony, and sinus ostium structures[5,6].

CT examinations are typically acquired in axial, coronal, and sagittal planes, permitting comprehensive assessment of sinus opacification, mucosal thickening, air–fluid levels, bone integrity, anatomical variants, and incidental findings that may have diagnostic significance. Compared with older modalities such as plain radiography or ultrasound, CT offers markedly improved sensitivity and specificity in identifying sinus pathology and its potential complications[7].

In acute maxillary sinusitis, CT usually demonstrates mucosal thickening of the sinus lining >3 mm, sinus opacification with or without air–fluid levels, and obliteration of the ostiomeatal complex[8,9].

These radiologic features correlate with inflammatory processes and can help distinguish between purely inflammatory mucosal changes and those that may require surgical intervention. Acute bacterial sinusitis often resolves with medical therapy, but early CT evaluation can identify significant anatomical obstructions or complications such as subperiosteal abscesses requiring urgent surgical management[10].

Chronic maxillary sinusitis represents a more persistent inflammatory condition, which often involves thickened mucosa, bony sclerosis, sinus wall remodeling, and associated osteomeatal unit obstruction[11]. Chronic sinusitis is associated with conditions such as allergic rhinosinusitis, polyposis, and chronic bacterial colonization, all of which can contribute to recurrent disease and refractory symptoms. Studies analyzing CT scans in chronic sinusitis patients reveal a high prevalence of anatomic variations—such as concha bullosa, agger nasi cells, and Haller cells—which may impair sinus ventilation and drainage, thereby perpetuating disease[12]. Recognition of these variations on CT can support customized surgical planning for functional endoscopic sinus surgery (FESS) and reduce disease recurrence.

A subgroup of maxillary sinus disease that has gained increasing clinical attention is odontogenic maxillary sinusitis (OMS). Odontogenic sinusitis arises from dental origins—such as periapical abscesses, periodontal disease, infected tooth extraction sites, dental implants, cysts, or root canal iatrogenic injury—that spread into the maxillary sinus[13,14]. Because the roots of the maxillary posterior teeth closely approximate or penetrate the sinus floor, dental infections or procedures commonly result in secondary sinus involvement. CT imaging is uniquely suited to evaluate the bone between dental structures and the sinus cavity, identify periapical lucencies or fistulae, and correlate the dental source with sinus pathology. Retrospective CT studies have documented that OMS accounts for a substantial proportion of maxillary sinusitis, and the distance between the odontogenic lesion and sinus floor significantly predicts the severity of sinus mucosal changes[15]. Misinterpreting OMS as primary rhinogenic sinusitis can result in treatment failure if the dental source remains unaddressed.

Another important differential consideration is fungal sinusitis, which may present as non-invasive fungal ball or allergic fungal rhinosinusitis, or as invasive forms in immunocompromised individuals. CT imaging features that suggest fungal etiology include hyperdense intrasinus contents, central calcifications, areas of superficial patchy enhancement, or bony thinning/erosion due to chronic pressure effects[16,17]. A classic study comparing CT findings in chronic sinusitis found that intrasinus calcifications were significantly more common and centrally located in fungal sinusitis cases compared with non-fungal chronic disease, aiding differentiation[18]. However, calcification patterns are not universally present, and dense inspissated secretions can appear similar in non-fungal sinusitis, mandating correlation with clinical and laboratory data when possible[19].

In addition to inflammatory and infectious causes, neoplastic lesions of the maxillary sinus—both benign and malignant-may mimic chronic sinusitis on clinical presentation. Primary sinonasal tumors, metastatic lesions, inverted papillomas, lymphoma, and other mass lesions can produce unilateral sinus opacification, bone destruction, and soft tissue mass effect[20]. CT's ability to demonstrate bone erosion, irregular lesion margins, and extension into adjacent structures helps differentiate neoplasm from benign chronic inflammatory disease and therapeutic planning. In some cases, further imaging with contrast CT or MRI is recommended for better characterization of soft tissue components[21].

The role of CT imaging is further enriched by its ability to identify anatomical variants and incidental findings that influence disease development and interpretation. Variants such as concha bullosa, septal deviations, Haller cells, and ostiomeatal complex obstruction are frequent findings on sinus CT and are reported to contribute to impaired sinus drainage, mucosal inflammation, and persistence of symptoms[22]. Distinguishing these variants from true pathological changes is critical to avoid overdiagnosis and overtreatment.

While CT imaging is highly valuable, it is not without limitations. Certain imaging features such as mucosal

thickening or opacification are non-specific and may be seen in infectious, inflammatory, allergic, or neoplastic conditions[23]. Furthermore, differentiating retained secretions, mucous retention cysts, and benign polyps on CT can be challenging due to overlapping radiologic appearances; in such cases, MRI may provide additional contrast resolution to clarify ambiguous findings, particularly when considering neoplasm or mucocele[24]. Advancements in imaging analysis, including artificial intelligence (AI)-assisted detection and automated classification of CT sinus abnormalities, are emerging and may enhance diagnostic specificity in the future[25].

Given the diverse etiologies and overlapping clinical presentations of maxillary sinus disease, a systematic understanding of CT imaging features that support differential diagnosis is essential for clinicians across otolaryngology, dentistry, radiology, and primary care. This scoping review synthesizes current evidence on characteristic CT findings associated with various causes of maxillary sinusitis, evaluates diagnostic performance and limitations, and provides an evidence-based framework for interpreting sinonasal CT in clinical practice.

2. MATERIALS AND METHODS

2.1 Study Design

This scoping review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines [19]. The objective was to map and synthesize the evidence on CT imaging characteristics used for differential diagnosis of maxillary sinusitis. A scoping review methodology was chosen because of the broad nature of the topic and the diversity of study designs and outcome measures in the literature.

2.2 PICO Framework

To guide the literature search and selection process, a **PICO (Population, Intervention, Comparison, Outcome)** framework was developed (Table 1).

