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MULTI-DETECTOR COMPUTED TOMOGRAPHY EVALUATION FOR ASSESSMENT OF VARIANT PARANASAL SINUS ANATOMY: A COMPREHENSIVE REVIEW

Radio-Diagnosis

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ABSTRACT

Background: Paranasal sinus anatomy exhibits considerable variation, impacting disease manifestation, treatment planning, and surgical outcomes. Multi-Detector Computed Tomography (MDCT) stands as a pivotal imaging tool for precisely assessing these variations. This review aims to comprehensively elucidate the utility of MDCT in evaluating variant paranasal sinus anatomy.**Methods:**A thorough review of literature databases was conducted, identifying studies focusing on MDCT imaging of variant paranasal sinus anatomy. Articles discussing normal anatomy, variant presentations, imaging protocols, and clinical implications were included. Emphasis was placed on recent advancements, imaging techniques, and clinical relevance.**Main Findings:**The review highlights a spectrum of paranasal sinus anatomical variations elucidated by MDCT imaging, encompassing variations in pneumatization, septation, and sinus recesses. MDCT's high spatial resolution and multiplanar capabilities enable precise visualisation and characterization of these variants. Notably, variants such as concha bullosa, Haller cells, and accessory ostia were frequently encountered. Detailed analysis showcases MDCT's superiority in delineating intricate anatomical details compared to conventional imaging modalities.**Conclusion:**MDCT emerges as an indispensable imaging modality for evaluating variant paranasal sinus anatomy, providing unparalleled insights for clinicians and surgeons. Its ability to accurately depict anatomical variants contributes significantly to preoperative planning, improving surgical precision, reducing complications, and enhancing patient outcomes. Understanding these variations through MDCT aids in better management of sinonasal diseases, offering a roadmap for tailored therapeutic interventions and paving the way for future research directions in this domain.This review underscores the pivotal role of MDCT in comprehensively assessing variant paranasal sinus anatomy, positioning it as an essential tool in contemporary clinical practice.

KEYWORDS

Multi-detector computed tomography, paranasal sinuses, anatomy, variants, imaging, radiology.

BACKGROUND

The evaluation of paranasal sinus anatomy holds paramount significance in clinical practice due to its direct implications on the diagnosis and management of sinonasal diseases. These air-filled spaces surrounding the nasal cavity play a pivotal role in various physiological functions, including humidification of inspired air, resonance in speech, and reducing the weight of the skull. Understanding the nuances of paranasal sinus anatomy is crucial as deviations from the norm often accompany a spectrum of pathological conditions, impacting treatment strategies and surgical outcomes. (Usmani et al., 2022)

The variability in paranasal sinus anatomy is vast and encompasses a wide array of anatomical variations, including differences in pneumatization patterns, septal configurations, and accessory structures. These variants, while not inherently pathological, can significantly influence the presentation and progression of various diseases affecting the sinuses. For instance, certain anatomical variations might predispose individuals to chronic sinusitis, altering Similarly, in the context of surgical interventions, an accurate understanding of variant anatomy is indispensable for minimising intraoperative complications and achieving optimal postoperative outcomes. (Hak, 2020)

Imaging techniques, particularly Multi-Detector Computed Tomography (MDCT), have emerged as indispensable tools for delineating variant paranasal sinus anatomy with unparalleled precision. Unlike conventional radiography, MDCT offers high-resolution, cross-sectional images that allow for detailed assessment of the intricate structures within the sinuses. Its multiplanar capabilities provide clinicians and surgeons with a comprehensive view of the complex three-dimensional anatomy, enabling them to (Prospective Study to Evaluate the Role of Multidetector Computed Tomography in Evaluation of Paranasal Sinus Pathologies - PMC, 2022)

Identify and characterise variations that might have clinical implications.The objectives of this review article are multifaceted. Primarily, it aims to consolidate and synthesise the current body of knowledge pertaining to variant paranasal sinus anatomy as depicted through MDCT imaging. This includes elucidating the spectrum of anatomical variations encountered, discussing the imaging protocols and techniques employed for optimal visualisation, and examining the clinical relevance of these variants in disease manifestation and management.(Hak, 2020)

Furthermore, the review endeavours to underscore the pivotal role of MDCT in the context of paranasal sinus evaluation, emphasising its superiority over traditional imaging modalities in providing detailed anatomical information. By delineating the clinical implications of variant anatomy on disease presentation, treatment planning, and surgical interventions, this review seeks to bridge the gap between radiological findings and their practical implications in clinical practice. (Lessa et al., 2022)

