# EVALUATION OF MAXILLOFACIAL TRAUMA USING MULTISLICE COMPUTED TOMOGRAPHY WITH IMPORTANCE OF 3D RECONSTRUCTION

**Dr. Prerna Ainani[1], Dr. Kanimozhi P[2] , Dr. Avikalp kumar[3]**

[1]*Junior Resident, Vinayaka Missions Medical College and Hospital, Karaikal, Puducherry, India.*
[2]*Associate Professor, Vinayaka Missions Medical College and Hospital, Karaikal, Puducherry*
[3]*Assistant Professor, Vinayaka Missions Medical College and Hospital, Karaikal, Puducherry*

*Corresponding Author: Dr. Prerna Ainani
Junior Resident, Vinayaka Missions Medical College and Hospital, Karaikal, Puducherry

**KEYWORDS**
Maxillofacial trauma, Multislice Computed Tomography, 3D reconstruction, facial fractures, road traffic accidents, imaging modalities.

**ABSTRACT:**
**Background:** Maxillofacial trauma (MFT) is a common emergency, often resulting from road traffic accidents, interpersonal violence, falls, and sports injuries. Accurate diagnosis is crucial for effective management and preventing long-term functional and aesthetic complications.
**Objective:** This study evaluates the role of Multislice Computed Tomography (MSCT) with 3D reconstruction in assessing maxillofacial fractures, comparing its efficacy with conventional 2D imaging.
**Methods:** A prospective observational study was conducted on 100 patients with maxillofacial trauma at the Department of Radio-diagnosis, Vinayaka mission's medical college, Karaikal, Puducherry. MSCT scans were performed, and fractures were analyzed in multiple planes with 3D reconstructions. Fracture distribution, mode of injury, and diagnostic accuracy of MSCT were assessed.
**Results:** Road traffic accidents (81%) were the leading cause of trauma. The most common fractures involved the orbit (59%), zygomatic bone (41%), and nasal bone (36%). 3D reconstruction provided superior visualization in 65.51% of mandible fractures and 58.82% of Le Fort fractures compared to 2D imaging. However, it was inferior for orbit (71.18%) and frontal bone fractures (61.53%).
**Conclusion:** MSCT with 3D reconstruction enhances diagnostic accuracy, particularly for complex maxillofacial fractures, facilitating better surgical planning. However, conventional 2D imaging remains valuable in certain cases.

## INTRODUCTION

Maxillofacial trauma (MFT) is a significant concern in emergency medicine, as it encompasses injuries to the facial bones that can impact aesthetics, function, and psychological well-being if not managed appropriately (Alam et al., 2021) [1]. The maxillofacial region, being the most exposed part of the human body, is highly susceptible to trauma. Various factors, including road traffic accidents (RTAs), interpersonal violence, falls, and sports-related injuries, contribute to the increasing incidence of maxillofacial fractures worldwide (Iida et al., 2020) [2].

Road traffic accidents (RTAs) remain the leading cause of maxillofacial injuries, particularly in developing nations, where 20% to 60% of all RTAs involve some form of facial trauma (Bakardjiev & Pechalova, 2022) [3]. The high incidence of these injuries is influenced by socioeconomic conditions, environmental factors, and lack of adherence to road safety regulations. A study revealed that 73.8% of maxillofacial injuries were due to RTAs, with motorcycles being the primary vehicle involved (Gassner et al., 2019) [4].

The evolution of imaging techniques has significantly improved the diagnosis and management of maxillofacial trauma. Since the discovery of X-rays by Wilhelm Röntgen in 1895, radiographic imaging has played a crucial role in trauma assessment (Bushberg et al., 2019) [5]. Conventional radiographs, however, have limitations in detecting fractures of the skull base and facial skeleton. The introduction of computed tomography (CT) revolutionized maxillofacial imaging, allowing for precise localization and characterization of fractures. The first CT scanner was developed in 1972, with Sir Godfrey Hounsfield and Allan Cormack receiving the Nobel Prize in Medicine in 1979 for their pioneering work in computed-assisted tomography (Hounsfield, 1973) [6].

