



## "ROLE OF MULTIDETECTOR COMPUTED TOMOGRAPHY IN THE EVLAUATION OF MAXILLOFACIAL TRAUMA"

 $\mathbf{B}\mathbf{y}$ 

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In partial fulfilment of the requirements for the degree of

## DOCTOR OF MEDICINE IN RADIODIAGNOSIS

**Under the Guidance of:** 

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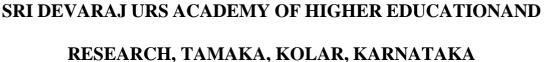
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#### ABSTRACT

#### INTRODUCTION:

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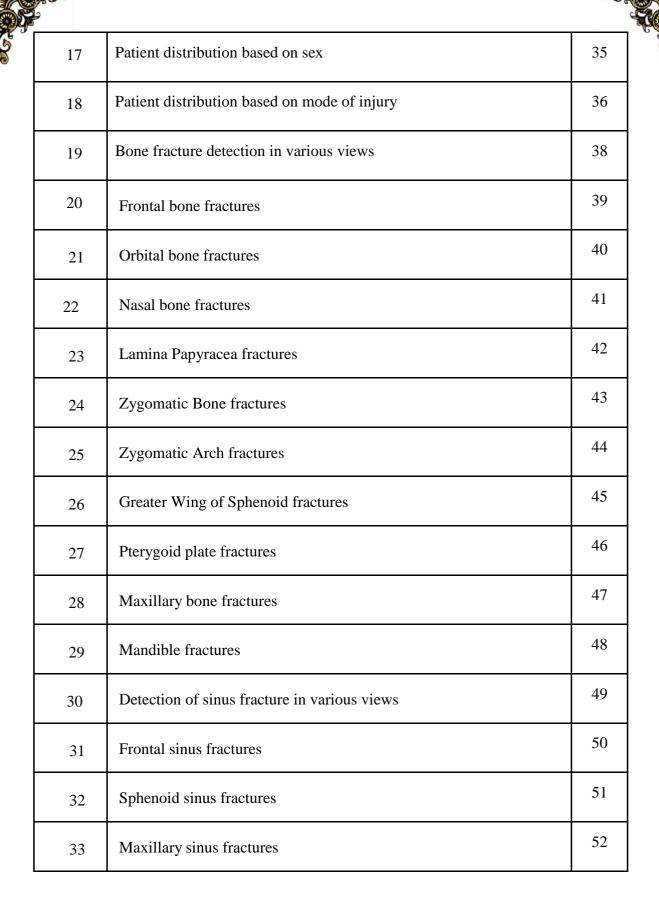


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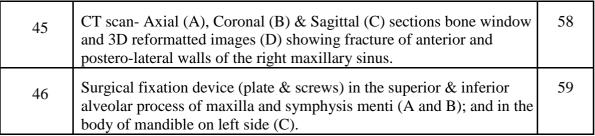


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## LIST OF ABBREVIATIONS

GLOSSARY	ABBREVIATIONS
CT	Computed Tomography
MDCT	Multidetector Computed Tomography
СВСТ	Cone beam CT scan
3D VR/ 3D CT	Three dimensional volume rendering CT
MPR	Multiplanar Reformation
RTA	Road traffic accident
HU	Hounsefield unit
ТМЈ	Temporomandibular joint
NOE	Nasoethmoidal
ZMC	Zygomaticomaxillary complex
ATLS	Advanced trauma life support
CSF	Cerebrospinal fluid
PPF	Pterygopalatine fossa







### **ABSTRACT**



### **INTRODUCTION:**

Maxillo-facial fractures are the commonest injuries occurring in trauma patients. Computed Tomography (CT) is a widely used radiological investigation which accurately reveals the number, location and extent of fractures & concomitant soft tissue injuries has been found to be superior in diagnosis of maxillofacial fractures owing to high sensitivity and specificity. In this study, the effectiveness of axial, coronal, sagittal, and 3D reformatted images in identifying fractures in maxillo-facial trauma were evaluated.

#### **MATERIALS AND METHODS:**

Using a 16-slice SIEMENS® SOMATOM EMOTION multidetector CT scanner, this cross-sectional descriptive study involved 49 adult patients with maxillo-facial trauma. CT Protocol consists of plain axial 16 slice helical series, Beam collimation ~ 3 mm, Pitch ~ 0.8 - 1, Tube current ~ 270mAs, Voltage ~ 130 kV, Total exposure time ~ 18 s and Total Radiation ~ 200mGy. Coronal and sagittal images were reformatted with 0.5 mm increments in addition to the axial images. Additionally, three-dimensional volume rendering images were obtained. Axial, coronal, and sagittal plane images were compared with 3D images. The principal investigator and an expert clinician worked together to interpret the computed tomography results. SPSS version 20 was utilised for the statistical analysis after the data were entered into an MS Excel sheet.









### **RESULTS:**

49 subjects were included in the study. The majority of cases were between the ages of 21 and 30, with a male to female ratio of 5.12:1. Road traffic accidents were the main cause of injuries. The most frequent fractures were found to be mandible (20 patients, 40.8%), followed by nasal bone (18 patients, 36.7%). Incidence of frontal bone fractures was found to be the least (6 patients, 12.24%). Axial & coronal images were found to be better for fractures of orbit fractures. All 4 views (axial, coronal, sagittal as wellas 3D) were equally useful in detection of nasal bone fractures. Lamina papyracea fractures are not assessed in sagittal and 3D images and are seen best in Axial and coronal images. Zygomatic bone fractures are assessed in all four views (axial, coronal, sagittal as well as 3D) with good accuracy. 3D images were found to be superior to axial and coronal images in detection of zygomatic arch fractures. Axial & coronal images are better for fractures of pterygoid plates compared to sagittal and 3D images. 3D images are much better for detection of fractures and degree of displacement of maxilla and mandible compared to axial, coronal or sagittal views. In general, our study found that 3D images are superior to than axial in assessing extent and degree of displacement of maxillofacial fractures. Maxillary sinus is the most common fractured sinus (19 patients, 38.7%). Sphenoid sinus fractures were the least common (seen in 2 patients, 4.08%). CT findings are correlating with the operative findings in most types of fractures.









