



## Spectrum of Mandibular Fractures in Motor Vehicle Accidents: MDCT Evaluation (Original Article)

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### Abstract

**Background:** Mandibular fractures consist of significant number of facial fractures, especially in cases of Motor vehicle accidents. MDCT plays a major role in determining the presence/ absence of fracture, gives accurate information of displacement and associated soft tissue injury and thin section and multiplanar reconstructions help in better evaluation of the fracture. This study describes the age and gender predilection and site of fracture with some clinical and treatment relevance.

**Materials and Methods:** A retrospective and prospective study was conducted in the department of radiodiagnosis, Bangalore Medical college and research institute for over a period of 1 year, from November 2014-October 2015 which included 98 cases of mandibular fracture by using multidetector computed tomography (MDCT). Cases were divided and assessed based on age, gender predominance, unifocal/ multiplicity, site of fracture and associated facial fractures.

**Results:** Of the 98 cases, male constituted 88% and remaining 12% were females. Most common age group was between 21-30 years. Most cases had multifocal fractures and the most common site of injury was condylar process (32%).

**Conclusion:** Road traffic accidents are very common in metropolitan cities like Bangalore and facial injuries

*with mandibular fractures constitute a significant number. Young and middle aged males are more prone for injury because of increased habit of risk taking and more exposure to risk. MDCT plays a major role in evaluation of patients with facial and mandibular trauma. It not only gives information about site and displacement of the fracture; but also helps in detection of adjacent soft tissue injury and airway.*

**Keywords:** Multidetector computed tomography, fractures, mandible, zygomatic fractures.

## Introduction

Mandibular fractures consist of significant number of facial fractures, especially in cases of Motor vehicle accidents. Prompt recognition and stabilization of such fractures are important as they can be life threatening by blocking the airway and have significant long term complications like mal-occlusion, mal-union and osteomyelitis. They can be unifocal or multiple depending on the force and direction of injury and position of the individual. In metropolitan like Bangalore, motor vehicle accidents are very frequent owing to increasing number of motorcycles on road, increasing need to travel distance to work, especially during dark hours of the day and drink and drive by the drivers, more so of heavy motor vehicles like lorries and tempos. Classification based on location (Figure 1 and 2) is the most useful classification, because both the signs and symptoms, and treatment are dependent upon the location of the fracture <sup>[1]</sup>.

Condylar fractures are classified by location with respect to capsule of ligaments that hold the temporomandibular joint (intracapsular or extracapsular), based on presence or absence of dislocation (whether or not the condylar head has come out of the glenoid fossa as the lateral pterygoid tend to pull the condyle antero-medially) and neck of the condyle fractures. Because the coronoid process lies deep to many structures, like the zygomatic complex (ZMC), it is rare to be broken in isolation. It usually occurs with mandibular fractures in other sites or with fracture of zygomatic arch or complex. Isolated fractures of the coronoid process must be viewed with suspicion and fracture of the ZMC should be ruled out <sup>[2]</sup>.

Ramus fractures are said to be present if it involves a region inferiorly bounded by an oblique line starting from the lower third molar region to the postero-inferior insertion of the masseter muscle, and which could not be classified as either condylar or coronoid fractures. The angle of the mandible refers to the angle created by the arrangement of the body and the ramus of the mandible. Angle fractures are those that involve a triangular region bounded anteriorly by the anterior border of masseter muscle and an oblique line extending from the lower third molar to the postero-inferior attachment of the masseter muscle. Fracture of the mandibular body is defined as that involving a region bounded anteriorly by the para-symphysis (vertical line just distal to the canine tooth) and posteriorly by the anterior border of masseter muscle. Para-symphyseal fractures are defined as mandibular fractures that involve an area bounded on both sides by vertical lines distal to the canine tooth. Symphyseal fractures are linear fractures that run in the midline of the mandible (symphysis menti). Alveolar fracture involves the alveolar process of the mandible <sup>[1]</sup>.

Dentition of mandible – Each Hemi mandible in adults is composed of two incisor teeth (Central and lateral incisor), one canine, two pre molars and three molars. Thus eight teeth in each hemi mandible and 16 teeth in mandible or lower jaw (Figure 3)

MDCT plays a major role in determining the presence/ absence of fracture, gives accurate information of displacement and associated soft tissue injury and thin section and multiplanar reconstructions help in better evaluation of the fracture. This study describes the age and gender predilection and site of fracture with some clinical and treatment relevance.

## Methods and Materials

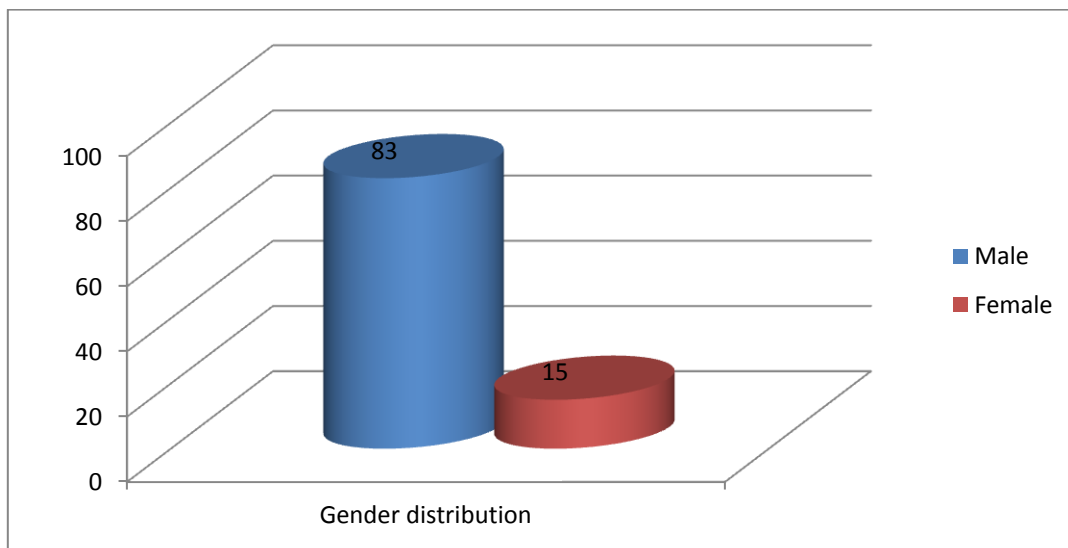
This study is conducted in Department of radio-diagnosis, Bangalore medical college and research institute, Bangalore which is a referral as well as a teaching institute. Multi slice CT GE somatom scanner was used to evaluate every patient who was referred to the department with motor vehicle accident. Scans were acquired

