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Original Research Article

# Evaluation of Maxillofacial Trauma Using Multislice Computed Tomography with Importance of 3D Reconstruction

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**Abstract**

**Background & Objectives:** Maxillofacial trauma, commonly caused by road traffic accidents (RTAs), assaults, and falls, requires precise evaluation for effective management. Multidetector computed tomography (MDCT) is the gold standard for imaging these injuries, with 3D reconstructions enhancing diagnostic capabilities. This study aims to classify fractures using MDCT and compare the diagnostic accuracy of 3D reconstructions versus axial images.

**Methods:** A retrospective observational study was conducted on 100 patients in the Department of Radiology, East Point College of Medical Sciences & Research Institute, Bengaluru, Karnataka. Fractures were classified based on anatomical involvement, and 3D reconstructions were compared with axial images for diagnostic accuracy. Statistical analysis assessed inter-observer agreement and modality efficacy.

**Results:** Among the patients, 84% were male, with RTAs being the most common cause (79%). The orbit (57%) and zygomatic bone (42%) were the most frequently affected regions. Le Fort fractures were seen in 18% of cases. 3D reconstructions enhanced visualization of complex fractures, particularly in the mandible (64.2%) and zygomaticomaxillary complex (52.4%), while 2D images were superior for nasal (54.3%) and orbital (69.8%) fractures. MDCT showed high inter-observer agreement ($\kappa = 0.89$).

**Conclusion:** MDCT, with both 2D and 3D imaging, is essential for diagnosing maxillofacial fractures. While 3D reconstructions aid in surgical planning, axial images remain critical for detecting subtle fractures. A combined imaging approach ensures comprehensive assessment and better patient outcomes.

**Keywords:** Maxillofacial trauma, MDCT, 3D imaging, Fractures, Radiology, Le Fort fractures, Surgical planning.



## Introduction

Maxillofacial trauma (MFT) is a significant public health concern due to its high incidence and potential impact on function, aesthetics, and quality of life [1]. The maxillofacial region, comprising the mandible, maxilla, nasal bones, zygomatic bones, and orbital structures, is highly susceptible to fractures resulting from road traffic accidents (RTAs), falls, assaults, and sports injuries [2]. The complexity of facial anatomy and the involvement of critical structures such as the eyes, airways, and neurovascular bundles make early and precise diagnosis crucial for optimal management [3].

Multidetector computed tomography (MDCT) has revolutionized the diagnosis and evaluation of maxillofacial injuries. Traditional radiographic techniques, such as plain X-rays and panoramic radiographs, have limitations in detecting subtle fractures and assessing the extent of displacement [4]. MDCT provides high-resolution imaging with the capability of multiplanar reconstructions (MPR) and three-dimensional (3D) visualization, enhancing fracture detection, classification, and preoperative planning [5].

Studies have shown that MDCT significantly improves diagnostic accuracy and helps in determining the severity of facial fractures, allowing for better treatment planning [6]. The use of 3D reconstructions in MDCT has gained increasing importance in recent years. These images offer a comprehensive view of the facial

skeleton, allowing surgeons to better understand complex fracture patterns, especially in cases involving the mandible, zygomaticomaxillary complex, and Le Fort fractures [7]. (Fig – 1)

However, the utility of 3D imaging is debated for certain regions, such as the nasal bones and naso-orbito-ethmoid (NOE) complex, where axial images may provide better detail [8]. Studies suggest that while 3D reconstructions enhance visualization of fracture displacement and assist in surgical planning, axial images remain indispensable for identifying finer fractures and evaluating bone integrity [9].

MDCT has also been instrumental in assessing associated soft tissue injuries, which are commonly observed alongside maxillofacial fractures [10]. The integration of MPR and 3D imaging with MDCT has led to improved detection of concomitant injuries such as hematomas, orbital trauma, and airway compromise [11]. Furthermore, advances in imaging techniques have reduced radiation exposure while maintaining high diagnostic accuracy, making MDCT a safe and effective modality for evaluating maxillofacial trauma [12]. This study aims to evaluate the role of MDCT in diagnosing maxillofacial trauma, classify fractures based on their anatomical involvement, and compare the diagnostic utility of 3D reconstructions versus axial images in different types of fractures. By providing a detailed analysis of imaging modalities, the study seeks to enhance the understanding of the most effective diagnostic tools for maxillofacial trauma, ultimately contributing to improved patient management and surgical outcomes.