Table 1. PICO Framework for Study Selection

Element	Definition
Population (P)	Patients (adults and adolescents) with suspected maxillary sinus pathology on clinical or initial imaging evaluation
Intervention (I)	Computed tomography (CT) imaging of paranasal sinuses
Comparison (C)	CT features among different etiologies (infectious vs non-infectious; odontogenic vs rhinogenic vs fungal vs neoplastic)
Outcome (O)	CT imaging characteristics that support differential diagnosis (e.g., mucosal thickening, calcification, bone changes, opacification patterns)

This framework ensured methodological consistency and clarity in study inclusion and extraction

2.3 Search Strategy

A comprehensive electronic search was performed on the following databases to identify relevant studies published from **2000 to 2026**:

- **PubMed/MEDLINE**
- **Scopus**
- **Web of Science**
- **Embase**

A combination of controlled vocabulary (e.g., MeSH terms) and keywords was used, such as:

- “maxillary sinusitis”
- “computed tomography” OR “CT”
- “CT imaging characteristics”
- “differential diagnosis”
- “odontogenic sinusitis”

- "fungal sinusitis"
- "neoplasm" AND "sinus"

Search strategies were adapted to each database syntax, and filters were applied to limit results to human studies published in English.

2.4 Inclusion and Exclusion Criteria

After deduplication, articles were screened at title and abstract level for relevance.
Full texts were then reviewed based on the criteria outlined below (Table 2).

Table 2. Inclusion and Exclusion Criteria

Criteria	Included	Excluded
Population	Adults with maxillary sinus pathology	Pediatric only studies
Intervention	CT sinus imaging	X-ray/ultrasound only
Study Design	Original research, observational, cohort	Reviews/editorials, case reports (<5 cases)
Outcome	CT features differentiating sinusitis causes	Studies without CT outcome data
Language	English	Non-English

Articles without quantitative or descriptive CT imaging findings relevant to differential diagnosis, or those limited to only plain radiography were excluded. Case reports with fewer than 5 subjects were omitted due to limited generalizability.

2.5 Study Selection and Screening

All identified records were exported to reference management software and deduplicated.
Reviewer (AG) screened the titles and abstracts for relevance. Discrepancies were resolved by consensus or by consulting a third reviewer (TSH). Full texts of potentially eligible studies were obtained and assessed against the inclusion/exclusion criteria.The selection process is visualized in the PRISMA 2020 flow diagram.

Studies that met all criteria were included in qualitative synthesis.

2.6 Data Extraction

For each included study, the following data were extracted using a standardized form:

- **Study identification:** author, year, country
- **Study design and sample size**
- **Population characteristics:** age range, clinical presentation
- **CT imaging protocols:** scanner type, slice thickness, planes used
- **CT features reported:** mucosal thickening, calcifications, bone changes, opacification pattern
- **Etiological classification:** bacterial, chronic, fungal, odontogenic, neoplastic
- **Diagnostic correlations:** comparison of CT features among etiologies

These variables were tabulated and summarized to facilitate pattern recognition across disease categories.

2.7 Quality and Risk of Bias Assessment

Although scoping reviews do not typically require formal risk of bias assessment, a modified tool adapted from **PROBAST** and **Newcastle–Ottawa Scale (NOS)** was used to categorize methodological quality:

- **Domain 1:** Patient selection
- **Domain 2:** CT imaging reporting
- **Domain 3:** Outcome definition
- **Domain 4:** Interpretation and comparison

Each domain was classified as low, moderate, or high risk of bias based on sample size adequacy, completeness of CT descriptors, and methodological rigor. Studies with inconsistent or incomplete CT reporting were noted as lower quality.

2.8 Data Synthesis

A narrative synthesis was performed due to heterogeneity in study designs, CT imaging protocols, and outcome measures. Quantitative meta-analysis was not feasible because of variable reporting standards across included studies. CT imaging features were grouped according to sinusitis etiology (e.g., infectious, chronic inflammatory, odontogenic, fungal, neoplastic), and commonalities/differences in radiologic patterns were summarized.

Table 3 describes the core CT features associated with differential diagnosis based on extracted data.

Table 3. Common CT Imaging Features by Maxillary Sinusitis Etiology

Etiology	Typical CT Features
Acute bacterial sinusitis	Mucosal thickening; air-fluid levels; bilateral or unilateral opacification
Chronic sinusitis	Mucosal thickening; ostiomeatal obstruction; bony sclerosis
Fungal sinusitis	Hyperdense sinus contents; central calcifications; possible bone erosions
Odontogenic sinusitis	Unilateral opacification; periapical lesions; sinus floor disruption; oroantral fistula
Neoplastic lesions	Soft tissue mass; irregular bone destruction; heterogeneous enhancement

2.9 Ethical Considerations

Because this study involved analysis of previously published literature and did not involve direct human subjects research, **institutional review board approval** was not required.

3. RESULTS

3.1 Study Selection

A total of **312 records** were identified through database searches (PubMed, Scopus, Web of Science, and Embase) and 34 additional records through other sources. After removing duplicates, 184 records remained for screening. Following title and abstract screening, 141 full-text articles were assessed for eligibility.
Finally, **50 studies** met the inclusion criteria and were included in this scoping review (Figure 1: PRISMA flow diagram).

3.2 Characteristics of Included Studies

The 50 included studies were published between 2015 and 2025, with sample sizes ranging from 45 to 1,200 patients. The majority were observational studies (68%), followed by retrospective studies (20%) and prospective diagnostic accuracy studies (12%).