## **CONCLUSION:**

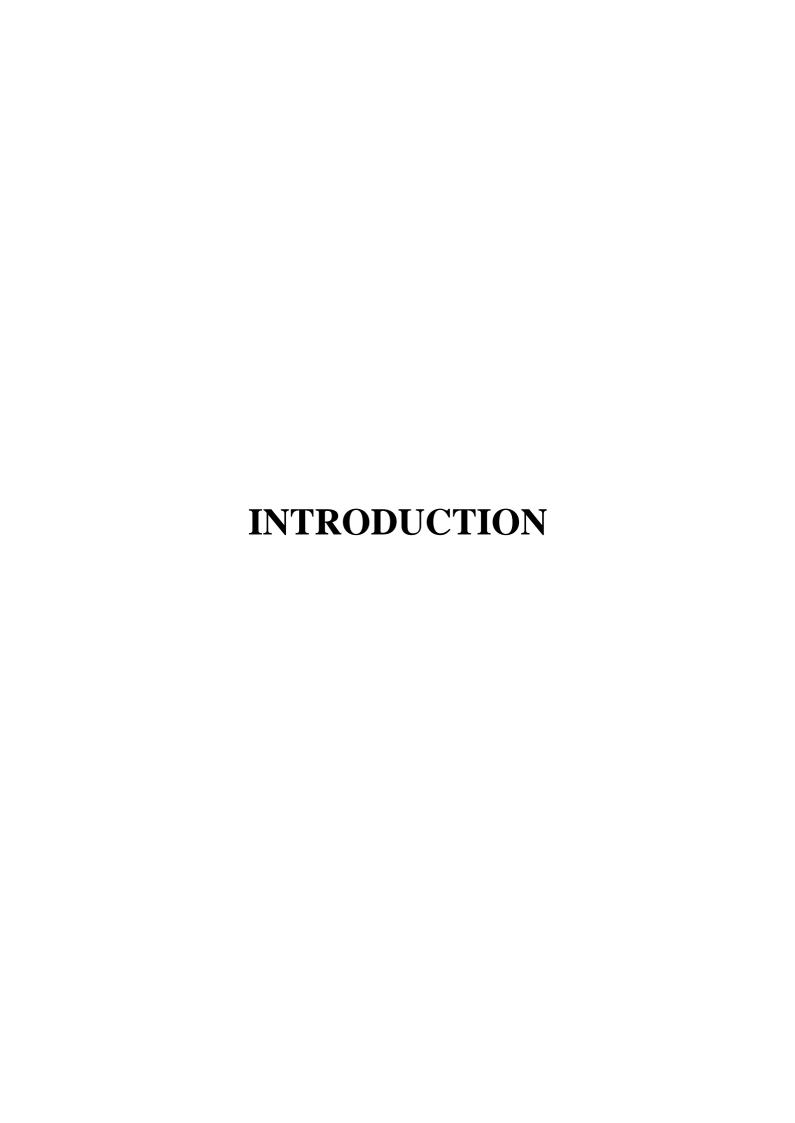
MDCT with multiplanar & 3D reformation is highly accurate in identification of fractures and assessing the extent & degree of displacement of fractures; hence it is the investigation of choice in maxillo-facial trauma.

## **KEYWORDS:**

Maxillo-facial fractures, Computed tomography, Sinus fractures







### INTRODUCTION

Maxillo-facial fractures are among the commonest injuries occurring in trauma patients. They are commonly seen along with varying extents of structural, physical and cosmetic damage.<sup>1</sup> As accident-related trauma is more common in young adults, and RTAs happen to be the commonest mode of maxillofacial injuries, these contribute to the bulk of morbidity and mortality in the present times.<sup>2</sup> Injuries to the head and face range from simple soft tissue damage to complex trauma to the underlying bony skeletal framework.<sup>3</sup>

The most frequent maxillofacial trauma presentation is involving soft tissues injuries and the injuries vary from clean sharp laceration to a contusion or an abrasion, avulsion or a puncture, burn wound or sometimes a combination of these.<sup>4,5</sup> Facial bones highly susceptible to trauma include the nasal bones, maxilla, mandible, zygomatic arch, and the orbit; all of which lie in close proximity with the cranial structures making untreated fractures a possible trigger for infections, serious complications and in some caseseven death.<sup>6,7</sup>

Type, severity and etiology of maxillofacial fractures depend on geographical and epidemiological factors leading to differences between populations being studied.<sup>8-9</sup> Effective treatment modalities are thus influenced by newer research keeping in mind these factors.<sup>10</sup>

Multi slice Computed Tomography (CT) is a widely used radiological investigation which accurately reveals the number, location, extent of the fracture and concomitant soft tissue injury as well. CT is thus gradually overtaking the conventional radiograph for

maxillofacial trauma. It is being performed for evaluation and classification of facial trauma. 11

Previously, two dimensional (2D) CT images as diagnostic tool had a limitation in complicated maxillofacial fractures. However modern imaging modalities have evolved to include 3D CT which has greater value in diagnosing and treating acute face trauma. When planning the stabilisation of facial fractures, imaging investigations do an outstanding job of helping surgeons determine the extent of skeletal damage.<sup>12</sup>

3D films provide a thorough view that gives better perception of complex findings on 2D axial Computed Tomography. Images can be adjusted for better understanding of anatomic disruption and separate images can be generated to centre on specific areas of clinical and surgical concern. 3D reconstruction further helps in analysis of bony shards. <sup>15</sup> This emphasizes its superiority in the evaluation of facial asymmetry as the reconstructed images can be studied in detail. MDCT has therefore revolutionized the diagnosis of maxillofacial injuries by permitting accurate and complete facial evaluation. Furthermore, advances in software technology has made the generation of these images easier, faster and more economical. Patients are not subjected to unnecessary radiation since the images are prepared using the axial computed tomography images. <sup>13</sup>

Multiplanar imaging facilitates diagnostic approach via its inherent concept to obtain volumetric data (CT, cone beam CT (CBCT), MRI) and subsequently generate images in different planes. Further, this data can be adjusted to generate different images to help the radiologist in diagnosis.<sup>33</sup> Cone-beam imaging provides images which reveal spatial orientation of the anatomical structures in the maxillo-facial area, which may not be easily seen in projectional imaging.<sup>34</sup>



## **AIM AND OBJECTIVES**

- 1. To assess efficacy of axial, coronal, sagittal and 3D reformatted images in detection of fractures in maxillofacial trauma.
- 2. To assess efficacy of 3D reformatted images over axial, coronal and sagittal in detection of fractures in maxillofacial trauma.
- 3. To co-relate the computed tomography findings with the operative findings.

## **Study Hypothesis**

Utilization of Multi-detector Computed Tomography can be useful in assessing maxillofacial trauma.



## **REVIEW OF LITERATURE**

### **Facial Anatomy**

The bony structure of the skull protects the brain. The skull is studied in two groups-calvarium (which forms the skullcap) and base of skull. The calvarium has occipital, frontal and parietal bones. Base has frontal, ethmoid, sphenoid, temporal and occipital bone.

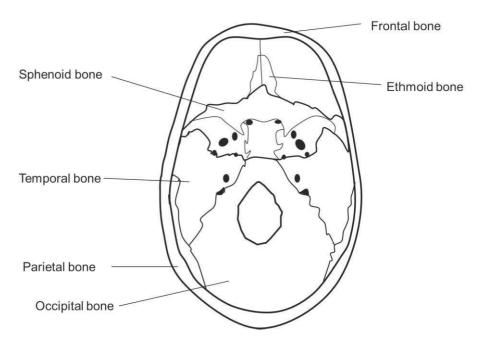


Fig 1. Anatomy of the skull base

Frontal bone makes up the upper part of the skull and mandible makes the inferior part.

The middle face is formed by the nasal, lacrimal, ethmoid, palatine, maxillae, zygomatic, temporal and sphenoid bones.

Fractures of the face are a common surgical problem in most countries. They are seen as a result of falls at workplace or from heights, road accidents and assaults.

Bones commonly fractured secondary to facial trauma include orbital, nasal, nasoorbito-ethmoid complex, frontal, maxillary, zygomatic arch, mandibular and skull base bones.

According to studies, zygomatic and nasal fractures are the most frequent signs of an underlying, more severe fracture in situations involving falls from heights. In trauma sustained

to face secondary to violence or assault, fractures of nasal bones and orbit are more likely. However in road accident, Le Fort (I, II, III) fractures are mostly asymmetric or unilateral.