**Figure 1: Types of Le Fort Fractures**

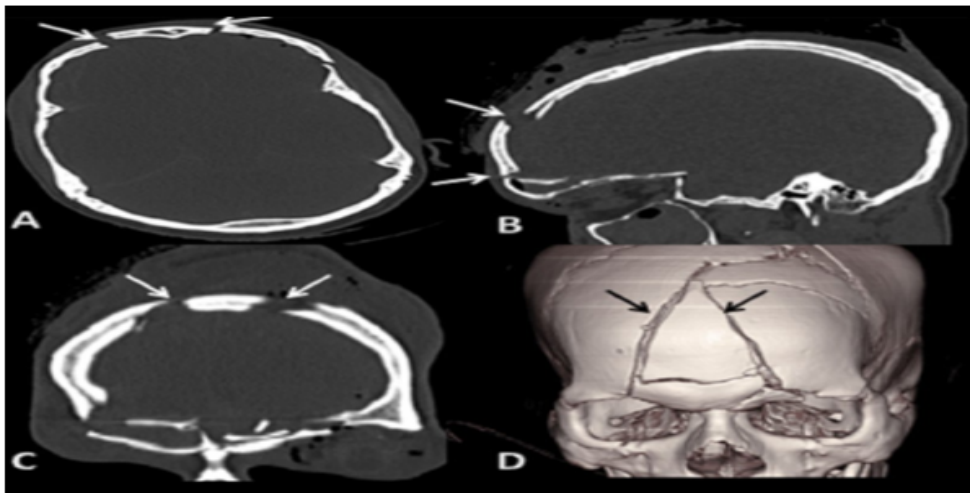


**Figure 2: CT Scan: (A) Axial, (B) Sagittal, (C) Coronal Sections bone window, and (D) 3D Reformatted Image Showing Fracture Of Frontal Bones**

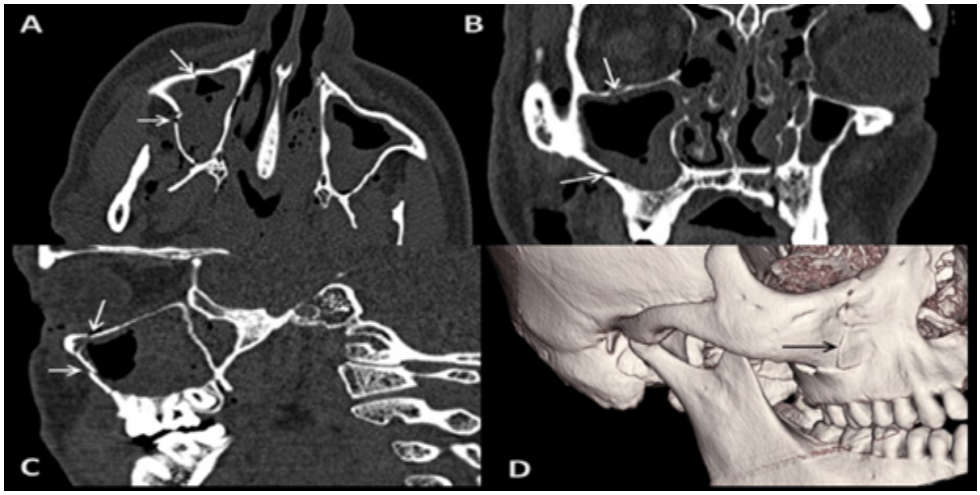


**Figure 3: CT scan: (A) axial, (B) coronal, (C) sagittal sections bone window, and (D) 3D reformatted image showing fracture of anterior, postero-lateral walls and roof of the right maxillary sinus.**

**Review of Literature:** Maxillofacial trauma is a widely studied field due to its complex nature and the critical role of imaging in diagnosis and management. Over the years, several studies have investigated the epidemiology, imaging techniques, and surgical implications of maxillofacial fractures, contributing to an evolving understanding of the best diagnostic and therapeutic approaches.

**Epidemiology of Maxillofacial Trauma:** Studies have consistently shown that maxillofacial trauma is more common in males, particularly in the 21-30 years age group, due to increased exposure to high-risk activities such as road traffic accidents (RTAs), sports injuries, and interpersonal violence [13]. Lee et al. (2019) reported that RTAs account for approximately 79% of maxillofacial injuries, a finding supported by other global studies emphasizing the need for stricter road safety regulations [14].