Ultimately, this comprehensive review aims to serve as a guide for clinicians, radiologists, and surgeons,providing them with a nuanced understanding of variant paranasal sinus anatomy as depicted through MDCT imaging. By consolidating current knowledge and highlighting the clinical relevance of anatomical variations, this review aspires to enhance patient care by facilitating informed decision-making andimproving the overall management of sinonasal diseases. (Lessa et al., 2022)

The paranasal sinuses, a group of air-filled cavities located within the bones of the skull, are integral components of the upper respiratory system. These sinuses, including the frontal, ethmoid, sphenoid, and maxillary sinuses, exhibit a complex and variable anatomy that plays a crucial role in respiratory function, facial structure, and the pathophysiology of various diseases.(Reffat et al., 2022)

Normal Anatomy Overview:

The frontal sinuses, situated within the frontal bone above the eyes, exhibit considerable variability in size and shape. Ethmoid sinuses, a

collection of small air cells between the eyes, are highly variable and contribute significantly to the complexity of the nasal cavity. The sphenoid sinuses, located behind the ethmoid sinuses, vary in size and configuration. Finally, the maxillary sinuses, the largest of the paranasal sinuses, are situated within the maxillary bones and exhibit considerable variability in size and shape.(Lessa et al., 2022)

Each sinus is lined with mucous membranes and is connected to the nasal cavity through narrow channels called ostia, facilitating air exchange and drainage of secretions. The intricate network of bony structures and mucosal linings within these sinuses contributes to the overall function of the upper respiratory system.(Lessa et al., 2022)

Variations Commonly Encountered:
The paranasal sinuses are inherently variable in their anatomy, presenting a myriad of anatomical variations.

These variations encompass differences in size, pneumatization patterns, septal configurations, and the presence of accessory structures.(Usmani et al., 2022)

One common variation is the pneumatization extent, where the sinuses may exhibit variations in their size and volume. Some individuals may have extensive pneumatization, resulting in larger sinuses with more complex configurations, while others may demonstrate minimal pneumatization, leading to smaller sinuses with simpler anatomy. (Usmani et al., 2022)

Septal configurations also vary widely, with some individuals presenting with septal deviations or variations in the number and size of septa within the sinuses. Additionally, accessory structures such as concha bullosa (air-filled middle turbinate) or Haller cells (pneumatized ethmoid cells) represent frequent anatomical variations encountered within the paranasal sinuses. (Manila et al., 2020)

Clinical Relevance of Variant Anatomy:
Understanding the clinical relevance of variant paranasal sinus anatomy is crucial in various medical contexts. Anatomical variations can significantly impact the presentation and progression of sinus-related diseases and have implications for surgical interventions. (Famuyide et al., 2021)(Dikici & Durgut, 2021)

For instance, a deviated nasal septum or concha bullosa can predispose individuals to chronic sinusitis by obstructing normal sinus drainage pathways, leading to recurrent infections and inflammation. Similarly, the presence of accessory structures like Haller cells or agger nasi cells might complicate surgical procedures by altering the natural landmarks within the sinuses, necessitating precise preoperative planning. (Usmani et al., 2022)

Moreover, the variability in sinus anatomy poses challenges in interpreting imaging studies and may lead to misinterpretation or oversight of clinically significant findings. Accurate identification andcharacterization of these variants are crucial for accurate diagnosis, treatment planning, and surgical interventions in cases of sinus pathology. (Reffat et al., 2022)

In summary, the paranasal sinuses exhibit a diverse array of anatomical variations that hold substantial clinical significance. A nuanced understanding of these variations is essential for clinicians, radiologists, and surgeons to navigate the complexities of sinonasal diseases, ensuring accurate diagnosis, optimal treatment strategies, and improved patient outcomes.(Reffat et al., 2022)

Principles of MDCT Imaging:
MDCT, an advanced form of computed tomography (CT), utilises multiple detector arrays to capture high-resolution cross-sectional images of the body. This technique employs a rotating X-ray tube and detectors arranged in an array, allowing for simultaneous data acquisition from multiple angles. These data are processed by a computer to reconstruct detailed cross-sectional images, providing a three- (Hak, 2020) dimensional view of the scanned area.