in bone soft tissue algorithm and thinner reconstructions, multiplanar imaging and volume rendering reconstruction were done in workstation. Each case was evaluated for the presence of mandibular fracture, site and multiplicity. Cases were collected retrospectively as well as prospectively over a period of 1 year, from November 2014- October 2015. Out of 533 cases of facial fractures, 98 cases had mandibular fracture. Patients belonged to age group between 11-60 years. Patients with non- motor vehicle accidents like fall from height and assault were excluded from the study. They were then divided and assessed based on age, gender predominance, unifocal/ multiplicity, site of fracture and associated facial fractures. Depending on site of fracture, cases were divided into condylar, angle, ramus, body, coronoid, symphyseal/ parasymphyseal and isolated alveolar ridge fractures.

**Results**

In this study, there were 533 cases with facial fractures, of which 98 cases had mandibular fractures.

**Chart 1: Gender distribution**



Out of the 98 cases of mandibular fracture (age group: 11- 60 years, mean 35.5), male constituted 83 number (88%) and females were 15 cases (12%).

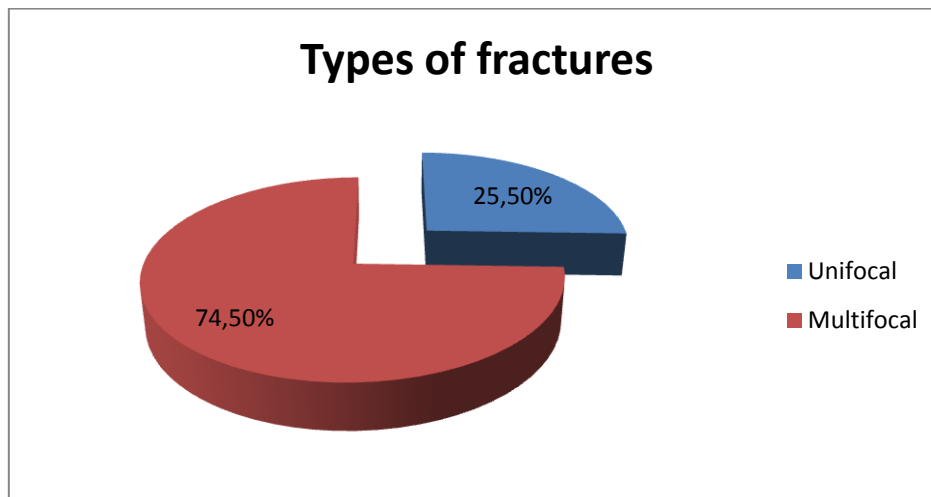
**AGE AND GENDER DISTRIBUTION:**

**Table 1:** Distribution of cases based on age and gender:

| Age group | Male | Female | Total number |
|-----------|------|--------|--------------|
| 11- 20    | 13   | 3      | 16           |
| 21- 30    | 40   | 7      | 47           |
| 31- 40    | 20   | 4      | 24           |
| 41- 50    | 9    | 0      | 9            |
| 51- 60    | 1    | 1      | 2            |

Most common age group was between 21-30 years followed by 31-40 years. Total numbers of fractures in these 98 cases were 887.

**Chart 2:** Types of fracture

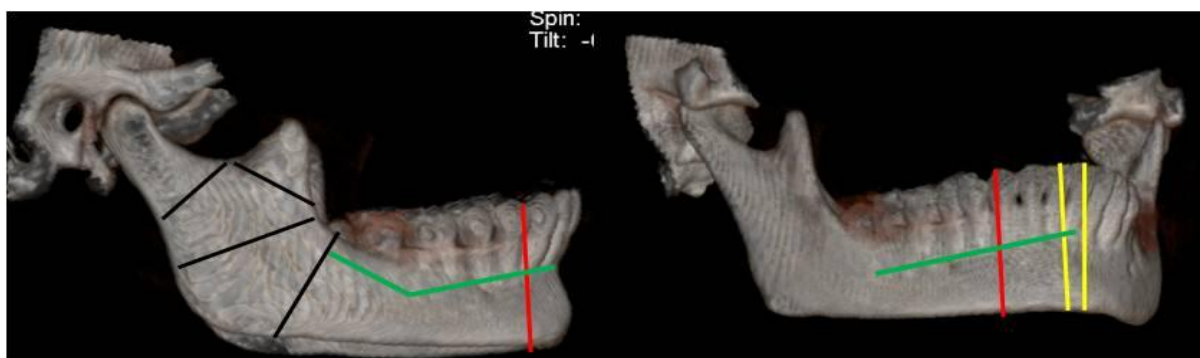


Single site fracture (unifocal) was found in 25 cases (25.5%) (Fig 4) and multiple fractures were the remaining 73 cases (74.5%) (Fig 5).