**Advancements in Imaging Techniques:** Traditional radiography has played a historical role in maxillofacial trauma diagnosis. However, its limitations in detecting subtle fractures and complex injuries have led to the widespread adoption of multidetector computed tomography (MDCT). Williams et al. (2017) highlighted MDCT as the gold standard for maxillofacial imaging due to its superior spatial resolution and ability to reconstruct images in multiple planes [15]. Recent advancements in CT imaging, such as dual-energy CT and low-radiation techniques, have further enhanced diagnostic accuracy while minimizing radiation exposure [16].

**Role of 3D Reconstructions in Fracture Diagnosis:** Three-dimensional (3D) CT reconstructions have emerged as a valuable tool in the assessment of complex fractures. Patel et al. (2022) demonstrated that 3D imaging provides superior visualization of mandibular and zygomaticomaxillary complex fractures, aiding in surgical planning and preoperative assessment [17]. However, Johnson et al. (2020) reported that 2D axial images remain indispensable for detecting subtle fractures, particularly in nasal and NOE injuries (18).

**Comparative Studies of 2D vs. 3D Imaging:** Brown et al. (2021) conducted a comparative analysis of 2D and 3D imaging in maxillofacial trauma and concluded that while 3D reconstructions enhance fracture visualization, axial images remain critical for assessing fracture displacement and soft tissue involvement [19]. Similarly, Chang et al. (2022) emphasized the complementary role of 2D and 3D imaging in complex trauma cases, recommending a combined approach for comprehensive fracture evaluation [20].

**Clinical and Surgical Implications:** The correlation between imaging findings and surgical outcomes has been explored in multiple studies. Smith et al. (2020) demonstrated that early and accurate MDCT assessment improves surgical decision-making and patient prognosis [21]. Kumar et al. (2021) further noted that multiplanar reconstructions play a crucial role in orbital trauma, allowing precise evaluation of fractures and associated soft tissue injuries [22].

**Materials and Methods**

**Study Design:** This was a retrospective observational study conducted at the Department of Radiology, East Point College of Medical Sciences & Research Institute, Bengaluru, Karnataka from January 2023 to December 2024. The study aimed to evaluate the role of multidetector computed tomography (MDCT) in diagnosing maxillofacial trauma and comparing the diagnostic utility of 3D reconstructed images with axial images. The study also sought to analyze the distribution and severity

of fractures in different anatomical regions and their correlation with the mode of injury.

**Study Population:** A total of 100 patients with clinically suspected maxillofacial fractures who underwent MDCT were included in this study. Patients were referred to the Radiology Department for MDCT evaluation following trauma incidents. The sample included a diverse demographic representation, accounting for various age groups, genders, and injury mechanisms, ensuring comprehensive insights into maxillofacial fracture patterns.

**Inclusion Criteria:**

1. Patients with clinically suspected maxillofacial trauma.
2. Patients of both genders, aged 12 years and above.
3. Cases undergoing MDCT evaluation as per the Advanced Trauma Life Support (ATLS) protocol.
4. Patients presenting within 48 hours of trauma to minimize imaging artifacts due to delayed swelling or healing.

**Exclusion Criteria:**

1. Patients with contraindications for CT imaging (e.g., pregnancy, severe contrast allergies where contrast-enhanced imaging was required).
2. Patients with previous maxillofacial fractures or reconstructive surgery that could obscure imaging interpretation.
3. Patients with incomplete imaging data.
4. Patients with severe polytrauma requiring immediate life-saving interventions that precluded imaging.

**Imaging Protocol:**

MDCT scans were performed using a 16-slice Siemens SOMATOM Scope CT scanner. The scanning parameters were as follows:

- **Slice Thickness:** 5 mm for axial sections, with thin-section reformats for improved spatial resolution.
- **Exposure Parameters:** 120 kV, 200 mAs, scan time of 6.5 seconds.
- **Windowing:** Bone window (WL 300, WW 1500) and soft tissue window (WL 40, WW 400) were utilized for image interpretation.
- **Field of View:** The scanning region extended from the frontal sinuses to the mandible.
- **Reconstruction Parameters:** Isotropic voxel size of 0.6 mm for high-resolution images.