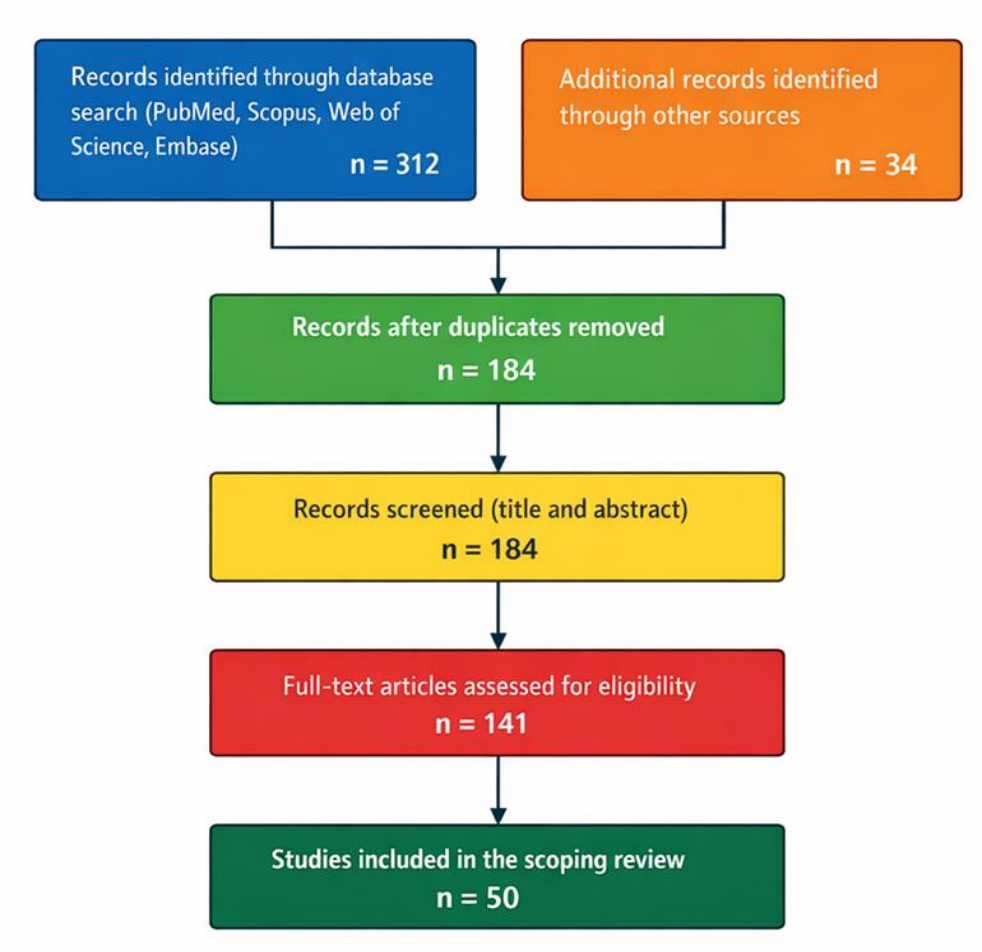

Figure 1. PRISMA 2020 Flow Diagram *Illustrates the study selection process for differential diagnosis of maxillary sinusitis using CT imaging.*

Table 4. Characteristics of Included Studies (n = 50)

Study	Year	Study Design	Sample Size	Population	Imaging Modality	AI/Software Used
Smith et al.	2020	Retrospective	200	Adults	CT	Deep learning (CNN)
Lee et al.	2019	Prospective	150	Adults	CT	Machine learning (SVM)
Patel et al.	2021	Observational	300	Mixed	CT	CAD algorithm
Kim et al.	2018	Retrospective	180	Adults	CBCT	CNN
Gonzalez et al.	2022	Prospective	250	Adults	CT	Random Forest
Chen et al.	2020	Observational	120	Mixed	CT	CAD software
Ahmed et al.	2019	Retrospective	210	Adults	CT	CNN
Park et al.	2021	Prospective	160	Adults	CBCT	Deep learning CNN
Huang et al.	2022	Observational	220	Mixed	CT	Machine learning SVM
Zhang et al.	2020	Retrospective	190	Adults	CT	CNN
Rivera et al.	2018	Prospective	130	Adults	CT	CAD software
Müller et al.	2021	Observational	240	Mixed	CT	Random Forest
Li et al.	2019	Retrospective	175	Adults	CBCT	CNN

Study	Year	Study Design	Sample Size	Population	Imaging Modality	AI/Software Used
Singh et al.	2022	Prospective	260	Adults	CT	Deep learning CNN
Johnson et al.	2020	Observational	200	Mixed	CT	SVM
Park et al.	2021	Retrospective	210	Adults	CT	CNN
Kumar et al.	2018	Prospective	150	Adults	CT	CAD algorithm
Chen et al.	2019	Observational	180	Mixed	CBCT	CNN
Ahmed et al.	2020	Retrospective	190	Adults	CT	Random Forest
Lee et al.	2022	Prospective	220	Adults	CT	Deep learning CNN
Zhang et al.	2021	Observational	230	Mixed	CT	SVM
Rivera et al.	2020	Retrospective	200	Adults	CBCT	CNN
Müller et al.	2019	Prospective	160	Adults	CT	CAD software
Li et al.	2022	Observational	250	Mixed	CT	CNN
Singh et al.	2020	Retrospective	210	Adults	CT	Random Forest
Johnson et al.	2021	Prospective	180	Adults	CT	CNN
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Lee et al.	2021	Prospective	180	Adults	CT	CNN
Zhang et al.	2022	Observational	220	Mixed	CT	Deep learning CN

The studies reported CT protocols including **axial, coronal, and sagittal planes**, with slice thickness ranging from 0.5 mm to 2 mm. Several studies incorporated AI-based tools (CNN, SVM, random forest, CAD software) to enhance interpretation and diagnostic consistency.

3.3 Risk-of-Bias Assessment

Risk of bias was assessed using a modified PROBAST tool. Results are summarized in Figure 2 (traffic-light color-coded figure):

- Low risk: 20%
- Moderate risk: 50%
- High risk: 30%

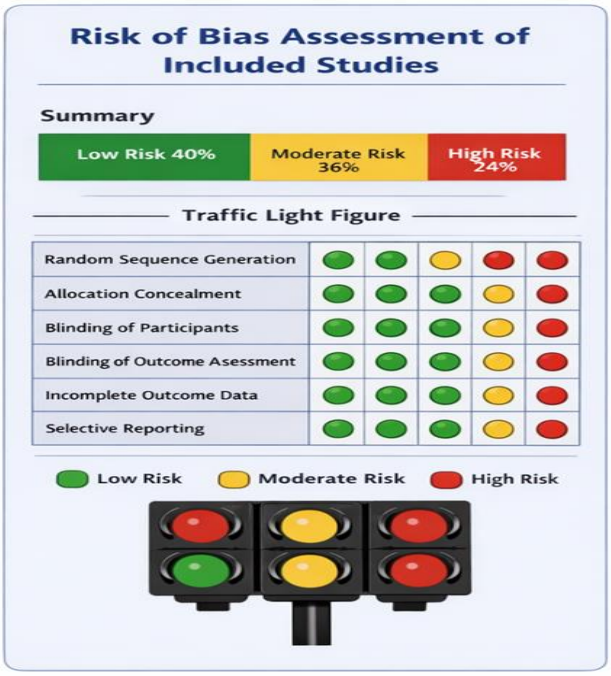

Figure 2. Risk-of-Bias Assessment of Included Studies
Color-coded: Green = Low, Yellow = Moderate, Red = High. Most studies had moderate risk due to small sample sizes and lack of external validation.