In the year 1895, a major revolution in diagnosing fractures took place as Wilhelm Rontgen found X-rays. Plain radiography thus formed the basis of imaging for at least 50 years from then. In the year 1972, the first CT machine discovered and 5 years later, for creating and perfecting tomography, Sir Godfrey N. Hounsfield and Alan M. Cormack received the Nobel Prize in medicine.<sup>66</sup>

Reconstruction images in CT aimed at evaluating the full extent of injury.<sup>76</sup> 3D volume rendered CT images have one drawback of volume averaging and may require evaluation in additional orthogonal planes. In comparison, coronal CT has better use in assessing fault size, spatial relation and orbital contour. Axial and sagittal CT is better at delineating posterior margin defect. CT images with windows for soft tissue help in assessment of extraocular muscles and fibrofatty tissue and their involvement in fractured segments.<sup>77,78</sup>

A maxillofacial surgeon seeks to identify radiological images in order to correlate the same with patient's clinical findings, and uses it for timely decision making and surgical management, thus optimizing the patient care and outcome.<sup>79</sup>

The buttresses of the face are where the thickness of the facial bones is considerably increased. They provide as support for the face's structural elements; including the eyes, eye muscles & airway and they also serve to prevent occlusion.<sup>67</sup>

The frontal, sphenoid, maxillary, and ethmoid sinuses are the paranasal sinuses of the face. 68 Largest in terms of volume is maxillary sinus. 69

## **Types of Facial fractures**

Pattern of facial fracture depends on the point of contact, amount and disposition of power rendered and the impedance to force.<sup>70</sup>

Anatomically, facial fractures are frontal, zygomatico- maxillary complex (ZMC), orbital, zygomatic arch, nasal, Le Fort I, II & III fractures, naso-orbito-ethmoidal (NOE), maxillary sinus wall and maxillary alveolar process, palate, mandible and skull base.<sup>70,71</sup>

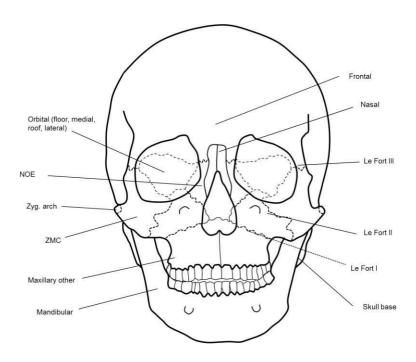


Fig 2: Categorization of facial fractures.<sup>72</sup>

Mandible fractures can be classified as symphyseal fractures, fractures of the parasymphysis, ramus, angle, body, coronoid process, condylar process, subcondylar fractures and alveolar fractures.<sup>70</sup>

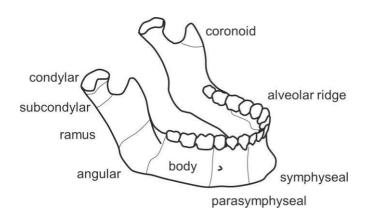


Fig 3: Mandibular fractures 72

### Soft tissue damage

Damage to vascular tissue will cause considerable blood loss requiring packing and ligation to achieve hemostasis.

Nerve injuries namely the trigeminal and facial nerves are likely in facial injuries.

Parotid duct may be injured in facial trauma too, requiring surgical repair.<sup>73</sup>

Among the countless cases of polytrauma seen at the emergency department, facial trauma happens to be among the commonest ones. Trauma to the maxillofacial region necessitates special consideration since facial structures are so close to vital structures in head & neck region. Apart from the severe complications, patients are also affected psychologically in case of disfigurement which might result as a complication of facial and maxillary trauma. Timely and accurate diagnostic evaluation is therefore crucial. Mode and mechanism of injury determine the pattern and location of maxillofacial fractures. Vector of the impact beyond the tolerance limit, along with patient's age, bone density, presence or absence of dentition are among decisive factors. 15-17

## **Etiology**

The most frequent causes of maxillo-facial injuries, regardless of location, are road traffic accidents (RTA), falls, assaults, sports injuries and industrial occupational hazards. Mid facial bones and the mandible, being superficial skeletal structures are among the frequently reported while lacerations and dental injuries are also common. Incidence is found to be greatest in young males, usually in second to fourth decades of life. <sup>18</sup>

### **CLINICAL PRESENTATION**

### Frontal bone fractures:

Most patients present with disruption or crepitus of the supraorbital ridge, subcutaneous emphysema, and in some instances paresthesia along the nerve supply of supraorbital and supratrochlear nerves. In a conscious and vocalizing patient the primary complaint may be facial pain. External injuries such as lacerations, contusions, hematoma ora visible depression to the forehead may be an indicator to underlying injury and the physician/ surgeon should suspect frontal sinus fracture. Cerebrospinal fluid (CSF) leak maybe seen in some patients. <sup>19</sup>

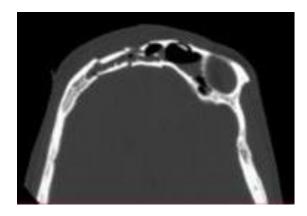


Figure 4: Frontal sinus fracture.

### **Nasal bone fractures:**

Clinical examination in a trauma victim may reveal a displaced nasal septum or bridge. However, CT scan may not provide dependable data on timing of such an injury, as nasal fractures may not show ossification of the fragments thus mimicking a new fracture. In an acute injury, the nose may be edematous and tender on palpation. Septal haematoma, crepitus, and bleeding may also be seen.

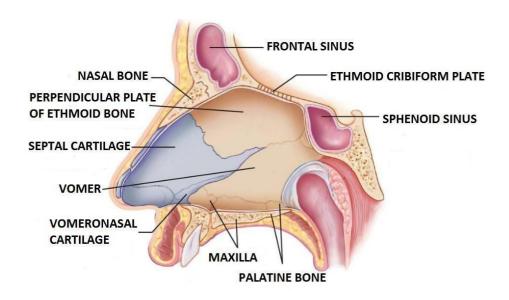


Figure 5: Nasal bone with Vomer

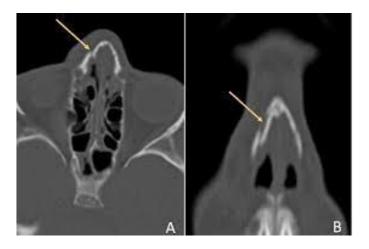


Fig 6: Right nasal bone fracture

### Naso-ethmoidal (NOE) fractures:

Severely displaced nasoethmoidal fractures may lead to increased inter-canthal distance (telecanthus), epistaxis, CSF from nose, and lacrimation due to block of the naso-lacrimal duct. Asymmetry of the medial canthal ligament is another common occurrence. A test of traction to the medial canthus simultaneously palpating bridge of nose is done to differentiate nasoethmoid bone fracture from edema of nose bridge.

## **Zygomatic arch fractures:**

Fracture Zygoma or its arch may present as a palpable defect on the cheek associated with pain and immobility. This may be attributed to restricted mobility of coronoid process mandible which is assessed by physical examination.