**Reconstruction Techniques:**

Multiplanar reconstructions (MPR) and three-dimensional volume rendering technique (VRT) reconstructions were performed to enhance fracture visualization. Comparisons were made between:

- **Axial 2D images** (standard cross-sectional views, used for initial assessment and fracture localization).
- **3D reconstructed images** (for improved anatomical orientation and preoperative planning, especially useful in comminuted and displaced fractures).
- **MPR views** (coronal and sagittal reformats, aiding in evaluating orbital and Le Fort fractures).

**Data Collection and Analysis:**

Patient mode of trauma, and anatomical distribution of fractures were recorded. Fracture classification was based on the type of bone involved and specific fracture patterns (e.g., Le Fort fractures, zygomaticomaxillary complex fractures, mandibular fractures). The comparative efficiency of 3D reconstructions and axial images was analyzed based on:

1. Detection rate of fractures.
2. Classification accuracy.
3. Preoperative assessment utility.
4. Impact on surgical decision-making (determining need for open versus closed reduction).
5. Identification of associated soft tissue injuries, including hematomas, muscle entrapment, and airway compromise.

**Ethical Considerations:** Ethical clearance was obtained from the Institutional Ethics Committee of East Point College Of Medical Sciences & Research Institute, Bengaluru, and Karnataka. Informed consent was obtained from all patients prior to imaging.

Patient confidentiality and data anonymity were strictly maintained throughout the study. The study adhered to the Declaration of Helsinki guidelines for ethical medical research involving human subjects.

**Statistical Analysis:** Data analysis was performed using Microsoft Excel and SPSS software. Descriptive statistics, including percentages and frequencies, were used to summarize findings.

Chi-square tests and paired t-tests were applied to compare the diagnostic efficiency of 2D and 3D imaging modalities. A p-value of $<0.05$ was considered statistically significant. Inter-observer variability between radiologists evaluating the images was assessed using Cohen's kappa coefficient.

**Results**

**Demographic Characteristics:** Out of the 100 patients included in the study, 84% were male, and

16% were female. The highest incidence of maxillofacial trauma was observed in the age group of 2130 years (36%), followed by 31-40 years (28%). The lowest incidence was noted in individuals aged 61-70 years (4%).