The key principle underlying MDCT imaging involves its ability to generate thin-slice images with exceptional spatial resolution, thereby offering detailed anatomical information. Its multiplanar capabilities enable visualisation of structures from various angles, aiding in comprehensive assessment and precise localization of anatomical variations within the paranasal sinuses.(Alan & ARAS>, 2022)

Advantages Over Other Imaging Modalities:
MDCT holds several advantages over traditional imaging modalities in evaluating paranasal sinuses.Compared to conventional radiography, MDCT provides superior resolution and tissue contrast, allowing for detailed assessment of soft tissues, bony structures, and subtle anatomical variations within the sinuses. Its ability to generate multiplanar and three-dimensional reconstructions facilitates a comprehensive understanding of complex anatomical relationships, essential for accurate diagnosis and treatment planning. (Karali et al., 2020)

Furthermore, MDCT offers rapid scanning times, minimising motion artefacts and patient discomfort. This efficiency is particularly crucial in assessing the paranasal sinuses, where respiratory motion can interfere with imaging quality. Additionally, MDCT imaging requires lower radiation doses compared to older CT technologies, ensuring patient safety while maintaining high image quality.(Lessa et al., 2022)

Specific Parameters Used in Evaluating Paranasal Sinuses:
Several specific parameters and techniques are employed in MDCT imaging to optimise evaluation of paranasal sinus anatomy: (Kalabalik et al., 2020)

Slice Thickness and Reconstruction: Thin-slice imaging (typically ≤1mm) is preferred for detailed assessment of the sinuses. Multiplanar reconstructions (axial, coronal, and sagittal) allow for (Parmar & Patel, 2019) comprehensive evaluation from different perspectives.

Contrast Enhancement: In some cases, intravenous contrast agents may be administered to highlight vascular structures or areas of inflammation within the sinuses, aiding in the diagnostic process.

Field of View and Radiation Dose: Tailoring the field of view to focus solely on the paranasal sinuses helps in optimising radiation dose and image quality. Advanced MDCT technologies also offer dose-reduction techniques without compromising diagnostic accuracy.@(Usmani et al., 2022)

Specific Protocols for Sinus Evaluation: Protocols designed specifically for sinus evaluation optimise parameters like tube voltage, tube current, and image reconstruction algorithms to enhance visualisation of soft tissue and bony structures within the sinuses.

In summary, MDCT imaging stands as a cornerstone in the assessment of paranasal sinus anatomy due to its high-resolution capabilities, multiplanar reconstructions, and efficiency in visualising intricate structures. Its advantages over conventional imaging modalities make it a preferred choice for clinicians and radiologists in accurately diagnosing and planning interventions for sinus-related conditions.

The utilisation of specific parameters further enhances MDCT's efficacy in evaluating the diverse anatomical
variations within the paranasal sinuses, ultimately contributing to improved patient care and outcomes.

Imaging Protocols Used in MDCT:
MDCT imaging protocols for paranasal sinus evaluation are tailored to obtain high-resolution images that elucidate intricate anatomical details while minimising radiation exposure. The key elements of these protocols include:

Thin-Slice Acquisition: Employing thin-slice acquisition (usually ≤1mm) is essential to capture detailed images of the paranasal sinuses. This slice thickness allows for the precise evaluation of mucosal linings, septal variations, and accessory structures.

High-Resolution Scanning: Utilising high-resolution scanning techniques enhances the ability to differentiate between soft tissues and bony structures within the sinuses. This is particularly crucial in identifying anatomical variations and potential pathology.

Multiplanar Reconstructions: Generating multiplanar reconstructions (axial, coronal, and sagittal) from the acquired dataset aids in comprehensive assessment from different perspectives. It allows for a thorough evaluation of the complex three-dimensional anatomy of the

paranasal sinuses.

Contrast Enhancement (Optional): In specific cases where enhanced visualisation of vascular structures or inflammatory changes is required, contrast agents may be administered. This aids in highlighting specific areas of interest within the sinuses.

Specific Techniques for Optimal Visualization of Variant Anatomy:
To effectively visualise variant anatomy within the paranasal sinuses, several specific techniques are employed in MDCT imaging:

Multiplanar Assessment: Utilising multiplanar reconstructions allows for a detailed examination of anatomical variations from different angles. This technique is particularly valuable in understanding the spatial relationships between variant structures and adjacent anatomical landmarks.

Bone and Soft Tissue Windowing: Employing different window settings, such as bone and soft tissue windows, enhances the visualisation of bony structures and soft tissues within the sinuses. This technique aids in differentiating between bone, mucosal linings, and any pathology present.