#### **Orbital floor fractures:**

Periorbital ecchymosis, edema, crepitus may lead to suspicion of underlying orbital floor fracture. Ocular injury and enophthalmos may be concomitantly seen. Injury to infraorbital nerve can cause paresthesia of nose, upper lip, and maxillary gingiva. If the inferior and medial rectus muscles are entrapped, it may result in diplopia in the acute stage and possible inferior rectus muscle atrophy if left untreated.<sup>20</sup>



Fig. 7: Coronal view of orbit

## **Zygomatico- maxillary complex (ZMC) fractures:**

Zygomatico-maxillary complex fractures present as a malar eminence depression appearing as flatter cheekbone associated with pain on pressure at the site. Depression of lateral canthal tendon may be seen as the "flame sign". Subconjunctival hemorrhage may also be present. Impingement of the infraorbital nerve leads to paraesthesia of the nose and lip. Diplopia is seen on upward gaze due to entrapment of the inferior rectus. Trismus due to depression of the arch leading to impingement on coronoid of the mandible is another feature. Injury to the temporalis muscle may also contribute to trismus.

#### **Maxillary fractures:**

Described as per the Classification of LeFort suspected in the presence of edema, telecanthus, hemorrhage in subconjunctiva, abnormal movement of maxilla at naso-frontal suture, CSF rhinorrhea and epistaxis. Additionally, the mid-facial skeleton's posterior displacement may be the cause of an open bite. On examination, the movement of the facial bone in relation to the skull's base may also be visible.

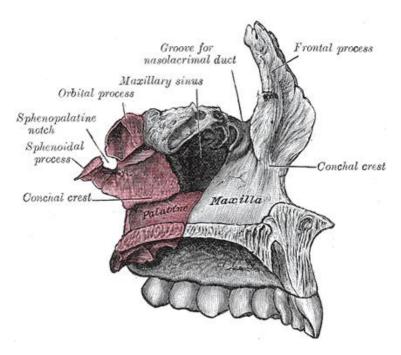


Figure 8: Maxilla

### **Alveolar fractures:**

These may be suspected in the presence of gingival bleeding, abnormal movement of the alveoli and loose avulsed dentition.

### **Mandibular fracture:**

Commonly presenting as trismus and non-alignment of teeth or malocclusion, condyle fractures are sometimes overlooked. The pre-auricular areas may be tender to palpation. When the mandible is opened and closed, the condyle might not move. Mobility fracture segment and crepitus can be felt along the symphysis, body or angle the mandible.

Inferior alveolar nerve injury, especially to the mental branch, cause paraesthesia, anesthesia of lip, mentum and gum when fracture includes the mandibular angle, body, parasymphysis of the mandible.

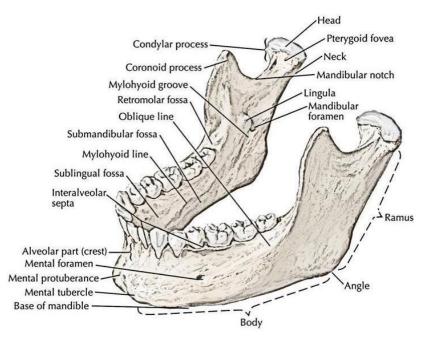


Figure 9: Mandible

## Physical and systemic examination

Trauma patients are initially assessed and stabilized as per ATLS protocol. The history and examination gives an idea of a maxillofacial injury.<sup>21</sup> For a more accurate clinical evaluation, details about allergies, drugs, tetanus, medical and surgical history are obtained for a better clinical assessment.

Compared to injuries to the rest of the body, oral and maxillofacial injuries are shown to be inevitable in high impact trauma since the face is not protected by other structures. This makes challenging to the maxillofacial surgeon.<sup>8,9,22</sup>

Understanding the causes and mechanisms of injuries are essential for managing trauma patients effectively.<sup>23,24</sup> Maxillofacial casualties have equal prevalence of both soft tissue as well as bony injuries.<sup>25</sup>

Governance of maxillofacial trauma has developed significantly over time.<sup>26</sup> A thorough inspection, palpation and examination of function ensure that the injuries are correctly diagnosed.<sup>27</sup> Unequivocal soft and hard tissue treatment enables patients to recover to pretrauma features, or as close as possible.<sup>28</sup>

Treatment is thus prioritized as urgent, semi-urgent and elective intervention. As per recommendations, urgent intervention such as in the case of airway obstruction should be carried out for 8 hours of sustaining trauma in order to prevent airway-compromising edema.<sup>2</sup>

Enhancive value of the face and neck are the domain of the diagnostic radiologist and the operating surgeon.<sup>29</sup> Hard-hitting surgery for complex oral and maxillofacial trauma, including flap repair are found to achieve good reconstruction results with favourable outcomes.<sup>30,31</sup>

### **MAXILLOFACIAL ANATOMY:**

The frontal bone and sinus made up the upper third of the human face, while the zygomatic, nasal, ethmoid, and maxillary bones made up the middle third. The alveolus, symphysis, condyle, ramus, angle, and body are the different parts of the mandible forms lower third.

Part of the frontal bone is the superior orbital margin. The zygoma, the larger wing of the sphenoid bone, and the zygomatic portion of the frontal bone make up the lateral orbital margin. The inferior margin includes the zygoma and maxilla. The frontal process of the maxilla, the angular and orbital processes of the frontal bone, the lacrimal bone, and the ethmoid all contribute to the formation of the medial part of the orbit. The palatine, sphenoid, ethmoid lesser and larger wings form the orbital apex.

#### **Nerves:**

The ophthalmic branch of the trigeminal nerve which is the first of the three branches, and it is a sensory nerve that supplies the conjunctiva, forehead, and eyelid skin. The frontal, nasal, nasociliary, supraorbital, supratrochlear, lacrimal and infratrochlear nerves are branches.

# **Blood supply:**

Branches of the carotid artery supply the face through facial, lingual, superficial temporal and maxillary arteries. Venous flow occurs through superficial temporal, retromandibular, lingual, facial, pterygoid venous plexus and jugular veins. They drain into a joint trunk which finally drains into the internal jugular vein (IJV).

**Regions:** Multiple bone segments make up the maxillofacial region, including the nasal, orbital, maxillary, mandibular, zygomatic, and ethmoid bones. The maxillary region is made up of the hard palate and alveolar process. The mandibular region is made up of mandible and the temporomandibular joint (TMJ).<sup>76</sup> The nasal region is made up of the nasal bones, nasal septum, lacrimal bones, frontal process of the maxilla, and ethmoid cells.

Orbital anatomy is complex owing to its formation by 7 bones which includes frontal, lacrimal, maxillary, zygomatic, palatine, ethmoid and sphenoid bones. The zygomatic region is made up of the maxilla, zygomatic bone, and zygomatic process of frontal bone. <sup>32</sup>

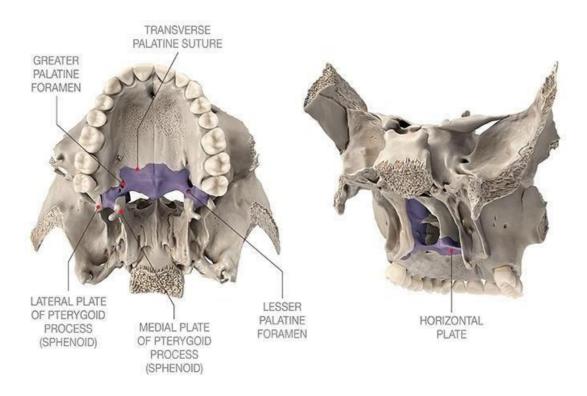


Figure 10: Palatine bones

### NOSE AND PARANASAL SINUSES

Air-filled bony cavities in four pairs are found around the nose and orbits known as the paranasal sinuses. These are named based on anatomical location as frontal, ethmoid, maxillary and sphenoid sinuses. These sinuses can be well studied in coronal sections; as this section is best for structures with postero-anterior orientation and the sinuses will be best analyzed in these views.