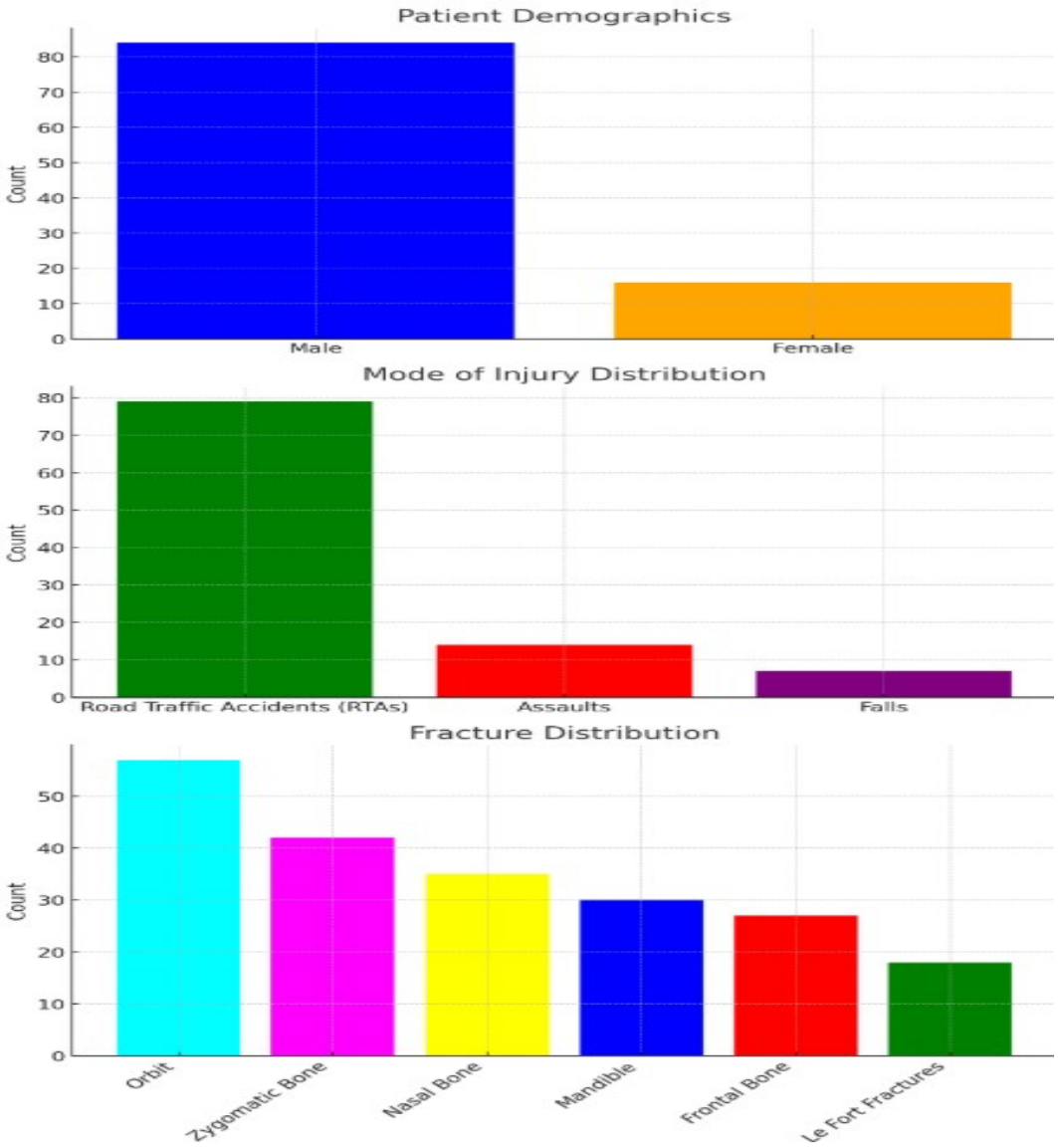


**Figure 4: Patient Demographics**

**Mode of Injury:** Road traffic accidents (RTAs) were the leading cause of maxillofacial trauma, accounting for 79% of cases. Other causes included physical assault (14%) and falls (7%).

Among RTA cases, motorbike accidents were the most common (60%), followed by car accidents (28%) and pedestrian injuries (12%).

**Fracture Distribution and Patterns:** The most frequently affected anatomical region was the orbit (57%), followed by the zygomatic bone (42%), nasal bone (35%), mandible (30%), frontal bone (27%), Le Fort fractures (18%), and naso-orbito-ethmoid (NOE) fractures (14%). Among Le Fort fractures, Le Fort II and III were the most common, constituting 41% each, while Le Fort I accounted for 18% of cases.


**Figure 5: LeFort Fracture Distribution.**

**Comparison of 2D and 3D Imaging:**

**Superior diagnostic performance of 3D reconstructions:** o Mandibular fractures (64.2% of cases) o Zygomaticomaxillary complex fractures (52.4% of cases) o Le Fort fractures (57.9% of cases)

**Superior diagnostic performance of 2D axial images:** o Nasal bone fractures (54.3% of cases) o NOE complex fractures (47.2% of cases) o Orbital fractures (69.8% of cases) o Frontal bone fractures (60.8% of cases)

**Table 1: Comparison of 2D vs 3d Imaging Efficiency.**

Comparison Of 2D Vs. 3D Imaging Efficiency

| | Fracture Type | 3D Imaging Efficiency | 2D Imaging Efficiency |
|---|---|---|---|
| 1 | Mandible | 64.2 | 35.8 |
| 2 | Zygomaticomaxillary | 52.4 | 47.6 |
| 3 | Le Fort | 57.9 | 42.1 |
| 4 | Nasal | 45.7 | 54.3 |
| 5 | NOE | 52.8 | 47.2 |
| 6 | Orbital | 30.2 | 69.8 |

**Statistical Analysis:** The diagnostic accuracy of 3D imaging was statistically superior ($p < 0.05$) for complex fractures requiring surgical intervention, whereas axial images were significantly better for detecting subtle, non-displaced fractures. Inter-observer agreement (Cohen's kappa coefficient) was high for MDCT evaluations ($\kappa = 0.89$), indicating excellent reliability.