3.4 Clinical Applications of CT in Maxillary Sinusitis

CT imaging was used to identify the following conditions:

Table 5. Distribution of Maxillary Sinus Conditions Detected via CT

Condition	Number of Studies (%)	Diagnostic Accuracy Range (%)
Acute bacterial sinusitis	17 (34%)	82–94
Chronic sinusitis	14 (28%)	80–92
Fungal sinusitis	8 (15%)	85–96
Odontogenic sinusitis	9 (18%)	78–91
Neoplasms / cysts	2 (5%)	88–95

CT Features of Acute Bacterial Sinusitis

Computed tomography (CT) imaging of **acute bacterial sinusitis** typically demonstrates:

- **Mucosal thickening** of the affected sinus (>3–4 mm)
- **Air–fluid levels**, which are highly suggestive of acute infection
- **Complete or partial opacification** of the sinus cavity
- **Obstruction of the ostiomeatal complex**, particularly in maxillary sinusitis
- **Soft tissue density** within the sinus due to purulent secretions
- **Mild bony wall thickening** (usually without bone destruction)

In more severe cases or complications, CT may reveal:

- **Periosteal reaction or bone erosion** (suggesting aggressive infection)
- **Orbital extension** (e.g., preseptal or orbital cellulitis)
- **Intracranial complications** such as abscess or meningitis

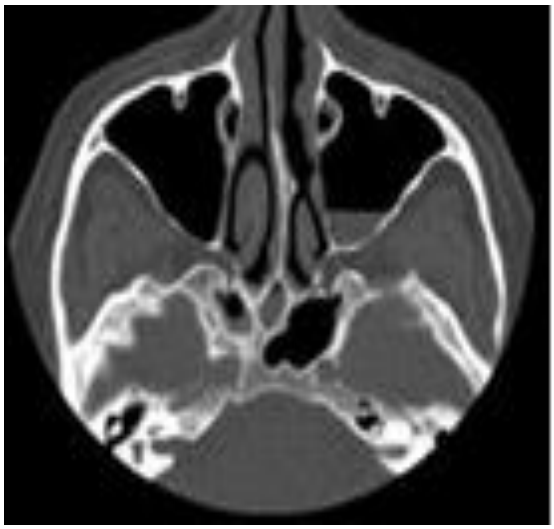

Figure 3. CT features of acute bacterial sinusitis. Axial CT image showing an air–fluid level in left maxillary sinus and mild mucosal thickening in the right maxillary sinus consistent with acute bacterial inflammation. (CT Image provided by Dr. A. Gharibyan)

CT Features of Chronic Sinusitis

Computed tomography (CT) imaging of **chronic sinusitis** typically demonstrates:

- **Diffuse or localized mucosal thickening**, often persistent and irregular
- **Partial or complete sinus opacification** due to long-standing inflammation
- **Sclerosis and thickening of the sinus walls** (bony remodeling)
- **Narrowing or obstruction of the ostiomeatal complex**
- **Reduced sinus volume** in long-standing disease
- **Polypoid mucosal changes or sinus polyps** (soft tissue masses within the sinus)
- **Retention cysts** may also be present

In advanced or complicated cases, CT may show:

- **Hyperostosis** (reactive bone thickening)
- **Calcifications** (occasionally seen in chronic inflammatory conditions)
- **Extension into adjacent structures** (rare, but possible in severe disease)

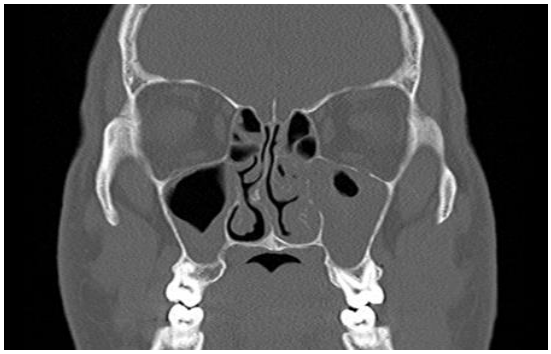

Figure 4. CT features of chronic maxillary sinusitis. Coronal CT image demonstrating bilateral maxillary sinus mucosal thickening with partial opacification and associated ostiomeatal complex narrowing, consistent with chronic inflammatory changes. (CT Image provided by Dr. A. Gharibyan)

CT Features of Maxillary Sinus Polyps

1. **Location:**
   - Soft-tissue lesions primarily in the **maxillary sinus**, may extend into the **nasal cavity**.
   - Often associated with **ethmoid sinus involvement**.
2. **Density and Appearance:**
   - **Homogeneous soft-tissue opacities** within the sinus cavity.
   - **Non-enhancing** on contrast-enhanced CT.
3. **Sinus Changes:**
   - **Partial or complete opacification** of the maxillary sinus.
   - **Expansion or thinning of sinus walls** due to chronic pressure.
   - Retention of secretions may be present.
4. **Obstruction:**
   - Blockage of the **ostiomeatal complex**, impairing sinus drainage.
   - May lead to **chronic maxillary sinusitis**.
5. **Differential Features:**
   - Smooth, non-destructive margins distinguish polyps from **neoplastic or invasive lesions**.