Nasal cavity appears like a pyramid having two divisions with a nasal septum in between and each division has 3 chambers - inferior, superior, and middle turbinates.

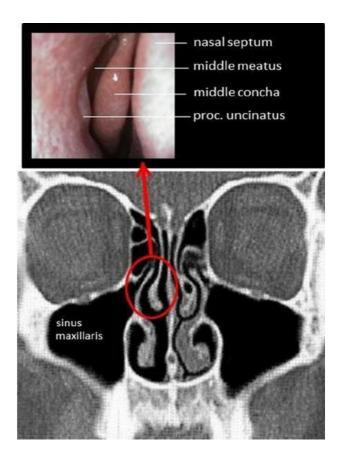


Fig 11: Nasal cavity- Coronal section

The inferior concha is a distinct bone, while others are ethmoid-derived. The largest paranasal sinus, the maxillary sinus, appears on computed tomography as a low density structure that uniformly black (CT). Any appearance which is not black may indicate an abnormality in the sinus cavity.

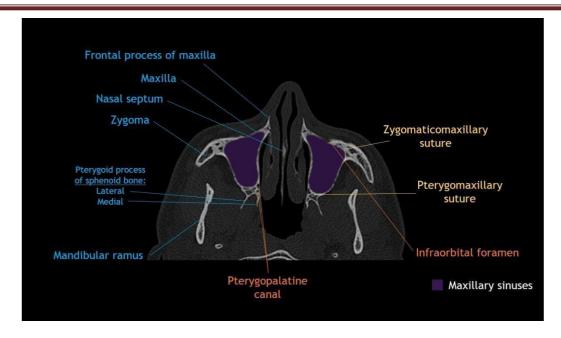


Fig 12: Maxillary sinus- CT image

Thus CT images reveal in detail the disruption of anatomy of maxillary sinus walls. Ostia through which the sinuses drain are better visualized in coronal cuts and they drain into the ostiomeatal complex .<sup>35-36</sup> The orbit and sinuses are divided by the lamina papyracea. Sphenoethmoid recess is where the sphenoid sinuses appear posteriorly and drain into the superior meatus. The frontal recess is where the frontal sinuses drain into the middle meatus.

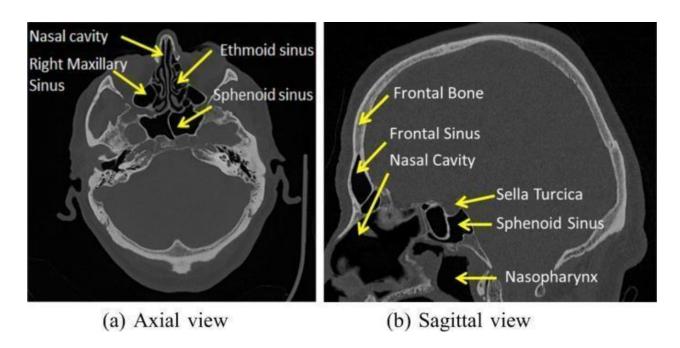


Fig.13: Ethmoid and sphenoid sinus

### SKULL BASE AND MIDFACE

The floor of the sinuses marks the beginning of the midfacial structures and the base of the skull. The superior, greater and lesser palatine foramina are seen at this level. The nasopalatine nerve exits on the palatal facet of the maxillary bone in the centre of the incisors through the superior ones, which are situated on the floor of the nasal cavity as the inferior meatus. Greater and lesser palatine nerves and veins exit through the palatine foramina.

The pterygopalatine fossa (PPF), which is closely associated with the posterior wall of the maxillary sinuses, can be observed at this exact level if the sections are made parallel to the base of the skull.

Pterygopalatine fossa (PPF) opens into the Vidian opening and the foramen rotundum. Using this as passage, communication between the middle cranial fossa and orbits takes place and infection from the orbits, oral cavity or nasal cavity can spread into the cranium fossa. This identification is thus necessary in assessment of maxillofacial trauma.<sup>37,38</sup>

Axial sections which are done more cephalad will show the sinuses of ethmoid, orbits, and the sphenoid. The anatomy of maxillofacial region thus sheds light on the course, location and relation with anatomical structures in 3D and helps know and identify pathological conditions.

#### "CLASSIFICATION OF THE FRACTURES:

The system for categorizing maxillary fractures was introduced by Renée Le Fort in 1901. He called them the "great lines of weakness in face" by his experiments on cadaver skulls.<sup>39</sup>

There are three types of facial fractures: central mid-face, lateral mid-face and mandibular fractures. Nasal, maxillary sinus, Le Fort I and II fractures, nasoethmoidal, and orbital wall fractures includes central midface fractures. Lateral mid-face ones are zygomatic-malar and orbital floor fractures, while Le Fort III fractures are combined. 11,40,41

**Le Fort type I:** Alveolar zygomatic arch, internal maxillary sinus walls, internal pterygoid plates, and vomer are all involved transversely. Leads to the shifting of the hard palate, which splits it from the facial bones.<sup>88</sup> Such fractures are caused by blow on the upper lip.<sup>40</sup>

**Le Fort type II:** Fracture line pass crosswise the nasal bridge, internal wall and floor of both orbits, lacrimal bones, obliquely through the anterior maxillary sinus, extends to the pterygoid plates. <sup>42</sup> It can be considered a severe central or mid facial fracture and commonly is seen as a consequence of a blow over the central part of face. <sup>40</sup>

**Le Fort type III:** This divides the base of the skull from the facial skeleton. Transverse fracture line passes through nasofrontal suture, maxillo-frontal suture, orbital wall, and zygomatic arch/zygomaticofrontal suture. From the orbital floor to the lower margin of the pterygoid plates, the second line of fracture is seen. 42,40

Le Fort type II and III fractures are differentiated by their involvement of the lateral orbital wall and zygoma". 11

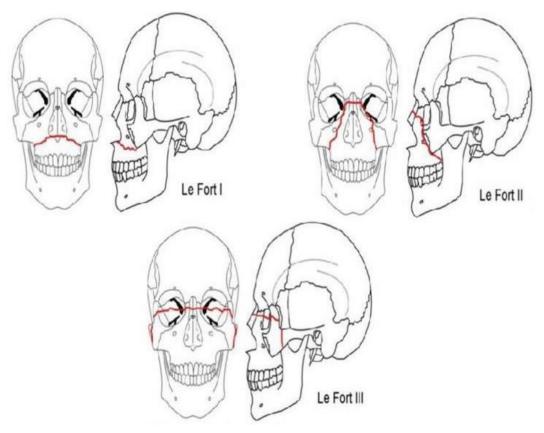


Fig.14: Le Fort Fractures

Maxillofacial traumas are a common cause of frontal bone fractures.<sup>86</sup> 61% of these fractures involve the anterior table. 28% of these fractures involve anterior and posterior sinus walls and only 5% involve posterior sinus table.<sup>86</sup> Pneumocephalus is seen for posterior table fractures.