**Table 2:** Location of fractures

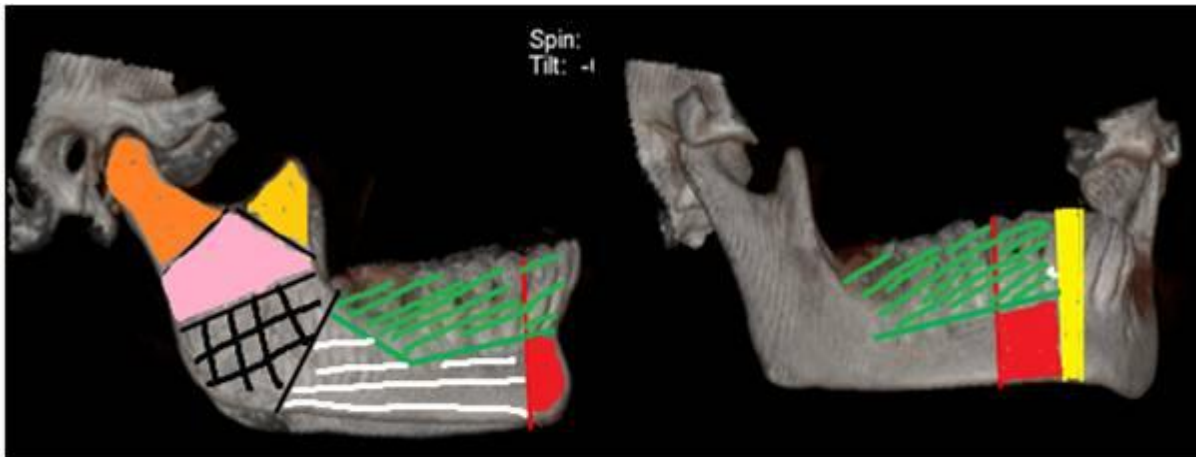
| Sl. No. | Location of fracture     | Number | Percentage |
|---------|--------------------------|--------|------------|
|         | Condylar process         | 284    | 32         |
|         | Angle of mandible        | 160    | 18         |
|         | Ramus                    | 53     | 6          |
|         | Body of mandible         | 230    | 26         |
|         | Coronoid process         | 18     | 2          |
|         | Symphysis/ parasymphysis | 115    | 13         |
|         | Alveolar ridge           | 27     | 3          |

Site of fractures were divided into condylar, angle, ramus, body, coronoid, symphyseal/ parasymphyseal and alveolar ridge. Of these 887 fractures, there are 284 condylar fractures (32%) (Fig 6) and one normal variant of condyle mimicking fracture was found (Fig 7), 160 fractures at the angle (18%) (Fig 8), 53 at the ramus (6%) (Fig 9), 230 fractures at the body of mandible (26%) (Fig 9), 18 at the coronoid process (2%) (Fig 10), 115 at the symphyseal/ parasymphyseal region (13%) (Fig 11, 12), and 27 cases had fractures at alveolar ridge (3%). In this study, condylar process fractures constituted majority, consisting of 32% of total number, followed by fractures of body of the mandible.

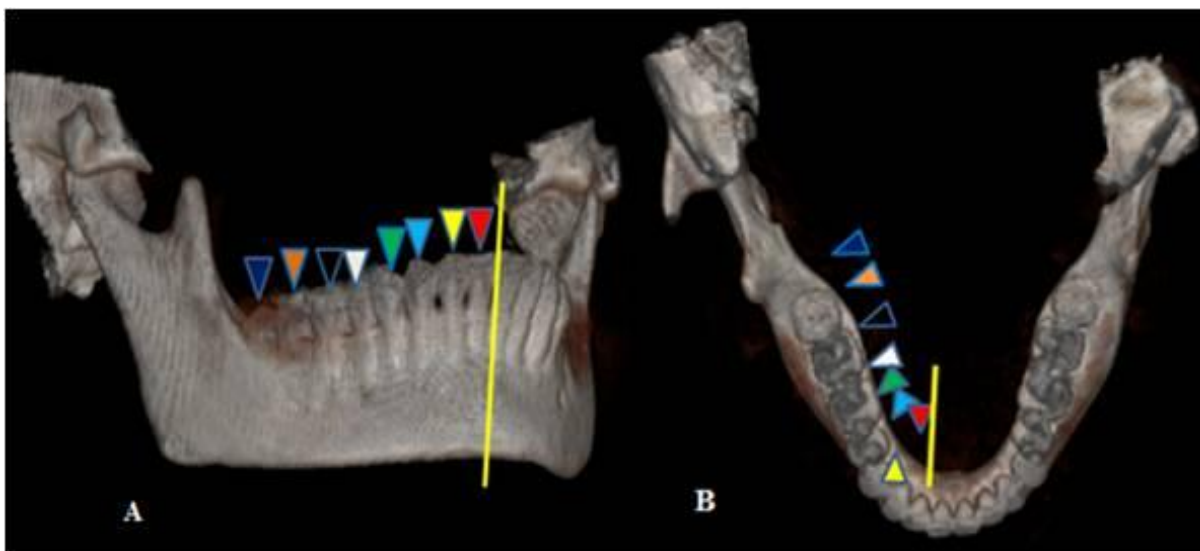


**Figure 1:** GRAPHIC DEPICTION SHOWING HOW PARTS OF MANDIBLE ARE CLASSIFIED: Symphysis – Area between central incisors (area between yellow lines), Para symphysis – Area between central incisor and canine (Area between lateral yellow line and red line), Alveolar process of mandible –