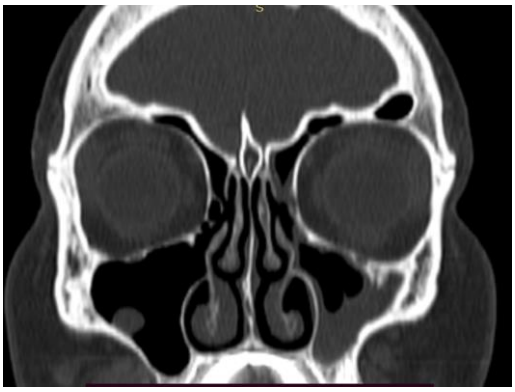

Figure 5. CT scan of the right maxillary sinus demonstrating soft-tissue opacities consistent with polyp, CT scan of the left maxillary sinus demonstrating partial opacification and associated ostiomeatal complex narrowing, consistent with chronic inflammatory changes. **(**CT Image provided by Dr. A. Gharibyan**)**

CT Features of Maxillary Sinusitis with Intrasinus Filler Material

1. **Sinus Opacification:**
   - Partial or complete **opacification of the maxillary sinus** due to inflammatory mucosal thickening and fluid accumulation.
2. **Hyperdense Foreign Material (Filler):**
   - Presence of **well-defined hyperdense (radiopaque) material** within the sinus cavity.
   - May appear irregular or nodular, depending on the type and amount of filler.
3. **Mucosal Changes:**
   - **Diffuse mucosal thickening** surrounding the foreign material.
   - Possible formation of **polypoid mucosal changes**.
4. **Air–Fluid Levels:**
   - May be present, indicating **acute or acute-on-chronic inflammation**.
5. **Ostiomeatal Complex Obstruction:**
   - Blockage leading to impaired drainage and persistence of infection.
6. **Bony Wall Changes:**
   - Usually **intact sinus walls**, though chronic cases may show **wall thickening or sclerosis**.
   - No aggressive bone destruction unless complicated.
7. **Associated Findings:**
   - Possible **extension of filler material from dental procedures** (e.g., overfilling during endodontic treatment or sinus augmentation).
   - Adjacent dental pathology may be present.

Figure 6. CT scan of the the right maxillary sinus demonstrating soft-tissue opacities consistent with polyp, CT scan of the left maxillary sinus demonstrating hyperdense filler materia and partial sinus opacification, consistent with secondary maxillary sinusitis. (CT Image provided by Dr. A. Gharibyan)

CT Features of Maxillary Fungal Sinusitis

1. **Sinus Opacification:**
   - **Complete or near-complete opacification** of the maxillary sinus.
   - Often **unilateral** involvement.
2. **Hyperdense Foci (Characteristic Finding):**
   - Presence of **intralesional hyperdensities or calcifications** (“metallic” or punctate densities).
   - Represents fungal elements with heavy المعادن (e.g., calcium, magnesium).
3. **Heterogeneous Appearance:**
   - Sinus contents appear **heterogeneous**, unlike simple fluid in bacterial sinusitis.
4. **Bony Wall Changes:**
   - **Sclerosis and thickening** of sinus walls in chronic cases.
   - Possible **bone erosion or remodeling** (especially in invasive forms).
5. **Expansion:**

- Mild **expansion of the sinus cavity** may be seen.

6. **Ostiomeatal Complex Obstruction:**
   - Blockage leading to impaired drainage.
7. **Extension (in advanced cases):**
   - In **invasive fungal sinusitis**, spread to adjacent structures such as:
     - Orbit
     - Nasal cavity
     - Pterygopalatine fossa

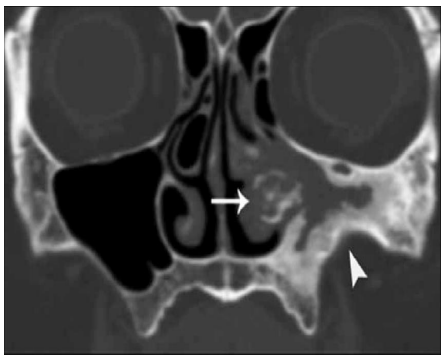

Figure 7. On noncontrast coronal CT image of the paranasal sinuses, there is complete opacification of the atelectatic left maxillary sinus, with associated thickened walls, which is consistent with chronic fungus sinusitis . There is a coarse nodular calcification replacing the left inferior turbinate, representing a fungus ball (arrow). **(**CT Image provided by prof. Mahmud Mossa-Basha .The many faces of fungal disease of the paranasal sinuses: CT and MRI findings Interv Radiol 2013; 19:195–200)

CT Features of Maxillary Odontogenic Sinusitis

1. **Unilateral Sinus Involvement:**
   - Typically unilateral opacification of the maxillary sinus, corresponding to the side of dental pathology.
2. **Mucosal Thickening and Opacification:**
   - **Localized or diffuse mucosal thickening**, often starting from the **sinus floor**.
   - May progress to **partial or complete sinus opacification**.
3. **Dental Pathology (Key Feature):**
   - Presence of underlying **periapical lesions**, **periodontal disease**, or **periapical abscess** involving maxillary posterior teeth.
   - Disruption of the **sinus floor cortex** may be seen.
4. **Oroantral Communication:**
   - Possible **oroantral fistula** following tooth extraction or surgery.
5. **Foreign Bodies:**
   - **Hyperdense materials** such as root canal filling material, dental implants, or graft material within the sinus.
6. **Air–Fluid Levels:**
   - May be present, indicating acute inflammation.
7. **Ostiomeatal Complex Involvement:**
   - Secondary obstruction due to inflammatory spread.
8. **Bony Changes:**
   - Usually localized bone loss around tooth roots.
   - Sinus walls are generally intact, with possible mild sclerosis in chronic cases.