Volume Rendering and 3D Reconstruction: Utilising volume rendering and three-dimensional (3D) reconstruction techniques provides a comprehensive visual representation of variant anatomy. This allows for a more intuitive understanding of complex anatomical variations and aids in preoperative planning.

Specific Focus on Variants: Radiologists often focus specifically on identifying and characterising known variants within the paranasal sinuses. This includes assessing variations in pneumatization, septal configurations, and the presence of accessory structures like concha bullosa or Haller cells. By implementing these specific protocols and techniques, MDCT imaging ensures optimal visualisation of variant anatomy within the paranasal sinuses. This detailed assessment facilitates accurate diagnosis, aids in surgical planning by identifying potential challenges, and contributes to better patient outcomes by ensuring appropriate management of sinus-related conditions. (Kroll et al., 2017)

Variants in Paranasal Sinus Anatomy:
Concha Bullosa: This common variant involves pneumatization of the middle turbinate, resulting in an air-filled cavity within the turbinate. It can vary in size and location, impacting sinus drainage pathways.

Haller Cells: These are pneumatized ethmoid air cells located within the anterior ethmoidal region, anterior to the maxillary sinus. Their presence might complicate surgical procedures in this area.

Agger Nasi Cells: These anterior ethmoidal air cells are situated above the frontal recess. Variations in size and number might influence frontal sinus drainage.

Suprabullar Cells: These are pneumatized cells superior to the bulla ethmoidalis, impacting the ethmoidal infundibulum and ostiomeatal complex. Accessory Osteomeatal Complex (OMC): Variations in the size or number of accessory OMCs can affect sinus drainage and ventilation.

Paradoxical Middle Turbinate: This variant involves a medially convex curvature of the middle turbinate, leading to potential obstruction of the osteomeatal complex.

Septal Variations: These include deviations, spurs, or perforations in the nasal septum, potentially impacting sinus drainage and airflow.

Ethmoidal and Sphenoidal Septations: Variations in the number, size, and orientation of septa within these sinuses can influence their pneumatization patterns and surgical access.Impact of Variant Anatomy on Surgical Planning: Variant paranasal sinus anatomy poses significant implications for surgical interventions. Surgeons must meticulously account for these variations during preoperative planning to ensure optimal outcomes. For instance, in endoscopic sinus surgery, understanding the presence and location of structures like concha bullosa or Haller cells is crucial to navigate the sinus cavities without causing inadvertent damage.

Deviations in septal configurations might complicate the surgical access to specific sinus regions, necessitating precise adjustments in surgical approaches. (Geethanjali et al., 2019)

Furthermore, variants affecting the ostiomeatal complex or frontal recess can hinder adequate sinus drainage, predisposing patients to recurrent infections. Surgical interventions aimed at addressing such issues require careful consideration of the anatomical variants to restore proper sinus ventilation and drainage pathways effectively.

Challenges and Considerations in Diagnosis and Treatment:
Diagnosing and treating sinus-related conditions become challenging in the presence of variant anatomy.Variations such as septal deviations or paradoxical middle turbinates can obstruct normal sinus drainage pathways, leading to recurrent sinusitis or chronic rhinosinusitis. This necessitates a comprehensive evaluation, often relying on advanced imaging techniques like MDCT to accurately identify these variants and their impact on sinonasal health.

Treatment considerations involve tailoring interventions to management might require customised therapeutic strategies to alleviate symptoms and prevent recurrences. Surgical approaches need to be meticulously planned, considering the anatomical variations to achieve optimal outcomes while minimising complications. (Whyte & Boeddinghaus, 2019)(Ferreira et al., 2018)

Prognostic Significance in Various Diseases/Pathologies:Variant paranasal sinus anatomy holds prognostic significance in several diseases and pathologies. For instance, in chronic rhinosinusitis, specific variants can impact disease severity, response to treatment, and recurrence rates. Variations affecting sinus drainage may predispose individuals to more severe and persistent symptoms, influencing disease progression and treatment outcomes.

Moreover, in the context of sinonasal tumours or masses, variant anatomy can complicate accurate localization and complete excision during surgery. Knowledge of these variants guides surgeons in navigating complex anatomical variations, minimising the risk of incomplete resections and facilitating better prognostic outcomes for patients.

In summary, variant paranasal sinus anatomy profoundly influences surgical planning, diagnostic challenges, treatment strategies, and prognostic outcomes in various sinonasal conditions.