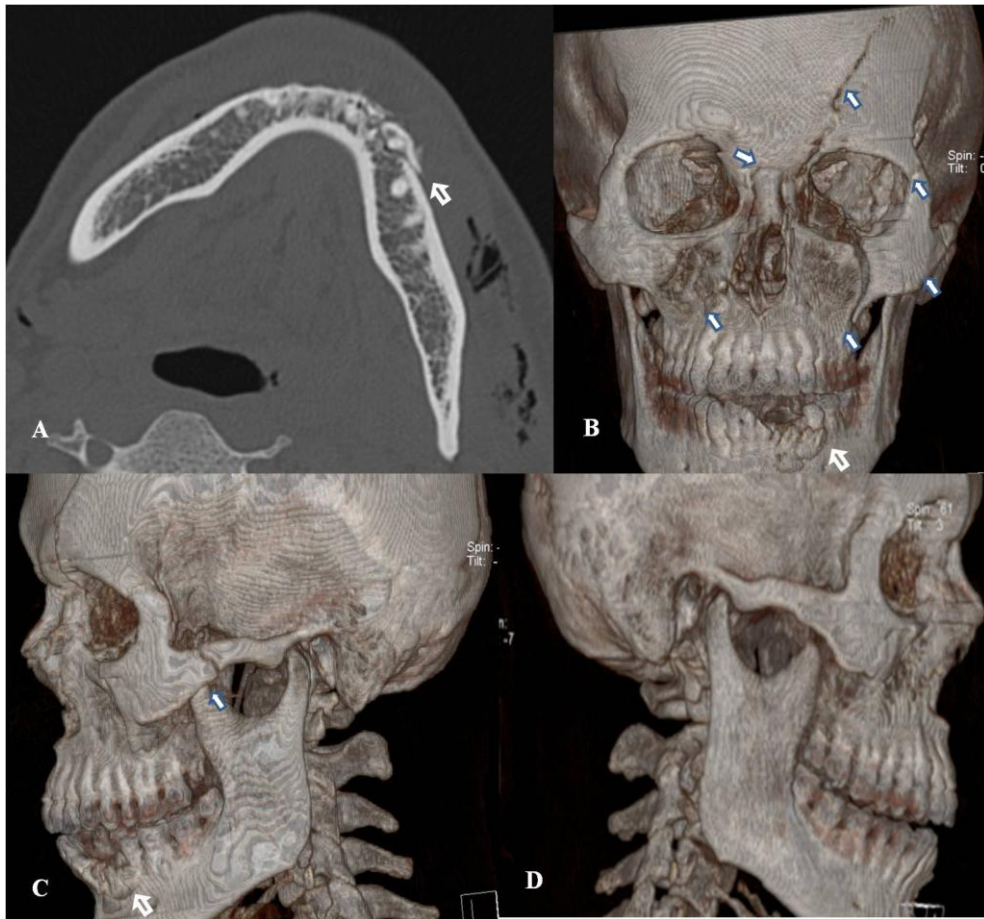
Superior part of mandible consisting of tooth (Area above green line), Body of mandible – Area bounded anteriorly by the parasymphysis (defined as a vertical line just distal to the canine tooth ) and posteriorly by the anterior border of the masseter muscle (Area between red line and medial most black line), Angle of mandible fractures are defined as those that involve a triangular region bounded by the anterior border of masseter muscle and an oblique line extending from the lower third molar (wisdom tooth) region to the posteroinferior attachment of the masseter muscle (Area bounded by medial most black line and black line distal to it, Condylar process of mandible : Area of projected part of mandible involved in TMJ, Coronoid process: Triangular area of projected bone of mandible anterior to condylar process, Ramus of mandible – Remnant area between body, condylar and coronoid process of mandible.



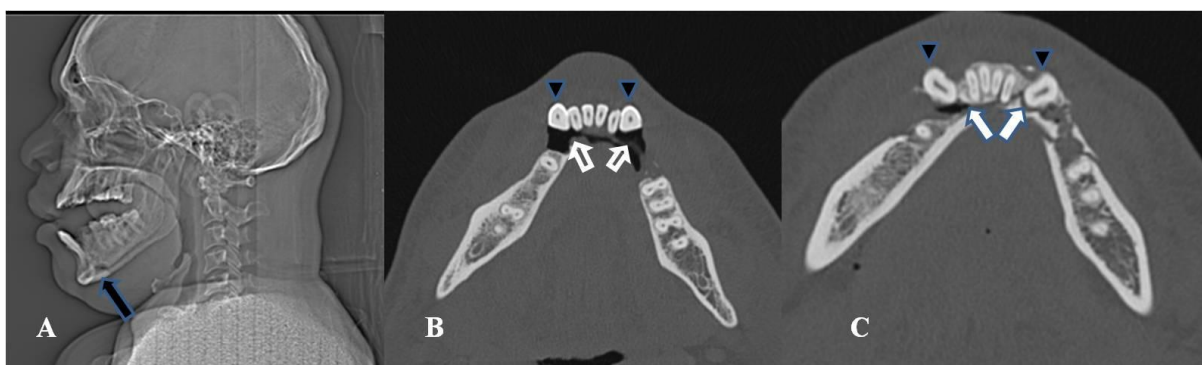
**Figure 2:** GRAPHIC DEPICTION OF PARTS OF MANDIBLE – Symphysis of mandible – Area shaded in yellow, Parasymphysis of mandible – Area shaded in red, Alveolar process of mandible – Area shaded with oblique green lines, Body of mandible – Area shaded with transverse white lines, Angle of mandible – Area Shaded with criss cross black lines, Ramus of mandible – Area shaded in pink, Coronoid process – Area shaded in yellow, Condylar process – Area shaded in orange.



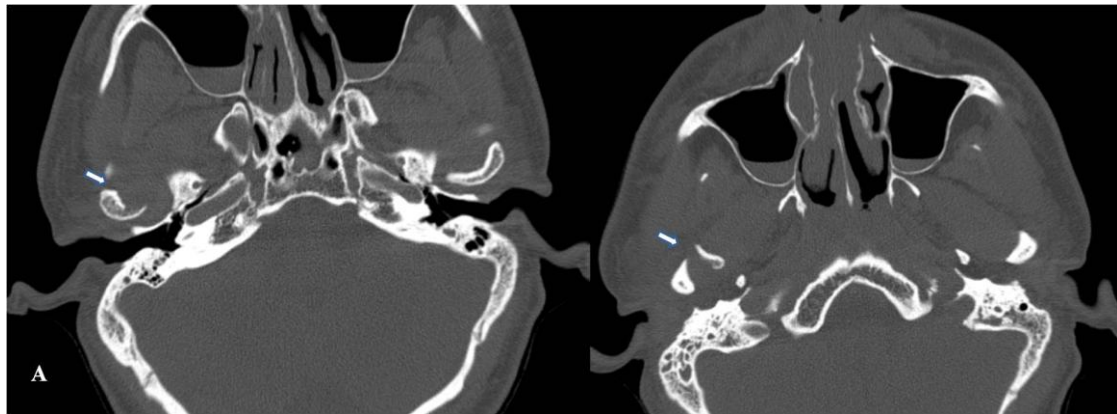
**Figure 3:** DENTITION OF RIGHT HALF OF MANDIBLE: Graphic depiction of mandible in A- lateral view, B-Anterior view and C – Superior view - Showing Central incisor (Red arrow head), Lateral incisor (Yellow arrow head), Canine (Blue arrow head), First Pre molar (Green arrow head), Second Pre molar (White arrow head), First Molar (Black arrow head), Second Molar (Orange arrow head), Third molar (Dark blue arrow head).