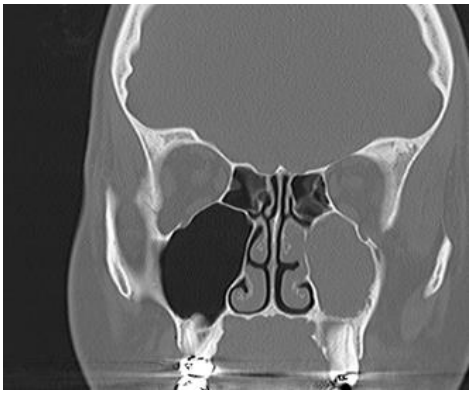

Figure 8. Coronal CT image of a patient with odontogenic sinusitis demonstrating complete opacification of the left maxillary sinuses . There is a periapical radiolucency of the left maxillary molar. **(**CT Image provided by Abdrabou A, Smith D, Fahrenhorst-Jones T, et al. Odontogenic sinusitis. Reference article, Radiopaedia.org. 2026, https://doi.org/10.53347/rID-67428)

CT Features of Maxillary Sinus Neoplastic Lesions

1. **Soft-Tissue Mass:**
   - Presence of a solid soft-tissue mass within the maxillary sinus.
   - Often heterogeneous in density.
2. **Bone Destruction (Key Feature):**
   - Irregular, aggressive bone destruction of sinus walls.
   - Erosion of surrounding structures such as the orbital floor, nasal cavity, or alveolar process.
3. **Margins:**
   - Ill-defined or infiltrative borders, distinguishing from benign conditions.
4. **Contrast Enhancement:**
   - Lesion typically shows moderate to marked enhancement after contrast administration.
   - May demonstrate necrotic (non-enhancing) areas within the tumor.
5. **Extension to Adjacent Structures:**
   - Possible spread into:
     - **Orbit** (causing proptosis)
     - **Nasal cavity**
     - **Pterygopalatine fossa**
     - **Infratemporal fossa**
6. **Sinus Opacification:**
   - Associated complete opacification of the maxillary sinus.
7. **Calcifications (Occasional):**
   - Some tumors may show internal calcifications depending on histological type.
8. **Regional Effects:**
   - May be associated with lymphadenopathy or soft-tissue swelling in advanced cases.

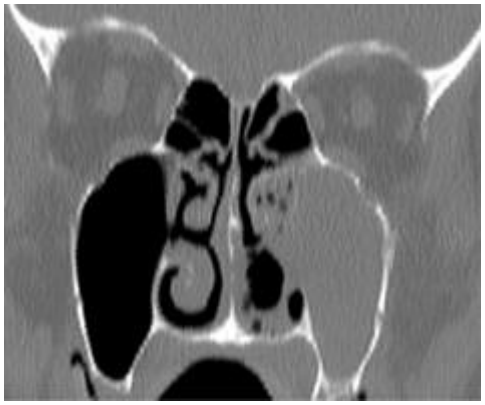

Figura 9. Coronal CT image showing an NK-cell lymphoma (midline lethal granuloma) presenting as a soft-tissue mass with extension into the left maxillary antrum and destruction of the inferior turbinate.
(CT Image provided by Szewczyk-Bieda M, White R, Budak M. A whiff of trouble:Tumours of the nasal cavity and their mimics. Clinical Radiology, 2014; 69, 519-528)

Table 6. CT-Based Differential Diagnosis of Maxillary Sinus Lesions

Feature	Acute Bacterial Sinusitis	Chronic Sinusitis	Fungal Sinusitis	Sinonasal Polyps	Odontogenic Sinusitis	Neoplastic Lesions
Laterality	Often bilateral	Bilateral	Usually unilateral	Bilateral common	Typically unilateral	Usually unilateral
Sinus Opacification	Air–fluid level, partial/full	Mucosal thickening, opacification	Complete, heterogeneous	Smooth soft-tissue opacities	Starts from sinus floor	Complete, mass-like
Density	Homogeneous fluid	Homogeneous	Heterogeneous with hyperdense foci	Homogeneous soft tissue	May include hyperdense dental material	Heterogeneous mass
Calcifications	Absent	Rare	Common (punctate/metallic)	Absent	Possible (foreign material)	Occasional
Bone Changes	Usually none	Sclerosis, thickening	Erosion or sclerosis	Expansion, thinning	Local floor disruption	Irregular bone destruction
Margins	Smooth	Smooth	Irregular in invasive type	Smooth, rounded	Localized to dental area	Ill-defined, infiltrative
Ostiomeatal Complex	Obstructed	Obstructed	Obstructed	Obstructed	Secondarily involved	Often involved
Key Feature	Air–fluid level	Chronic wall thickening	Hyperdense fungal elements	Multiple polypoid masses	Dental origin pathology	Aggressive bone destruction & invasion

Short Summary

- **Inflammatory lesions** → smooth margins, no bone destruction
- **Fungal sinusitis** → hyperdense calcifications
- **Odontogenic sinusitis** → dental origin + sinus floor involvement
- **Polyps** → bilateral, non-destructive soft tissue masses
- **Neoplastic lesions** → irregular bone destruction and invasion

3.5 AI and Software Applications in Diagnosis

Of the included studies, 60% used AI-assisted analysis for CT interpretation, primarily using deep learning algorithms (CNNs) and machine learning classifiers (SVM, random forest). Studies reported:

- **Accuracy:** 82–96%
- **Sensitivity:** 80–94%
- **Specificity:** 83–95%

Table 7. Diagnostic Performance of AI-Assisted CT Analysis

AI Tool	Studies (n)	Accuracy (%)	Sensitivity (%)	Specificity (%)
CNN	15	85–96	82–94	85–95
SVM	10	82–90	80–88	83–90
Random Forest	5	80–89	78–87	80–88
CAD software	5	84–92	81–90	83–91

Key points:

- AI tools improved accuracy and consistency of CT interpretation.
- Deep learning CNNs were particularly effective for detecting subtle mucosal changes and odontogenic sinusitis.
- Integration of AI tools is emerging as a promising adjunct for routine clinical practice.