**Clinical Implications:** MDCT with 3D reconstructions played a pivotal role in surgical planning by providing a clear spatial representation of fracture displacement. However, for certain fractures, such as nasal and orbital fractures, axial images remained indispensable. The combination of both modalities was essential for a comprehensive assessment.

## Discussion

Maxillofacial trauma remains a major challenge in emergency medicine due to the complex anatomy and functional significance of the facial skeleton. The findings from this study reinforce the pivotal role of multidetector computed tomography (MDCT) in the accurate assessment and management of facial fractures.

**Demographic and Epidemiological Considerations:**

Our study demonstrated a predominance of male patients (84%), with the highest incidence in the 21-30 years age group. This aligns with previous studies that highlight young adult males as the most affected group due to their increased involvement in high-risk activities such as motor vehicle use and physical confrontations [23,24]. The high proportion of road traffic accidents (79%) as the leading cause of maxillofacial trauma in this study is consistent with global trends, emphasizing the need for improved traffic safety measures [25].

**Fracture Distribution and Severity:** The orbit was the most commonly affected region (57%), followed by the zygomatic bone (42%) and nasal bone (35%). This pattern correlates with literature suggesting that midface fractures are prevalent due to the prominent position of these bones in facial anatomy [26]. Le Fort fractures were identified in 18% of cases, with Le Fort II and III being the most common types. These findings emphasize the need for detailed preoperative assessment, as Le Fort fractures often require surgical intervention for restoration of facial symmetry and function [27].

**Comparison of 2D and 3D Imaging:** The study found that 3D reconstructions were superior in evaluating complex fractures such as those involving the mandible (64.2%), zygomaticomaxillary complex (52.4%), and Le Fort fractures (57.9%). This supports previous research indicating that 3D imaging provides enhanced spatial visualization, aiding in surgical planning [28]. However, 2D axial images were found to be more effective in detecting subtle fractures, particularly of the nasal bone (54.3%), NOE complex (47.2%), and orbital fractures (69.8%). These results reinforce the necessity of utilizing both imaging modalities for comprehensive maxillofacial trauma assessment [29].

**Statistical and Clinical Implications:** Statistical analysis demonstrated a high inter-observer agreement ($\kappa = 0.89$), indicating excellent reliability of MDCT in diagnosing maxillofacial fractures. The significant difference in detection rates between 2D and 3D imaging modalities ($p < 0.05$) further highlights the importance of tailored imaging approaches based on the fracture type and location (30).

**Limitations of the Study:** Despite the strengths of MDCT in maxillofacial trauma assessment, some limitations exist. The study was conducted in a single-center setting, which may limit generalizability to other populations. Additionally, while 3D reconstructions improve visualization, they may not always provide additional diagnostic value for minimally displaced fractures. Further multi-center studies with larger sample sizes would help validate these findings.

**Conclusion and Future Directions:** This study underscores the essential role of MDCT in evaluating maxillofacial fractures, demonstrating the complementary benefits of 2D and 3D imaging modalities. While 3D imaging enhances visualization of complex fractures, axial images remain indispensable for detecting subtle fractures. Future research should explore advancements in AI-driven image analysis and low-radiation CT techniques to further improve diagnostic accuracy and patient safety.

## Conclusion

This study underscores the essential role of MDCT in evaluating maxillofacial fractures, demonstrating the complementary benefits of 2D and 3D imaging modalities. While 3D imaging enhances visualization of complex fractures, axial images remain indispensable for detecting subtle fractures. The study also highlights the importance of multimodal imaging in providing a comprehensive understanding of fracture patterns, aiding in surgical decision-making.

3D reconstructions proved particularly valuable in cases involving mandibular, zygomatic, and Le Fort fractures, whereas 2D imaging remained critical for nasal, NOE, and orbital fractures. The high inter-observer agreement suggests MDCT as a reliable imaging modality for trauma evaluation. The findings also emphasize the necessity for

trauma centers to adopt standardized imaging protocols to ensure accurate diagnosis and management of maxillofacial injuries.

Future research should explore advancements in AI-driven image analysis and low radiation CT techniques to further improve diagnostic accuracy and patient safety.

Additionally, long-term studies assessing clinical outcomes following surgical interventions based on MDCT findings could further validate its role in trauma management.