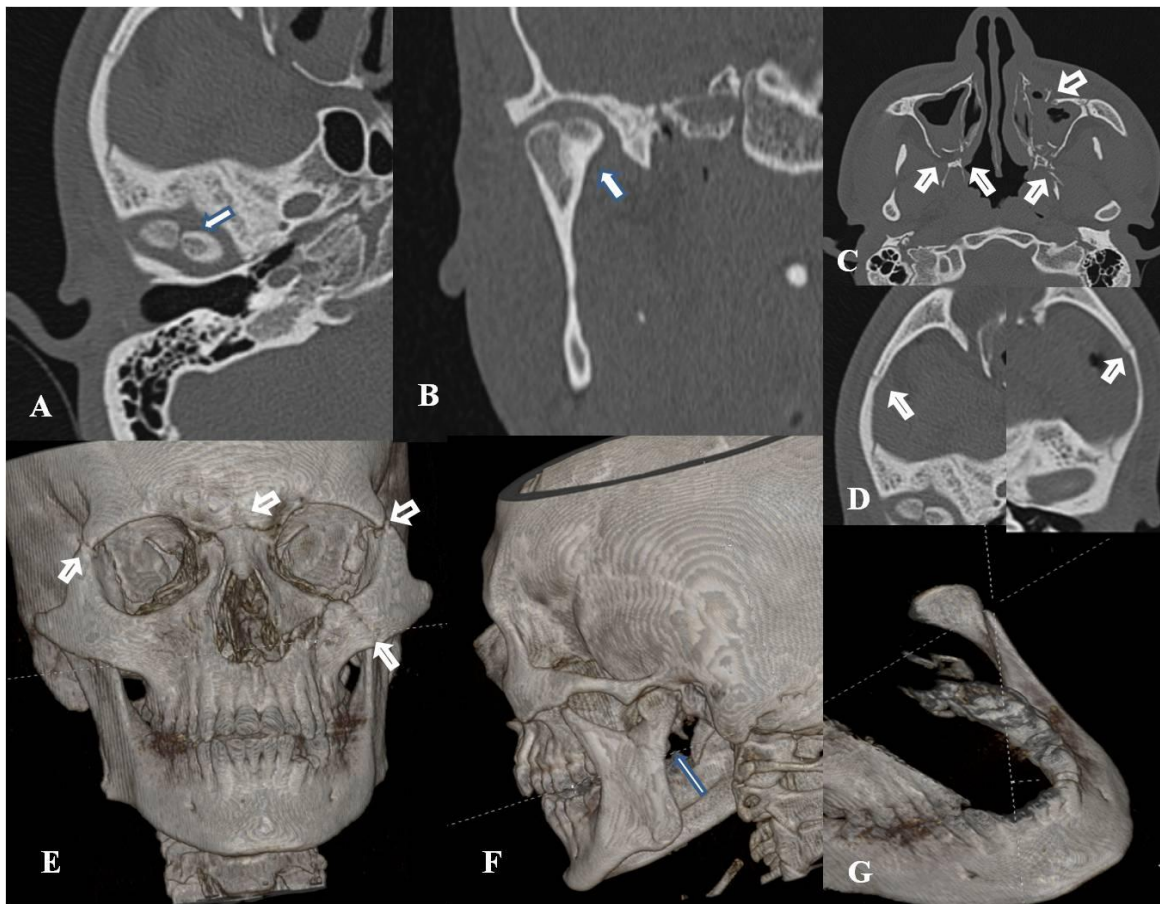
**Figure 4:** Left hemi mandible alveolar process unifocal fracture at symphysis and para symphysis region, left Le Fort I, II, III fracture, left tripod fracture, fracture of left frontal bone, bilateral maxillary sinuses wall fracture: A – Axial section bone window – Showing unifocal fracture of alveolar process of mandible at left symphysis and para symphysis region (outlined arrow), B,C,D – VRT AP, left lateral and right lateral view – Showing associated fractures (Normal arrow), fronto – nasal junction fracture, left frontal bone fracture, left tripod fracture, bilateral maxillary sinus wall fractures and unifocal left mandibular alveolar process fracture (outlined arrow) and rest of mandible is normal.



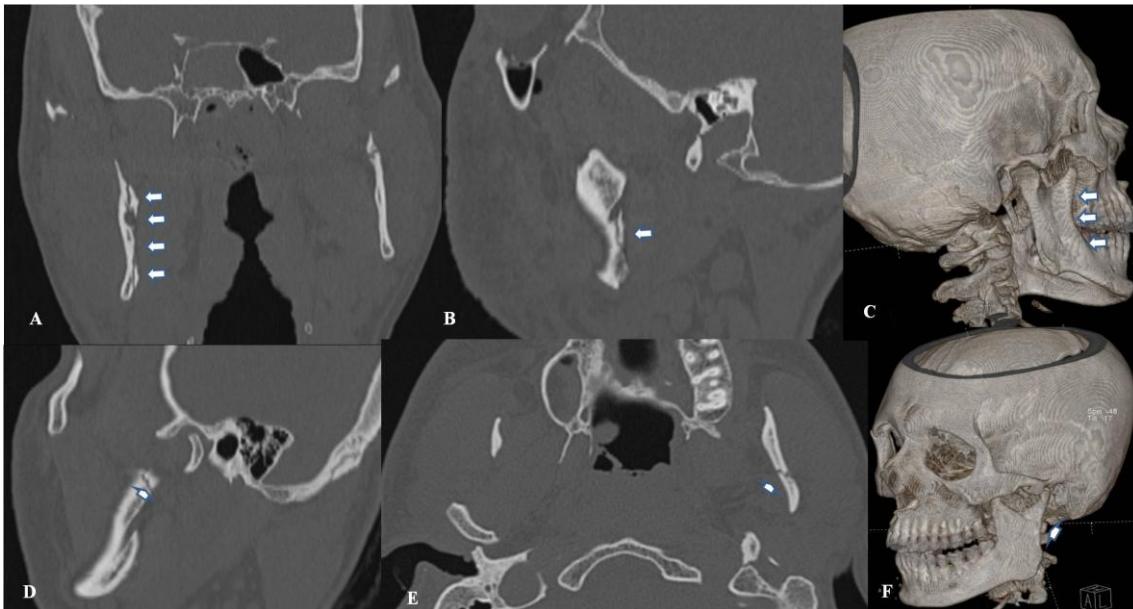
**Figure 5:** Bilateral body and para symphysis fracture of mandible – A, Scannogram showing fracture of body of mandible with significant anterior displacement (Long arrow), B, C- Axial section bone window showing fracture lines lateral (outlined arrows) to canine (Arrow head) and fracture lines medial (Normal arrows) to canine (Arrow head) - comminuted displaced fracture involving bilateral body and parasymphysis of mandible.