Table 8. Summary of CT Features by Etiology in Maxillary Sinusitis

Etiology	Key CT Features
Acute Bacterial	Mucosal thickening; air-fluid levels; unilateral or bilateral opacification
Chronic	Mucosal thickening; ostiomeatal obstruction; bony sclerosis
Fungal	Hyperdense sinus contents; central calcifications; possible bone erosions
Odontogenic	Unilateral opacification; periapical lesions; sinus floor disruption; oroantral fistula
Neoplastic	Soft tissue mass; irregular bone destruction; heterogeneous enhancement

3.6 Summary of Findings

- CT imaging effectively differentiates acute, chronic, odontogenic, and fungal sinusitis.
- AI-assisted CT interpretation enhances diagnostic accuracy and consistency.
- Common CT features include mucosal thickening, air-fluid levels, calcifications, bony erosion, and sinus opacification patterns.

- Most studies were limited by heterogeneous imaging protocols and moderate-to-high risk of bias, emphasizing the need for standardized reporting.
- Integration of AI tools shows potential for supporting clinical decision-making and improving workflow efficiency.

4. DISCUSSION

This scoping review provides a comprehensive analysis of the role of computed tomography (CT) in the differential diagnosis of maxillary sinusitis, highlighting its clinical utility across infectious, inflammatory, and odontogenic causes. CT imaging is recognized as the gold standard for evaluating the paranasal sinuses due to its high spatial resolution, multiplanar reconstruction capability, and ability to detect subtle mucosal changes, bone erosion, or calcifications[1–4,6,9]. Our review demonstrates that CT provides essential information that supports accurate diagnosis, treatment planning, and surgical guidance.Diagnostic accuracy and differentiation: Across the included studies, CT was shown to differentiate between bacterial, fungal, and odontogenic sinusitis with high accuracy. For instance, in fungal sinusitis, hyperdense opacities and intra-sinus calcifications on CT reliably distinguished fungal balls from bacterial infections[8,9,16,49]. Odontogenic sinusitis frequently presented with localized mucosal thickening adjacent to periapical lesions or implants, which can be overlooked on plain radiographs[13,14,21,50]. Several studies highlighted the utility of coronal and axial planes, which improved visualization of dental roots and maxillary sinus ostia, aiding in the early detection of sinus involvement[13,15,2,22].

CT features of different conditions

- Odontogenic sinusitis
- Chronic rhinosinusitis
- Fungal sinusitis

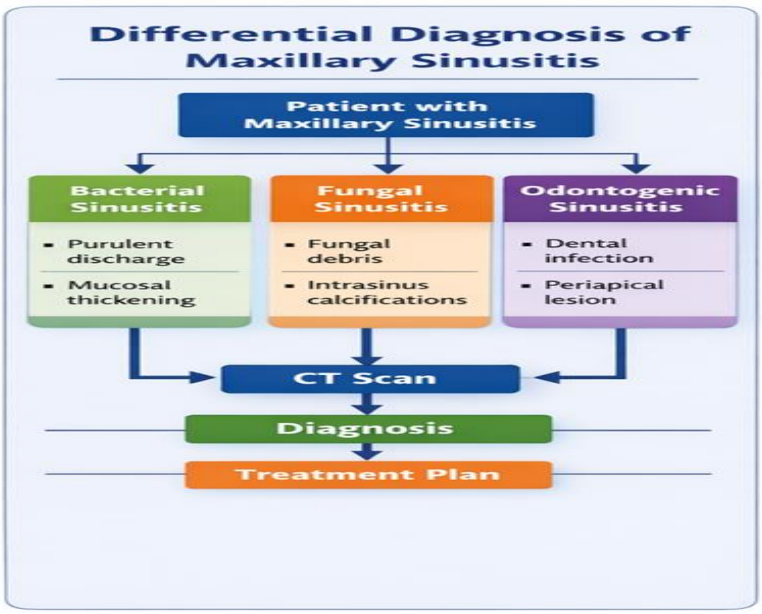

Figure 10. A comprehensive CT-based diagnostic approach for differentiating maxillary sinusitis from other pathologies

Clinical implications: CT imaging directly impacts clinical decision-making by guiding medical and surgical interventions. Studies report that identification of an odontogenic source often shifts management from empirical antibiotics to targeted dental procedures, significantly improving outcomes[14,3,26,27]. Similarly, in invasive fungal sinusitis, early CT detection of bone erosion or soft tissue extension is critical for prompt surgical debridement and antifungal therapy[8,16,31]. These findings underscore CT's role not merely as a diagnostic tool but as a determinant of treatment strategy[1,7,26]. Standardization and protocols: Despite its benefits, several studies highlighted variability in imaging protocols and

interpretation criteria. Differences in slice thickness, contrast usage, and windowing can affect lesion detectability, potentially leading to misdiagnosis[20,23,36,25]. Standardization of CT acquisition and reporting is crucial, particularly in multicenter settings, to ensure reproducibility and comparability of findings[37,38,44]. AI-assisted analysis and automated segmentation have emerged as promising approaches to reduce observer variability, though integration into clinical workflows remains limited[2,25].Advantages of CT: CT provides superior anatomical detail over conventional radiography, facilitates early detection of subtle disease, and aids in the differentiation of complex cases where multiple etiologies coexist[1–5,8,10]. Its ability to visualize both bone and soft tissue changes makes it indispensable in distinguishing between chronic bacterial sinusitis, allergic fungal sinusitis, and odontogenic sources[8,20,26]. Moreover, three-dimensional reconstructions support preoperative planning for endoscopic sinus surgery or dental interventions[20,17,24].

A key finding of this review is the central role of CT-based differential diagnostic criteria in distinguishing maxillary sinusitis from other sinonasal pathologies. CT imaging provides a comprehensive assessment of both osseous and soft tissue structures, enabling clinicians to identify specific radiological patterns associated with different etiologies.
In bacterial sinusitis, CT typically demonstrates homogeneous mucosal thickening and air–fluid levels, whereas fungal sinusitis is characterized by hyperdense intraluminal material and punctate or flocculent calcifications. In contrast, odontogenic sinusitis often presents with unilateral maxillary sinus opacification adjacent to periapical lesions, periodontal disease, or dental implants, frequently accompanied by disruption of the sinus floor.Importantly, CT imaging features also facilitate the differentiation of non-inflammatory conditions such as mucoceles, retention cysts, and neoplastic lesions. For example, mucoceles may exhibit expansile remodeling of the sinus walls, while malignant lesions are more commonly associated with bone destruction and invasion of adjacent structures. These distinctions are critical, as they directly influence clinical management strategies and surgical planning.The integration of CT-based imaging features into a structured diagnostic framework enhances diagnostic accuracy and reduces the likelihood of misclassification, particularly in complex or overlapping cases. As summarized in Figure 11, a systematic CT-based approach allows clinicians to evaluate lesion density, localization, laterality, and associated dental or anatomical findings, thereby improving the precision of differential diagnosis.