### **Orbital fractures:**

Because of their anatomical complexity, these are frequently found in association with zygomatic, maxillary, and/or nasal fractures. These can be internal or external, and they frequently accompany blowout trauma, which is when the eyeball is directly hit and the orbital rim and floor are also injured.<sup>88</sup> Because the eyeball rarely gets affected in these type of fractures, orbital emphysema is not seen.<sup>40</sup> Orbital fat protrusion is known as tear drop sign.<sup>11</sup> Diplopia is because of herniation of inferior rectus and oblique muscles. Surgery is

unquestionably necessary when the rim is involved.<sup>86</sup> Coronal CT images nicely shows fractures of the orbit. Other orbital fractures are of internal wall.<sup>40</sup> Lateral orbital wall fractures are frequent.<sup>40,43</sup>

Nasal fractures account for nearly 50% of isolated fractures and are the commonest facial bone fractures. <sup>40, 42</sup> The severity of these fractures depends on direction of the impact more so from lateral than frontal impact. <sup>40</sup> Lateral blow leads to depression of nasal bridge and nasal bone. Frontal blows can fracture the nasal septum as well as the nasal bones. Severe soft tissue injury or a septal fracture or dislocation are indications for open repair. <sup>44,45</sup> Severe nasal fractures may result in rhinorrhea, pneumocephalus or intracranial infection.

Maxillary sinus wall fracture constitutes another common fracture (16%). In fractures of the maxillary sinus, isolated maxillary sinus fractures are infrequent.<sup>44,42</sup>

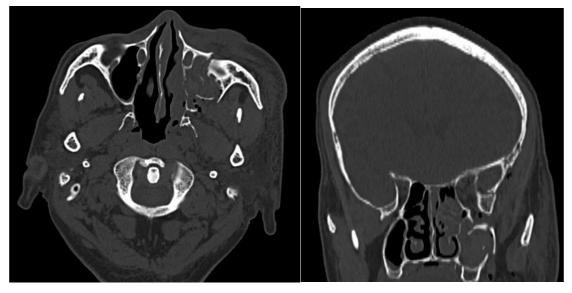


Figure 15: Axial and Coronal bone window CT images showing fracture of all walls of left maxillary sinus.

Direct blows to the lateral portion of the midface often result in zygomaticomaxillary complex fractures. Orbital, zygomatic and maxillary processes are commonly affected. 42When the fracture fragments get displaced, or there is trismus, ocular muscle entrapment with involvement of the apex of the orbit, it is usually an indication for surgery. 46 The classification is done according to the magnitude and direction of translation and also based on the integrity of the zygomatic bone.

"Classification of Zygomatic maxillary complex fractures on plain radiograph is followed as per the Knight and North classification of 1961 as follows:

Type 1: Fractures that are not displaced

Type 2: Zygomatic arch fracture-isolated

Type 3: Depressed but non-displaced fractures

Type 4: Fractures that are medially displaced

Type 5: Fractures that are laterally displaced

Type 6: Comminuted or complex fractures"

Mandibular fractures include symphyseal, alveolar process, body or horizontal ramus, angular, ascending ramus, coronoid process, and condylar fractures. Condylar fractures are intracapsular or extracapsular. Intracapsular are managed medically and conservatively while extracapsular fractures requires surgical management. Patients with mandibular fractures present with pain, trismus, inability to chew, malocclusion, swelling and hematoma in the jaw region. Malocclusion is one of the best indicators of a mandibular fracture. Horizontal ramus fractures present as ecchymosis. Mandibular oteomyelitis, Pseudoarthrosis, ischemia or necrosis of condyles and damage to the articular surface are other complications seen with mandibular fractures, which present late.

### **IMAGING:**

To identify and assess fractures, including their number and location, any dislocation of bone fragments and any accompanying soft tissue injuries as well. This valuable data is provided by radiography, MDCT as well as MRI.

### **PLAIN RADIOGRAPHY:**

The primary and routinely used imaging modality in patients who sustain trauma; however its relevance in maxillofacial trauma is limited and fast declining due to limited information obtained and difficulty in positioning patients (especially in cases of cervical spine injuries).

### **MULTIDETECTOR COMPUTED TOMOGRAPHY:**

Over the years, assessment of trauma has improved with the availability of imaging techniques which are minimally invasive and can provide cross sectional visualizations and interactive image analysis (3D volume rendering).<sup>49</sup> Thus conventional imaging used in assessment of Maxillofacial trauma patients has gradually phased out with the introduction of Computed Tomography.

"The Greek roots of the Tomography are "tomos," which means "slice" or "section," and "graphia," which means "describing." It was invented in the year 1972 by two individual's British engineer Godfrey Hounsfield of EMI Laboratories, England and physicist Allan Cormack of Tufts University in Massachusetts-who were later awarded the Nobel Prize".

Between 1974 and 1976, the first CT scanners were initially only used for imaging the head. Full body scanners became available in the coming years and started to be widely used by the year 1980.

The first CT scanner was developed by Hounsfield, and it took many hours to gather the rawdata for a single "slice" before the image could be made. The current CT system, in comparison, can gather up to 4 slices of data in roughly 350 milliseconds and reconstruct a  $512 \times 512$  matrix from millions of data points. An entire chest can be scanned. Current faster scanning has the additional advantage of eliminating artifacts from patient movement during breathing or peristalsis.

CT has become important in assessment of Maxillofacial trauma by offering excellent bone structure assessment and aiding accurate diagnosis and localization of maxillofacial fractures. The axial images involve 1 mm slices which provide meaningful image quality. Multislice CT scanners have further transformed the transaxial cross sectional imaging techniques into the current generation of 3D images which allow display of the data volume and also to select arbitrarily cut planes.

Computer-generated 3D CT imaging can offer better views and spatial orientation, which is helpful for surgical planning in situations involving complex trauma with significant displacement. These scanners have minimized scanning time and expanded the area of interest by incorporating a larger Z axis.

Multislice CT systems consist of a synchronized rotating tube and detector array and a much faster rotation time. Until an adequate or desirable image is obtained, radiographic data is obtained as computerized data rather than on films.<sup>50,51</sup> MDCT is important in diagnosing mandibular condylar fractures on sagittal plane. Using 3-D reconstructions can help in surgical management planning.<sup>52</sup> Multidetector computed tomography (MDCT) have 100% sensitivity compared to radiograph and x-rays have 86% sensitivity.<sup>47</sup> In order to accurately assess for maxillofacial injuries, multi detector computed tomography is the

imaging method of choice. It enables quick scanning of seriously ill, elderly and uncooperative individuals. Maxillofacial fractures can be quickly evaluated by clinicians with an early and accurate diagnosis. The resolution of MDCT is superior in enabling reformations and reconstructions, providing superior quality and better planning. <sup>86</sup> Bony architecture in massive comminuted fractures can be noted using 3-D reconstruction and reformation in various planes <sup>103</sup> which aids surgeons in proper surgical planning. <sup>53</sup>

Harshitha K R (2016) performed a study to know the pattern of mandible fractures at Kolar by evaluating the database of 350 patients who were admitted at a multispecialty hospital in Tamaka, Kolar. Their study found that individuals affected by RTA or fall from height were young adults and formed a majority of the study population. Most common maxillofacial fracture sustained was that of the mandible that is fracture of the parasymphysis followed by body of the mandible.<sup>74</sup>