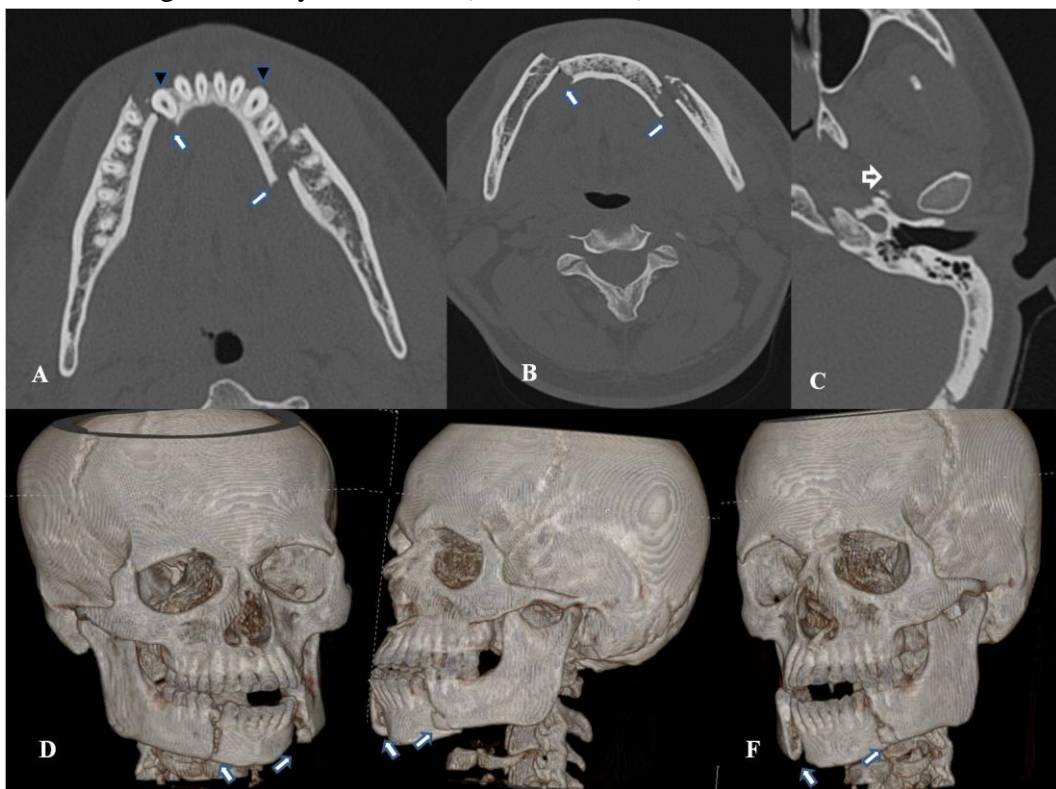
**Figure 6:** Axial section bone window - unifocal displaced fracture involving articular surface of right condylar process (arrows).



**Figure 7:** Normal variant of right condylar head with bilateral le fort i, ii, iii fracture, left tripod fracture and unifocal left sub condylar fracture : A, Axial section bone window showing suspicious fracture of articular surface of right condylar head (Normal arrow), B, coronal section bone window – showing no fracture of right condylar head but a normal variant of condylar head (Normal arrows), C,D and E – Axial section bone window and VRT AP view – showing associated fractures (outlined arrow) fracture of walls of bilateral maxillary sinuses, bilateral pterygo maxillary disjunction and fractured pterygoid plates, bilateral zygomatic arch fracture, fronto – nasal disjunction, fracture of lateral wall of bilateral orbits and left tripod fracture, F-G – VRT left posterior view and oblique view of mandible - showing sub condylar fracture of left condyle ( Long arrows).

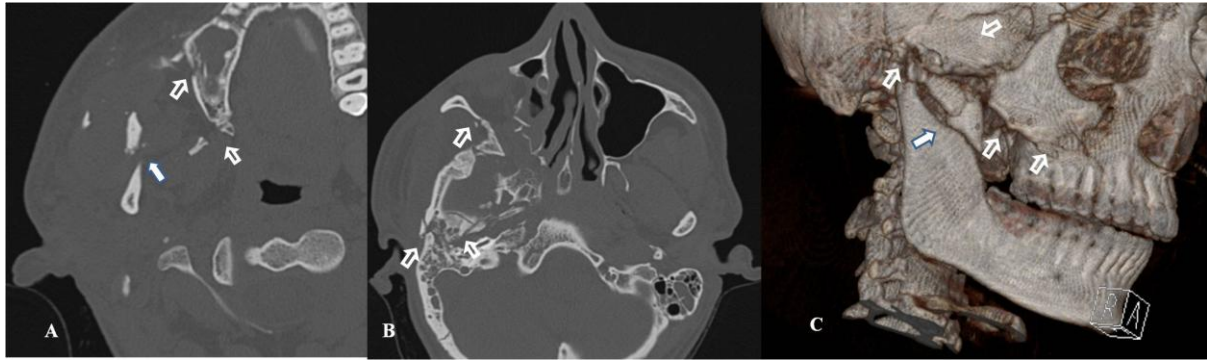


**Figure 8:** Right longitudinal fracture of ramus and angle of mandible and left condylar fracture – A,B,C – Coronal, right sagittal reconstructed image and VRT right lateral oblique view - showing longitudinal fracture involving right ramus and angle of mandible (Normal arrows) – D,E,F – left sagittal, axial and VRT left lateral view – showing left condylar fracture (Short arrows).