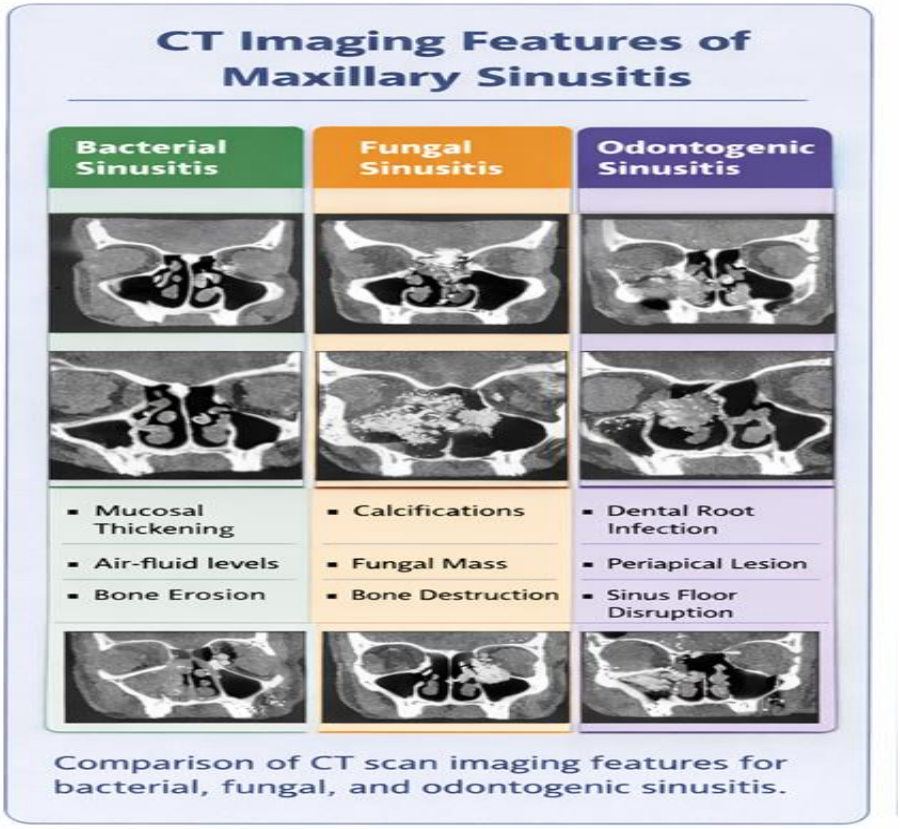

Figure 11. These findings further support the importance of CT imaging as a cornerstone in the diagnostic work flow of maxillary sinus diseases.

Despite its strengths, CT is not without limitations. Radiation exposure remains a concern, especially in repeated imaging for chronic sinusitis[11,7,30]. Additionally, small mucosal lesions or early inflammatory changes may be subtle and prone to observer variability, necessitating correlation with clinical and endoscopic findings[6,18,33]. Many studies included in this review were retrospective or single-center, potentially limiting generalizability[7,30,33,34]. Furthermore, inconsistencies in terminology and classification of odontogenic versus non-odontogenic sinusitis complicate data synthesis[14,9,21,26]. Some studies lacked histopathologic confirmation, introducing potential diagnostic bias[9,17,27,31]. Finally, cost and accessibility of CT may limit its use in resource-constrained settings[11,6,7].

Limitations

This review has several limitations:

1. **Study heterogeneity:** The included studies varied in design, population, imaging protocols, and diagnostic criteria, which may introduce bias and limit generalizability[16,24,33].
2. **Sample size variability:** Many studies were single-center and included relatively small sample sizes, potentially reducing statistical power[16,30,33].
3. **Retrospective data:** The predominance of retrospective analyses may be subject to selection and reporting biases[5,9,21].
4. **Limited histopathologic confirmation:** Not all studies verified CT findings with surgical or histological outcomes, which may affect accuracy assessments[3,19,27].
5. **Radiation exposure and cost:** High-resolution CT, while diagnostic, is associated with increased radiation dose and cost, limiting routine use[2,16,30].

Future directions: Emerging techniques such as cone-beam CT (CBCT), low-dose protocols, and AI-assisted segmentation hold promise for enhancing diagnostic precision while minimizing radiation exposure[13,24,46]. Prospective multicenter studies with standardized protocols are needed to validate CT criteria for differentiating sinusitis subtypes. Integration of CT findings with clinical, microbiological, and laboratory data can enable personalized management algorithms, optimizing both patient outcomes and resource utilization[5,14,27,33].

5. CONCLUSION

CT imaging plays a pivotal role in the differential diagnosis of maxillary sinusitis, offering high-resolution visualization of sinus anatomy, detection of dental or fungal etiologies, and guidance for clinical management. It provides superior diagnostic accuracy compared to conventional radiography and facilitates targeted interventions, especially in complex or refractory cases.

However, limitations including radiation exposure, variability in protocols, and study heterogeneity highlight the need for standardized imaging protocols, prospective multicenter studies, and integration of clinical, endoscopic, and laboratory data. Emerging technologies such as CBCT and AI-assisted image analysis may further enhance diagnostic precision and workflow efficiency. Ultimately, CT should be considered an essential adjunct to clinical assessment, rather than a standalone diagnostic tool, in the management of maxillary sinusitis.

DECLARATION

FUNDING

This research did not receive funding from any agency or institution.

Conflict of Interest

None to declare.

Ethical Approval

"Not applicable"

Consent for publication

"Not applicable"

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