Jayaraju RM et al (2014) assessed data of 100 road accident patients who sustained maxillofacial injuries. Patients were assessed both clinically and using plain radiographs and CT scan. The authors concluded that midfacial skeleton was commonly fractured and particularly it was seen as an isolated fracture of the maxilla and nasal bone. Le Fort type II was commonest to be seen. Parasymphyseal fractures were the commonest and were seen to have associated soft tissue injuries. The authors concluded that maxillofacial fractures in the younger age group are more common and more so in bike riders. Midface region is seen to be associated with complications.<sup>75</sup>

Ahmad K et al (2014) conducted a prospective study where they evaluated cases of maxillofacial fractures for one year. Patients underwent MDCT scan of facial region with multiplanar reconstruction in the sagittal and coronal planes. The study found that majority of the subjects were male and belonged to 11-35 years age group. The most common cause of facial fractures was RTA. Orbital floor fractures are most common followed by maxillary sinus. Three cases in the study had associated injury of the globe. The authors concluded that MDCT is superior in diagnosis of maxillofacial fractures owing to high sensitivity and specificity.<sup>64</sup>

Bessar AA (2020) conducted a study on 28 patients who sustained facial trauma. Among these 22 were males and 6 females, belonging 17 to 51 years age group. They were subjected to radiography and MDCT. The authors found that orbital wall fracture was the most commonly sustained fracture followed by zygomaticomaxillary complex fractures. The authors were of the opinion that CT is the best test for assessment of maxillo-facial fractures as fracture fragments, fracture lines and displacement can be easily detected.<sup>65</sup>

Salonen EM et al (2007) conducted a study where they used MDCT to assess extent of facial fractures in trauma patients with history of accidental fall from height. They studied 2413 cases of suspected facial injury, of which age range was 15.3–76.7 years with a mean of 42 years. They assessed 135 males and 20 females who met the criteria of fall from height. The authors were of the opinion that among patients with trauma secondary to fall from height sustaining facial trauma, zygomatic arch fractures and nasal bone injuries were common and were usually indicative of the other severe fractures in addition. According to the authors, clear sinus sign helps in assessing midface trauma in patients sustaining trauma from fall from height.<sup>55</sup>

In a study by Tomich G. (2011) to assess fractures in patients with facial trauma by examining them using multi-slice computed tomography combined with 3D CT, it was discovered that fractures are more common in males between the ages of 15 and 35. Orbital floor fractures were most common and the main etiology was found to be road accidents.<sup>12</sup>

Ogura I (2012) in a study to assess mandibular fractures using CT (MDCT) evaluated the scans of 140 cases with mandibular fractures and classified the fractures into paramedian, median, angle fractures, condylar and coronoid process fractures. The authors analyzed the data which revealed that in patients with facial trauma sustaining mandibular fractures, mixed type of fractures were seen in majority of cases.<sup>56</sup>

Ahmad K et al (2013) studied maxillofacial injuries presenting to casualty with facial injury. Road traffic accidents and trauma due to assault were the commonest etiology. Facial bones were studied using multiplanar CT. The commonest fracture was found to orbital fracture. The authors concluded that MDCT provides superior resolution, which is helpful in diagnostic reliability and planning of surgery in patients sustaining facial trauma.<sup>57</sup>

Singh S (2014) conducted a study to see multidetector computed tomography in surgical management and treatment in patients with maxillo-facial fractures.100 patient's data was analyzed. The efficiency of MDCT in diagnosing facial bone fractures was confirmed. The authors came to the conclusion that MDCT scan is the preferred imaging method for facial bone fractures and helps with surgical care planning.<sup>59</sup>

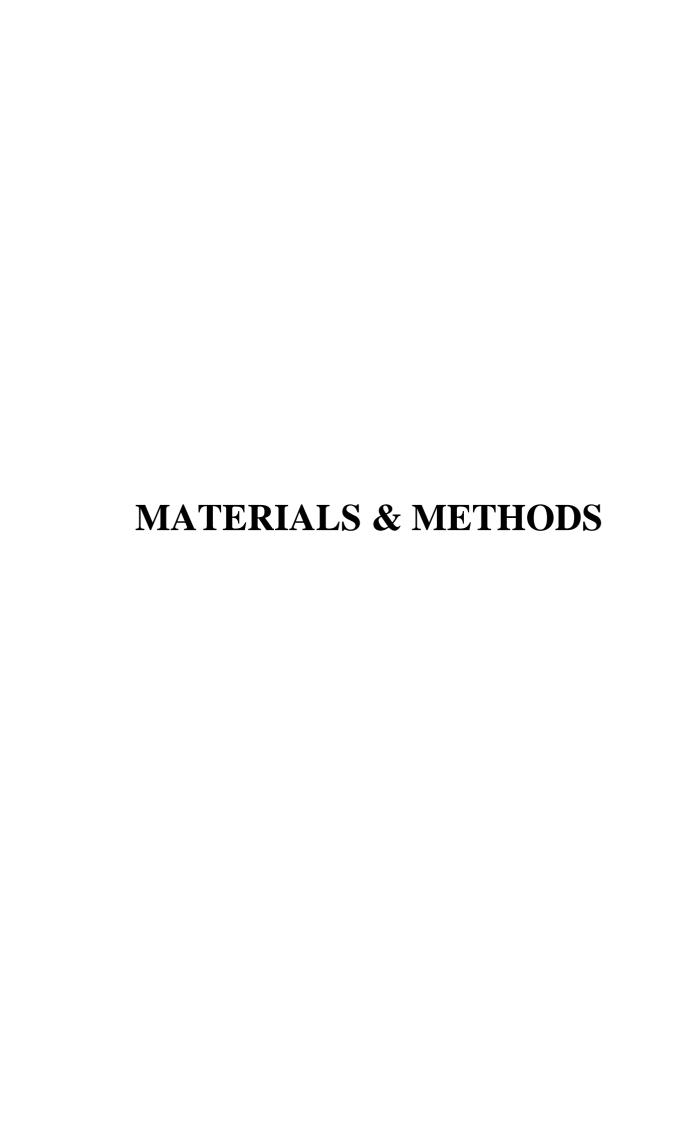
Patil S et al (2015) conducted a study for the assessment of orbital and maxillofacial fractures. 131 patients were subjected to imaging using Philips 16 slice CT. Males were the majority and aged between of 21-35 years. Commonest facial fractures were seen in road accident kubjects included in their study. Nasal fractures were the commonest, and then maxillary sinus fractures. Cribriform plate was rarely involved. Naso-ethmoido-orbital fracture wasthe commonest complex fracture. Lateral orbit was also seen associated with

these fractures. The authors suggest that MDCT allows better diagnostic accuracy, thereby aiding planning of surgical management. <sup>60</sup>

Kunal GS et al (2016) conducted a study to correlate clinical findings with MDCT findings in evaluation of mandible fractures. 70 such patients were included and subjected to MDCT. The authors confirmed that MDCT is a superior diagnostic tool in assessing mandibular fractures.<sup>61</sup>

A study by Srinivasa NR et al (2017) on 60 patients to assess efficacy of MDCT found that 3D reconstruction was equivalent or in some cases better than axial imaging in diagnosis of facial fractures. However the authors were of the opinion that MDCT was less useful in identifying fractures involving the thin bones of the orbital region.<sup>62</sup>

Raju N carried out a study on 50 patients with maxillofacial fractures due to road traffic accidents, fall from height or secondary to violence. The data analysis revealed that maxillary fractures were most frequent, closely followed by nasal, zygomatic, mandibular and orbital bone fractures. Soft tissue edema was present in most of the subjects. The authors concluded that fine fractures lines and displacement of fractures by MDCT were better owing to superior spatial resolution which enables three dimensional reconstruction. <sup>63</sup>



# MATERIALS AND METHODS

**STUDY DESIGN** – A cross sectional descriptive study.

**PLACE OF STUDY**– Department of Radio-Diagnosis at R.L. Jalappa Hospital and Research Centre attached to SDUMC, Kolar.

**SOURCE OF DATA:** This study will be performed on patients referred to Department of Radio-Diagnosis at R.L. Jalappa Hospital and Research Center attached to SDUMC, Kolar. Informed consent will be taken.