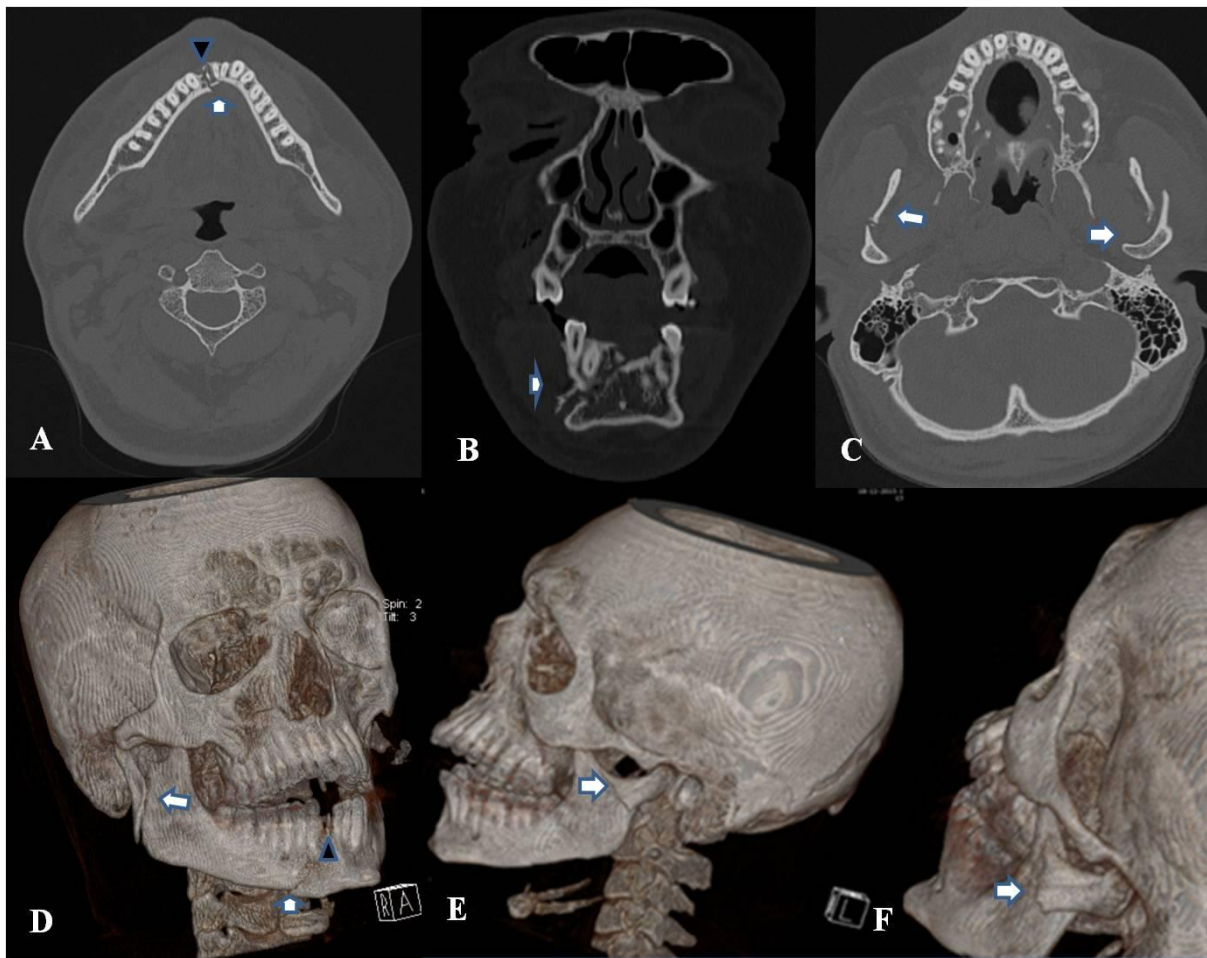


**Figure 9:** Displaced fracture involving bilateral body of mandible, mild left temporo mandibular joint dislocation – A,B,C – Axial section bone window, fracture line (Normal arrow) is seen lateral to right canine (Arrow head) and left canine (Arrow head) – suggestive of bilateral mandibular body fracture and Mild left TMJ dislocation (C -outlined arrow), D,E,F – Oblique AP, left lateral and left lateral oblique view – showing displaced bilateral mandibular body fracture (Normal arrow)