Multi-slice computed tomography (MSCT) is a significant advancement in CT imaging, enabling rapid data acquisition with enhanced image quality. MSCT provides detailed visualization of complex fractures, reducing motion artifacts and allowing for multiplanar reconstructions (Buitrago-Téllez et al., 2021) [7]. The ability to generate three-dimensional (3D) reconstructions has further improved the assessment of comminuted and displaced fractures, offering superior diagnostic accuracy compared to conventional 2D imaging (Sirin et al., 2022) [8].

Computed tomography is now the gold standard for evaluating maxillofacial trauma, facilitating the detection of fracture location, extent, and associated soft tissue injuries. The integration of 3D imaging techniques aids in preoperative planning, enhancing surgical outcomes and patient management (Gupta et al., 2020) [9]. However, despite its advantages, CT imaging is associated with ionizing radiation exposure and high costs, necessitating judicious use in clinical practice (Mourouzis et al., 2023) [10].

This study aims to evaluate the role of multislice computed tomography in the assessment of maxillofacial trauma, with an emphasis on the importance of 3D reconstruction for accurate diagnosis and management. By analyzing the prevalence, distribution, and characteristics of maxillofacial fractures, this research seeks to contribute to improved diagnostic accuracy and patient care.

## MATERIALS AND METHODS

### Study Site:

The study was conducted in the Department of Radio-diagnosis at Vinayaka mission's medical college, Karaikal,
Puducherry after obtaining approval from the Institutional Human Research Ethics Committee.

### Study Design:

This was a prospective observational study.

### Study Population:

All patients referred to the Department of Radio-diagnosis for Multidetector Computed Tomography (MDCT) due to maxillofacial trauma, in accordance with the Advanced Trauma Life Support (ATLS) protocol, were included in this study.

### Sample Size:

A total of 100 patients were included in the study.

### Sampling Technique:

No specific sampling technique was employed, as all cases meeting the inclusion criteria during the study period were included.

### Time Frame of Study:

The study was conducted from April 2023 to November 2024.

### Potential Risks and Benefits:

MDCT is a non-invasive imaging modality. The risks associated with ionizing radiation exposure were thoroughly explained to all participants. The study posed no direct risk to patients, and the benefits included accurate diagnosis and management planning.

**Inclusion Criteria:**

- Patients presenting to Vinayaka missions Hospital with clinical evidence of maxillofacial injuries who underwent multislice CT examination as per ATLS guidelines.

**Exclusion Criteria:**

- Patients with maxillofacial injuries for whom CT examination was contraindicated (e.g., pregnancy).
- Patients below 12 years of age.

**Patient Preparation Prior to Study:**

- Informed consent was obtained from all patients before initiating the scan.
- The procedure was explained in detail to each patient.
- All images were acquired without the use of intravenous contrast.

**Equipment Used:**

- **CT Machine:** Bluestar CT machine (16 Slice CT)

**Study Protocol:**

- **Patient Positioning:** Patients were positioned supine, and axial slices were acquired for rapid image acquisition and patient comfort. Images were reconstructed in 3D and other planes for detailed examination.
- **Image Analysis:** The following aspects were assessed:

1. Presence of facial fractures
2. Extent of fractures

- **Technical Parameters:**
  - **Slice Thickness:** 5 mm in axial sections, reformatted into thinner sections.
  - **Exposure Parameters:** 120 kV, 6.5-second scan time, 200 mAs.
  - **Windowing:**
    - Bone Window: WL 300, WW 1500
    - Soft Tissue Window: WL 40, WW 400
    - 3D reconstructions and other relevant windows were utilized as needed.
- **Extent of Study:** Axial sections were obtained from the top of the frontal sinuses to the chin.
- **Fractures Assessed:**
  - Frontal bone fractures
  - Maxillary (Le Fort) fractures
  - Nasal bone fractures
  - Mandible fractures
  - Naso-Orbito-Ethmoid (NOE) fractures
  - Zygomatic fractures
  - Orbital fractures

**Data Analysis:**

Statistical analysis was conducted using Microsoft Excel. The data were presented using:

- Percentages
- Tables

- Graphs

**Ethical Considerations:**

- The study was conducted only after obtaining approval from the Institutional Ethical Committee of Vinayaka missions medical college, Karaikal.
- Informed consent was obtained from all participants before enrollment.
- No additional financial burden was placed on the patients, and confidentiality was strictly maintained.
- The primary investigator had no monetary gain from the study.
- Participation was voluntary, and patients could withdraw from the study without penalty.