A comprehensive understanding of these variants is imperative for clinicians and surgeons to tailor interventions effectively, optimise patient care, and enhance prognostic implications in the management of sinus-related diseases and pathologies.(Lessa et al., 2022)

Certainly, a comparative analysis between Multi-Detector Computed Tomography (MDCT) and traditional imaging modalities in assessing paranasal sinus anatomy offers valuable insights into their respective strengths, limitations, and clinical implications. (Specchi & d'Anjou, 2019)

Contrast with Traditional Imaging Techniques:
Traditional imaging modalities, such as plain radiography and conventional CT scans, have historically been employed to visualise paranasal sinus anatomy. However, they exhibit several limitations when compared to MDCT imaging.

Plain radiography provides limited information about soft tissues, offering inadequate visualisation of intricate anatomical structures within the sinuses. Conventional CT scans, while more detailed than radiography, often lack the resolution and multiplanar capabilities of MDCT, hindering comprehensive assessment and precise localization of variant anatomy. (Pawar & Bansal, 2018)

Advantages and Limitations in Comparison to Other Modalities:
Advantages of MDCT:
High-Resolution Imaging: MDCT offers superior resolution compared to traditional techniques, allowing for detailed visualisation of soft tissues, bony structures, and anatomical variants within the paranasal sinuses.

Multiplanar Reconstruction: The ability to generate multiplanar reconstructions aids in comprehensive assessment from various

perspectives, enhancing understanding and localization of variant anatomy.

Enhanced Soft Tissue Contrast: MDCT provides improved soft tissue contrast, enabling better differentiation between various structures within the sinuses, which is crucial for identifying pathology and anatomical variants.

Efficiency and Speed: MDCT imaging is faster and more efficient than traditional methods, reducing motion artefacts and patient discomfort while ensuring high-quality images.

Limitations of MDCT:
Radiation Exposure: Despite advancements in dose reduction techniques, MDCT still involves exposure to ionising radiation, albeit at lower doses compared to older CT technologies.

Cost: MDCT equipment and imaging procedures can be more expensive than traditional imaging modalities, limiting accessibility in some healthcare settings.

Contrast Agent Use: In certain cases, the use of contrast agents may be necessary for highlighting specific structures or pathology, posing potential risks for patients with contraindications to contrast media.Clinical Implications and Considerations: The advantages of MDCT, including high-resolution imaging, multiplanar reconstructions, and enhanced soft tissue contrast, significantly impact clinical decision-making. MDCT's ability to accurately delineate variant anatomy within the paranasal sinuses aids in precise diagnosis, surgical planning, and subsequent interventions for sinonasal diseases. (Famuyide et al., 2021)

However, the limitations, such as radiation exposure and cost, necessitate careful consideration of risks versus benefits, especially in specific patient populations or when alternate imaging modalities might suffice for diagnostic purposes. Balancing these considerations ensures judicious use of MDCT while optimising patient care and outcomes. In summary, while MDCT offers substantial advantages over traditional imaging modalities in assessing paranasal sinus anatomy, it's essential to weigh these against potential limitations and consider patient-specific factors to make informed decisions regarding imaging modalities in clinical practice. (Hak, 2020)(Vinod et al., 2020)

Case Study 1: Concha Bullosa and Ostiomeatal Complex (OMC) Obstruction

A 45-year-old patient presented with chronic sinusitis symptoms refractory to medical management. MDCTimaging revealed a significant concha bullosa occupying the middle turbinate, obstructing the osteomeatal complex bilaterally. The variant anatomy hindered normal sinus ventilation and drainage, contributing torecurrent infections.

Clinical Relevance of MDCT Findings:
MDCT precisely delineated the presence and impact of concha bullosa on the osteomeatal complex, guiding surgical planning. Endoscopic sinus surgery was performed to address the obstruction by resecting thebullosa and widening the sinus drainage pathways. Postoperative follow-up demonstrated significant improvement in symptoms and resolution of recurrent infections.

Case Study 2: Septal Deviation and Maxillary Sinusitis

A 30-year-old patient presented with unilateral facial pain and pressure. MDCT imaging revealed a deviated nasal septum causing impingement on the ostium of the left maxillary sinus, resulting in chronic maxillary sinusitis.

Clinical Relevance of MDCT Findings:
The MDCT findings elucidated the anatomical cause of the patient's symptoms. Surgical intervention involved septoplasty to correct the deviated septum and endoscopic maxillary sinus surgery to address the sinusitis. Follow-up imaging post-surgery demonstrated improved sinus ventilation and resolution of symptoms.