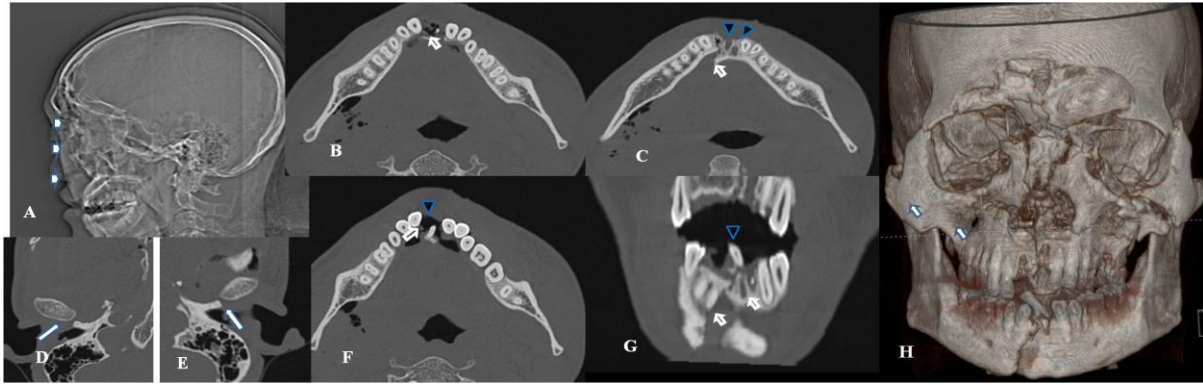




**Figure 10:** Right coronoid process fracture, right tripod fracture, complex fracture of right temporal bone, right hemi maxillary fracture, right Le Fort I fracture – A,B,C - Axial section bone window and VRT right lateral view – showing fracture of right coronoid process of mandible (A&C- normal arrows), and associated fractures like – complex fracture of right temporal bone, right tripod fracture, right hemi maxillary fracture, right pterygo maxillary disjunction (A,B,C – outlined arrows).



**Figure 11:** Right para symphysis fracture with traumatic dislocation of right lateral incisor tooth, fracture of right mandibular ramus, fracture of left condylar process – A, B – Axial and coronal section bone window – showing right para symphysis oblique fracture (Short arrow) with traumatic dislocation of right lateral incisor tooth (Arrow head), C – Axial section bone window - fracture of right mandibular ramus (normal arrow) and fracture of left condylar process (Normal arrow), D,E,F – VRT right oblique AP, left lateral and left posterior oblique view – Showing para symphysis fracture (Short arrow) with traumatic dislocation of right lateral incisor tooth (Arrow head), fracture of right mandibular ramus (normal arrow) and displaced fracture of left condylar process (Normal arrow)



**Figure 12:** Symphysis and right para symphysis fracture of mandible with dislocation of bilateral central incisors, bilateral le fort I, II and III fractures, bilateral tripod fracture, depressed fracture of frontal bone, bilateral tmj dislocation, bilateral nasal bone fracture – A – Scannogram showing depressed fracture of face with short arrows depicting probable direction of impact, B-G – Axial and coronal section bone window – showing Symphysis fracture and right para symphysis fracture (B,C,F and G – outlined arrow) with traumatic dislocation of bilateral central incisors (C,F,G - Arrow head), Bilateral TMJ dislocation (D&E – Long arrow), H - VRT – AP view – showing symphysis and para symphysis fracture of mandible (Outlined arrow) with traumatic dislocation of central incisors (arrow head) and other associated fractures (normal arrows) – bilateral tripod fracture, bilateral maxillary sinus wall fracture, bilateral nasal bone fracture with fronto nasal disjunction, depressed frontal bone fracture and maxillary bone fracture.

## Discussion

Facial trauma is the most common injury to the victims of motor vehicle accidents <sup>[3]</sup>. Road traffic injuries are a major public health problem worldwide. Every year, an estimated 1.2 million people die in road traffic accidents and up to 50 million suffer non-fatal injuries <sup>[4]</sup>. A broken jaw is the second most common facial injury- second only to a broken nose, Motor vehicle accidents (MVAs) cause 43% of mandibular fractures <sup>[5]</sup>.

Male constituted 83% of total number of cases owing to the fact that there are more men driving the motor vehicles. And the age group with maximum number of cases was between 21-30 years followed by 31-40 years as published in World Health Organization (2009) Global status report on road safety: time for action, where road traffic morbidity and mortality rates were higher in men than women <sup>[4]</sup>. Furthermore, a study conducted by Elvik R et al., reviewed that young drivers, especially males, are involved in accidents more than middle-aged drivers. The high accident rates of young drivers are attributable to deliberate risk taking and overestimation of skills <sup>[6]</sup>.

The gender difference in mortality and morbidity rates is likely related to both risk-taking behaviour and increased exposure to risk <sup>[7]</sup>.

A study conducted by *Escott EJ* et al., showed that multiple fractures in a single mandible are far more common than unifocal fractures, where the incidence of multiple mandible fractures was 58% as in this study where 74% of cases were multifocal <sup>[8]</sup>. MVA-induced injuries are the result of the remarkable amounts of kinetic energy released, when the steady state of a passenger is changed by sudden deceleration or acceleration; both speed and stopping distance have a significant influence <sup>[9]</sup>.

Condylar fractures are the most common site for injury in this study constituting 32%, followed immediately by fracture of body of the mandible. Similar results were obtained in a study by *Bag AK* et al., in which the prevalence of condylar process fractures ranges between 25% and 50% of all mandibular fractures <sup>[10]</sup>. Displacement of the condyle through the roof of glenoid fossa and into the middle cranial fossa is rare <sup>[11]</sup>. Malocclusion and restricted jaw movement are usually more severe in condylar fractures <sup>[1]</sup>. Bilateral body

or bilateral para-symphysis fractures are sometimes referred to as 'flail mandible', which can cause involuntary movement of the tongue posteriorly with subsequent obstruction of the upper airway<sup>[12]</sup>. Multi-detector CT is an invaluable aid in assessing mandibular injuries<sup>[14]</sup>. There is better clinician agreement on the location and absence of fractures with CT<sup>[15]</sup>. The capability of thin-section acquisition improves detection of even minor pathologic details, and the high spatial resolution capability of the scanner enables display in arbitrary planes, so that there is no need of manipulation of the head in prone or hyperextended positions to acquire images<sup>[16]</sup>. MDCT has revolutionized the imaging of suspected cases of facial fracture and, furthermore has improved diagnosis<sup>[17]</sup>.

### Conclusion

Road traffic accidents are very common in metropolitan cities like Bangalore and facial injuries with mandibular fractures constitute a significant number. Young and middle aged males are more prone for injury before of increased habit of risk taking and more exposure to risk. MDCT plays a major role in evaluation of patients with facial and mandibular trauma. It not only gives information about site and displacement of the fracture; but also helps in detection of adjacent soft tissue injury and airway. In cases of trauma, imaging is very essential in diagnosis, treatment planning, and in prognosticating.

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