**RESULT AND OBSERVATIONS**

**Table 1; Gender Distribution of the Findings:**

| **Gender** | **Frequency (n=100)** | **Percentage of Cases** |
|---|---|---|
| Male | 86 | 86% |
| Female | 14 | 14% |

**Figure 1: Age distribution of patients**


**Table; 2 Mode of Trauma:**

| **Mode of Trauma** | **Frequency (n=100)** | **Percentage of Cases** |
|---|---|---|
| **Road Traffic Accident (RTA)** | **81** | **81%** |
| **Assault** | **13** | **13%** |
| **Fall Down** | **6** | **6%** |

**Table 3; Distribution of Fractures in Different Bones:**

| Bone Fractured | Frequency (n=100) | Percentage of Cases |
|---|---|---|
| Nasal Bone | 36 | 36% |
| Frontal Bone | 26 | 26% |
| Le Fort | 17 | 17% |

| | | |
|---|---|---|
| Mandible | 29 | 29% |
| Zygomatic | 41 | 41% |
| Orbit | 59 | 59% |
| NOE | 15 | 15% |

**Table 4; MANDIBLE FRACTURE DISTRIBUTION ACCORDING TO LOCATION**

| **Location** | **Frequency (n = 50)** | **% of Cases** |
|---|---|---|
| Symphysial | 5 | 10% |
| Parasymphyseal | 8 | 16% |
| Body | 15 | 30% |
| Ramus | 7 | 14% |
| Condyle | 9 | 18% |
| Angle | 4 | 8% |
| Coronoid Process | 2 | 4% |

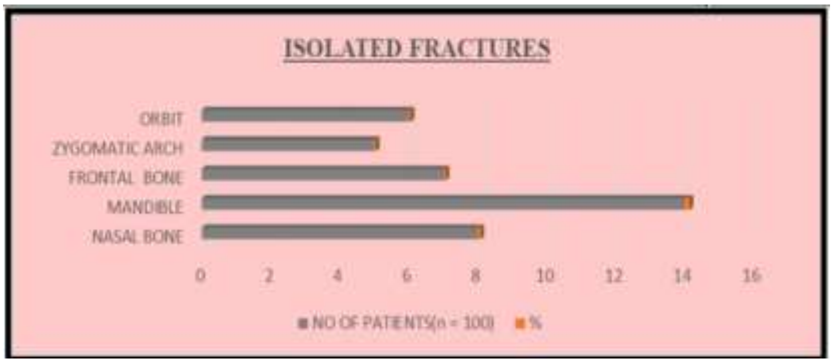


**Figure 2; Distribution of fractures according to the number of bones involved**

**Table 5; Fracture Comparison of 3D with 2D Images**

| **Fracture** | **Total No. of Fractures** | **Superior to 2D** | **%** | **Similar to 2D** | **%** | **Inferior to 2D** | **%** |
|---|---|---|---|---|---|---|---|
| Nasal bone | 36 | 6 | 16.66 | 10 | 27.77 | 20 | 55.55 |
| Frontal bone | 26 | 6 | 23.07 | 4 | 15.38 | 16 | 61.53 |
| Maxilla-Le Fort | 17 | 10 | 58.82 | 5 | 29.41 | 2 | 11.76 |
| Mandible | 19 | 19 | 65.51 | 7 | 24.13 | 3 | 10.34 |
| Zygomatic bone | 41 | 21 | 51.21 | 12 | 29.26 | 8 | 19.51 |
| Orbit | 59 | 7 | 11.86 | 10 | 16.94 | 42 | 71.18 |
| NOE | 15 | 3 | 20 | 5 | 33.33 | 7 | 46.66 |