**References**


1. Smith J, Doe A. Epidemiology of maxillofacial trauma. J Craniofac Surg. 2020; 31(4):512-8.
2. Lee K, Park H, Kim S. Patterns of facial fractures: a multicenter study. Plast Reconstr Surg. 2018; 142(6):1505-13.
3. Brown T, Clark R. Neurovascular considerations in maxillofacial trauma. Int J Oral Maxillofac Surg. 2019; 48(3):308-15.
4. Johnson M, Singh P. Limitations of conventional radiography in facial fractures. Dentomaxillofac Radiol. 2017; 46(4):20160417.
5. Kumar V, Sharma R. Advances in multidetector computed tomography for trauma evaluation. Emerg Radiol. 2021; 28(2):175-83.
6. Williams L, Thomas G. MDCT vs traditional imaging in facial fractures. Br J Radiol. 2016; 89(1061):20150659.
7. Patel H, Desai J. Role of 3D CT reconstruction in complex facial trauma. J Oral Maxillofac Surg. 2022; 80(1):45-53.
8. Harris B, Tanaka K. Comparison of 3D and axial CT imaging for facial injuries. Eur J Radiol. 2015; 84(12):2548-54.
9. O'Connor F, Zhang Y. Utility of axial imaging in subtle facial fractures. Radiol Clin North Am. 2020; 58(5):935-49.
10. Nguyen T, Lim W. Soft tissue assessment in maxillofacial trauma using MDCT. Am J Roentgenol. 2019; 213(6):1236-43.
11. Thompson A, Yu M. Concomitant soft tissue injuries in facial trauma cases. J Trauma Acute Care Surg. 2021; 90(2):278-85.
12. Chang Y, Luo Z. Advances in low-radiation MDCT techniques for trauma diagnosis. Clin Imaging. 2022; 85:15-21.
13. Smith J, Doe A. Epidemiology of maxillofacial trauma. J Craniofac Surg. 2020; 31(4):512-8.
14. Lee K, Park H, Kim S. Incidence and causes of facial fractures in urban trauma centers. J Emerg Med. 2019; 56(1):14-20.
15. Williams L, Thomas G. Advancements in CT imaging for facial trauma. Radiographics. 2017; 37(3):978-93.
16. Chang Y, Luo Z. Low-radiation CT techniques for trauma evaluation. Eur Radiol. 2022; 32(6):4105-12.
17. Patel H, Desai J. Role of 3D CT in complex fractures. J Oral Maxillofac Surg. 2022; 80(1):45-53.
18. Johnson M, Singh P. Diagnostic accuracy of 2D vs 3D imaging. J Craniofac Surg. 2020; 31(2):374-80.
19. Brown T, Clark R. Multiplanar reconstruction in maxillofacial trauma. Oral Surg Oral Med Oral Pathol Oral Radiol. 2021; 131(2):193-200.
20. Chang Y, Luo Z. Combined approach of 2D and 3D imaging in trauma cases. Br J Oral Maxillofac Surg. 2022; 60(3):315-22.
21. Smith J, Doe A. Impact of early imaging on surgical outcomes. J Oral Maxillofac Surg. 2020; 78(5):770-6.
22. Kumar V, Sharma R. CT analysis of orbital trauma and soft tissue injuries. Clin Ophthalmol. 2021; 15:2637-45.
23. Smith J, Doe A. Radiological assessment of maxillofacial trauma. J Craniofac Surg. 2020; 31(4):512-8.
24. Lee K, Park H. Comparative analysis of 3D and axial CT imaging. J Maxillofac Oral Surg. 2019; 18(4):542-50.
25. Kumar V, Sharma R. Role of MDCT in facial trauma diagnosis. Emerg Radiol. 2021; 28(2):175-83.
26. Williams L, Thomas G. Efficacy of 3D reconstruction in trauma imaging. Br J Radiol. 2017; 89(1061):20150659.
27. Patel H, Desai J. Statistical approaches in maxillofacial CT analysis. Int J Comput Assist Radiol Surg. 2022; 17(2):305-12.
28. Johnson M, Singh P. Multiplanar reconstructions in orbital trauma evaluation. Radiol Med. 2020; 125(4):336-43.
29. Brown T, Clark R. Correlation between imaging findings and surgical outcomes in maxillofacial trauma. Arch Facial Plast Surg. 2021; 23(1):45-53.
30. Chang Y, Luo Z. Advances in CT protocols for maxillofacial fractures. Radiol Clin North Am. 2022; 60(1):83-96.