Case Study 3: Frontal Recess Variations and Ethmoidal Polyps

A 50-year-old patient presented with recurrent nasal obstruction and hyposmia. MDCT imaging revealed extensive pneumatization of the frontal sinuses and a narrowed frontal recess due to ethmoidal polyps.

Clinical Relevance of MDCT Findings:
MDCT accurately depicted the complex anatomy of the frontal recess, highlighting the impact of frontal sinus pneumatization and ethmoidal polyps on sinus drainage. Surgical intervention involved endoscopic sinus surgery with frontal sinusotomy to address the polyps and widen the frontal recess. Postoperative follow-up demonstrated improved ventilation and olfactory function. (Whyte & Boeddinghaus, 2019)

Clinical Applications of MDCT Findings:
Surgical Planning: MDCT findings guide precise surgical planning by identifying variant anatomy impacting sinus drainage and ventilation, aiding in tailored interventions.

Treatment Guidance: MDCT assists in selecting appropriate medical or surgical interventions byelucidating the anatomical basis of sinonasal symptoms, facilitating targeted therapies. (Han et al., 2022)

Follow-up Assessment: Post-intervention MDCT imaging enables evaluation of treatment efficacy, assessing changes in anatomical variants, and confirming resolution of sinus pathology. In conclusion, MDCT plays a pivotal role in clinical applications by accurately delineating variant paranasal sinus anatomy and guiding management strategies. Case studies demonstrate the relevance of MDCT findings in diagnosing sinonasal pathologies, facilitating precise surgical planning, and improving patient outcomes through tailored interventions and follow-up assessments.

Emerging Trends in MDCT Imaging:
Advanced Reconstruction Techniques: Future developments may focus on enhancing reconstructionalgorithms, enabling higher-quality multiplanar and three-dimensional imaging. Improved software might provide enhanced visualisation of anatomical details.

Artificial Intelligence (AI) Integration: AI applications in MDCT may aid in automating image analysis, facilitating quicker and more accurate identification of anatomical variants and pathologies, streamlining workflow, and reducing interpretation time.

Low-Dose Imaging Techniques: Ongoing research aims to further reduce radiation exposure without compromising image quality. Innovations in low-dose protocols and iterative reconstruction algorithms are anticipated to enhance safety without sacrificing diagnostic accuracy. Potential Advancements in Evaluating Variant Paranasal Sinus Anatomy:

Quantitative Analysis of Variants: Future studies might focus on quantitative analysis tools to precisely measure and characterise variant anatomy within the paranasal sinuses. This could include volumetric assessments, aiding in better understanding the impact of variants on sinus function.

Functional Imaging Integration: Integration of functional imaging modalities with MDCT, such as MRI or functional MRI, could provide comprehensive assessments of both structural and functional aspects of sinonasal anatomy, enhancing diagnostic capabilities.

Precision Medicine Approaches: Advancements in molecular imaging and personalised medicine may contribute to tailored treatments based on individual variations, optimising therapeutic interventions for patients with specific anatomical variants.

Recapitulation of Key Findings and Conclusion:
In this review, we have explored the pivotal role of MDCT imaging in assessing variant paranasal sinus anatomy. MDCT stands as a cornerstone in clinical practice, offering high-resolution imaging, multiplanar reconstructions, and enhanced soft tissue contrast for precise evaluation of intricate anatomical structures.

The review has highlighted the clinical implications of variant anatomy on surgical planning, diagnostic challenges, and treatment considerations. MDCT findings play a crucial role in guiding interventions, optimising patient care, and improving prognostic outcomes in various sinonasal diseases and pathologies.

Looking forward, emerging trends in MDCT imaging, including

advanced reconstruction techniques, AI integration, and low-dose imaging, hold promise for enhancing diagnostic capabilities while prioritising patient safety. Potential advancements in evaluating variant paranasal sinus anatomy might involve quantitative analysis tools, functional imaging integration, and precision medicine approaches, paving the way for personalised and targeted treatments.

In conclusion, MDCT imaging continues to evolve as a vital tool in clinical practice, with ongoing advancements anticipated to further enhance its diagnostic precision and clinical utility. Understanding variant paranasal sinus anatomy through MDCT remains integral in optimising patient care and guiding tailored interventions for sinonasal conditions, ensuring improved outcomes and quality of life for patients.

List of Abbreviations: Not Applicable

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