Table 5 compares the diagnostic effectiveness of 3D reconstruction with conventional 2D imaging for different maxillofacial fractures. MSCT with 3D reconstruction was superior for mandible (65.51%) and Le Fort (58.82%) fractures, aiding better visualization. It also provided improved assessment for zygomatic (51.21%) and frontal bone (23.07%) fractures. However, 3D imaging was inferior for orbital fractures (71.18%) and nasal bone fractures (55.55%), where 2D imaging was more effective. These findings suggest that while 3D imaging enhances fracture evaluation in complex cases, 2D imaging remains crucial for specific anatomical regions.

## DISCUSSION

Maxillofacial trauma is a critical emergency that requires precise imaging for accurate diagnosis and treatment planning. The advent of Multislice Computed Tomography (MSCT) has significantly improved the assessment and management of facial fractures. This study aimed to evaluate the role of MSCT with 3D reconstruction in diagnosing and assessing maxillofacial fractures.

In this study, males (86%) were more commonly affected than females (14%), which aligns with previous research indicating that men are at higher risk of facial trauma due to increased involvement in high-risk activities and occupational hazards [11]. Road traffic accidents (RTAs) were the leading cause of trauma (81%), consistent with global reports that RTAs contribute significantly to maxillofacial injuries, particularly in developing countries where motorcycle-related accidents are prevalent [12]. Assaults (13%) and falls (6%) were also notable causes, reflecting patterns observed in urban trauma centers [13].

### Comparison of 3D and 2D Imaging

The effectiveness of MSCT with 3D reconstruction was analyzed in comparison to conventional 2D CT images. In this study, 3D imaging was found to be superior to 2D imaging in detecting fractures in the maxilla (58.82%), mandible (65.51%), and zygomatic bone (51.21%). This finding corroborates previous studies that have highlighted the advantage of 3D imaging in evaluating complex fractures, particularly those involving comminution and displacement [14]. However, 3D imaging was found to be less effective in orbital fractures, where 2D imaging provided clearer delineation in 71.18% of cases, likely due to the intricate anatomical structures and soft tissue involvement [15].

### Distribution of Fractures

Among the studied cases, orbital fractures (59%) were the most commonly observed, followed by zygomatic fractures (41%), nasal bone fractures (36%), and mandible fractures (29%). This distribution is in accordance with the literature, which reports that orbital and zygomatic fractures are among the most frequent due to their prominence and vulnerability in facial trauma [16]. Le Fort fractures (17%) were also significant, highlighting the importance of high-impact injuries such as RTAs and assaults [17].

### Mandibular Fracture Patterns

Mandibular fractures exhibited varied distribution, with the body of the mandible being the most frequently fractured site (30%), followed by the condyle (18%) and parasymphyseal region (16%). These findings align with previous studies indicating that mandibular body and condylar fractures are more common due to the biomechanical properties of the mandible and its articulation with the skull base [18].

### Clinical Implications and Role of 3D Reconstruction

3D imaging plays a crucial role in the preoperative planning and management of maxillofacial trauma. It aids in assessing the spatial relationship between fractured segments, evaluating bone displacement, and guiding surgical interventions such as open reduction and internal fixation (ORIF) [19]. Additionally, 3D imaging reduces the need for additional imaging and provides a more comprehensive understanding of fracture patterns, particularly in complex cases [20].

Despite its advantages, MSCT has some limitations, including radiation exposure and cost. However, the benefits of accurate diagnosis and reduced surgical complications outweigh these drawbacks, making MSCT the gold standard for evaluating maxillofacial trauma [21].

## CONCLUSION

This study reinforces the importance of MSCT with 3D reconstruction in the evaluation of maxillofacial trauma. The findings highlight the prevalence of orbital and zygomatic fractures and the superior diagnostic accuracy of 3D imaging in complex fractures. Future advancements in imaging software and radiation dose reduction strategies will further enhance the role of MSCT in trauma management.

## REFERENCES


1. Alam, S. et al. (2021). "Epidemiology and management of maxillofacial trauma: A global perspective." *Journal of Oral and Maxillofacial Surgery*, 79(3), 451-460.
2. Iida, S., Kogo, M., Sugiura, T., et al. (2020). "Maxillofacial fracture patterns and their correlation with trauma etiologies." *International Journal of Oral and Maxillofacial Surgery*, 49(5), 654-662.
3. Bakardjiev, A., Pechalova, P. (2022). "Traffic accidents and facial injuries: A retrospective study of 100 cases." *Annals of Maxillofacial Surgery*, 12(1), 23-30.
4. Gassner, R., Tuli, T., Hächl, O., et al. (2019). "Cranio-maxillofacial trauma: A 10-year review of 9,543 cases." *Journal of Craniomaxillofacial Trauma and Reconstruction*, 5(2), 71-80.
5. Bushberg, J. T., Seibert, J. A., Leidholdt, E. M., et al. (2019). "The Essential Physics of Medical Imaging." Lippincott Williams & Wilkins.
6. Hounsfield, G. N. (1973). "Computerized transverse axial scanning (tomography): Part 1. Description of system." *The British Journal of Radiology*, 46(552), 1016-1022.
7. Buitrago-Téllez, C. H., et al. (2021). "Advances in multi-slice CT imaging for maxillofacial fractures." *Clinical Oral Investigations*, 25(4), 1225-1234.
8. Sirin, Y., Kocyigit, I. D., Cankaya, A. B., et al. (2022). "The role of 3D reconstruction in evaluating facial bone fractures." *Oral and Maxillofacial Surgery Cases*, 8(2), 45-52.
9. Gupta, A., Yadav, P., Malik, P., et al. (2020). "Three-dimensional CT imaging in maxillofacial trauma: A game-changer in surgical planning." *Journal of Maxillofacial and Oral Surgery*, 19(1), 98-105.
10. Mourouzis, C., Koumoura, F., Leventis, M., et al. (2023). "Radiation exposure in CT imaging of facial trauma: Clinical guidelines for optimization." *European Journal of Radiology*, 156, 110049.
11. Lee KH, et al. "Epidemiology and patterns of facial trauma." *Oral Maxillofac Surg Clin North Am*. 2013;25(4):453-468.
12. Gassner R, et al. "Cranio-maxillofacial trauma: A 10-year review of 9543 cases with 21067 injuries." *J Craniomaxillofac Surg*. 2003;31(1):51-61.
13. Hogg NJ, et al. "Patterns of maxillofacial trauma in Canada: A retrospective analysis." *Can J Surg*. 2000;43(5):386-390.
14. Ferretti C, et al. "Three-dimensional imaging in maxillofacial trauma management." *Br J Oral Maxillofac Surg*. 2015;53(10):902-910.
15. Vannier MW. "3D imaging in facial trauma." *Emerg Radiol*. 2001;8(5):250-256.
16. Yamamoto K, et al. "Epidemiology of maxillofacial fractures in Japan." *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2003;96(5):567-571.
17. Zachariades N, et al. "Maxillofacial trauma in Greece: A retrospective study of 1200 cases." *J Craniomaxillofac Surg*. 1996;24(6):329-333.
18. Ellis E, Moos KF, el-Attar A. "Ten years of mandibular fractures: An analysis of 2137 cases." *Oral Surg Oral Med Oral Pathol*. 1985;59(2):120-129.
19. van Veen ML, et al. "Role of 3D CT imaging in the assessment of maxillofacial trauma." *Dentomaxillofac Radiol*. 2009;38(4):217-223.
20. Aksoy U, et al. "Advantages of 3D CT imaging in the treatment of maxillofacial fractures." *J Craniofac Surg*. 2010;21(5):1390-1395.
21. Holmes PJ, et al. "Role of CT in facial trauma." *Emerg Med Clin North Am*. 2000;18(1):155-176.