**DURATION OF STUDY**– 18 Months (January 2021 – June 2022).

**Inclusion Criteria:** All adult patients with maxillo-facial trauma who undergo multislice CT examination and are shown to be positive for fractures.

### **Exclusion Criteria:**

- 1. Images containing motion and other types of artifacts on CT scan.
- 2. Patients with past history of maxillofacial surgery or intervention.
- 3. Patients with any facial deformities or tumors like exostosis, fibrous dysplasia.

# **SAMPLE SIZE:**

The Estimated Sample Size is 43.

The sensitivity and specificity of CT were reported to be 90% and 95%, respectively, by Jon Marinaro et al. assuming alpha error of 5% (95% confidence limit) and an absolute precision (d) of 9%, the minimum required sample size to estimate the sensitivity of CT in detecting maxilla-facial injuries was estimated to be 43.

Sample size was calculated from the following formula:

"Sample size (n) = 
$$[DEFF*Np(1-p)]/[(d2/Z21-\alpha/2*(N-1)+p*(1-p)]"$$

Where:

- Z Value for Confidence Interval (95%)
- D Absolute precision (9)
- P Expected proportion (P= 90% +/- 9)

OpenEpi version 3.01 was used to calculate the sample size (Open Source Epidemiologic Statistics for Public Health).

Written Informed Consent will be taken from all the individuals.

# **Data Acquisition:**

After giving consent, a patient who fulfilled the requirements for inclusion in the study would receive the CT examination. All the CT scans in this study were performed using SIEMENS® SOMATOM EMOTION 16 slice CT machine.

CT Protocol consisted of the following:

- Non-contrast axial 16 slice helical series
- ➤ Beam collimation ~ 3 mm
- ➤ Pitch ~ 0.8 1:1
- ➤ Tube current ~ 270mAs
- ➤ Voltage ~ 130 kV
- > Total exposure time ~ 18 s
- ➤ Total Radiation ~ 200mGy

Along with axial images, coronal-plane and sagittal images were reconstructed with a 0.5 mmincrement. Additionally, three-dimensional volume rendering images were also obtained.

3D images will be compared with axial, coronal and sagittal plane images".

**Ethical considerations:** The institution's human ethics committee approved the study. All study participants provided written informed consent, and only those who were prepared to sign it were allowed to take part in the investigation. Before obtaining consent, it was mentioned to the participants the risks and advantages of the study as well as the voluntary nature of participation. The study participant's details were maintained confidentially.

**Data collection tools:** Consent is taken from all the patients. Prior to PNS and mandible MDCT scan, the patient's clinical history was obtained. Any previous imaging studies if available were reviewed. CT findings were recorded in the proforma.

#### **METHODOLOGY:**

After receiving approval from the institutional ethical committee, the study was started. Written informed consent was obtained from subjects who met the inclusion criteria. All maxillofacial trauma patients were subjected to multislice PNS CT scan. Images were obtained by axial plane, then reconstructed in coronal and sagittal planes and 3D volume rendering. These were assessed in terms of fracture identification, location, displacement, and extent of fracture. Other demographic data such as age, sex and cause & were also documented in a structured questionnaire to know the prevalence of maxillofacial injuries.

Clinical findings such as type of injury, whether isolated/multiple injuries, soft tissue/ hard tissue injuries were documented. Bruises, abrasions, cut wound, contusion, lacerations, avulsions, and burns were categorized as soft tissue injuries. Fracture of facial bones (nasal/maxilla/mandible/zygoma/frontal/palatal or orbital bones) were identified as hard tissueinjuries. The principal investigator and an expert clinician worked together to interpret the computed tomography results.

All trauma patients were resuscitated in the Emergency room (airway, breathing and circulation) by securing the airway by endotracheal intubation or surgical airway, whenever there was impending airway compromise. Bleeding if any, was controlled and fluid resuscitation/blood transfusion was done as per requirement. Intramuscular tetanus toxoid (TT) 0.5 ml, analgesics (Tramadol 50 mg IM) and antibiotics were also given when necessary.

# **STATISTICAL ANALYSIS:**

SPSS version 20 was utilised for the statistical analysis, after the data were entered into an MS Excel sheet. MS Excel 2010 was used for graphical representation. Mean and Standard deviation were used to present quantitative data. Unpaired t test was used tocompare the study groups, and qualitative data was shown as frequency and percentages. Using the chi-square test, student's test, and ANOVA test, associations between the study groups were evaluated. A "p" value of 0.05 or less was considered significant.



### RESULTS

In order to determine the role of multidetector CT in the diagnosis and evaluation of fractures in maxillo-facial injuries, this study was carried out. For patients with suspected fractures following maxillofacial trauma; axial, coronal, sagittal, and 3D images were obtained. Imaging was done and the data was analyzed; the findings of which are as follows:

## Patient distribution based on age:

The study included 49 subjects, with the age group of 21-30 years accounting for the greatest percentage of cases (42.8%), followed by 31-40 years with 12 cases (24.4%), 18-20 years with 8 cases (16.3%), 41-50 years with 6 cases (12.2%), and 51-60 years with 2 cases (4%). Mean age of subjects was 31.04+/-10.9 years. The least affected age range was found to be between 51 and 60 years (2 cases, 4%). This is shown in Table 1 and Figure 16.

Table 1: Patient distribution based on age

	Number (n)			
AGE (years)	Male	Female	Total	%
18-20	8	0	8	16.3
21-30	18	3	21	42.8
31-40	7	5	12	24.4
41-50	6	0	6	12.2
51-60	2	0	2	4
Total	41	8	49	100

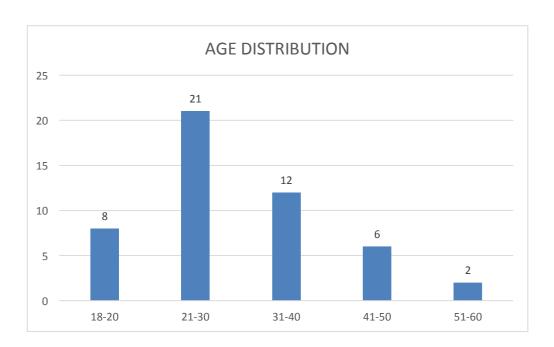


Figure 16: Patient distribution based on age

# Patient distribution based on Sex:

The majority of the study participants were male, 41 (84%) patients and the rest were female, 8 patients (16%). The ratio of men to women was 5.12:1. This is shown in Table 2 and Figure 17.

Table 2: Patient distribution based on Sex

Sex	Number (n)	%
Male	41	84
Female	8	16
Total	49	100

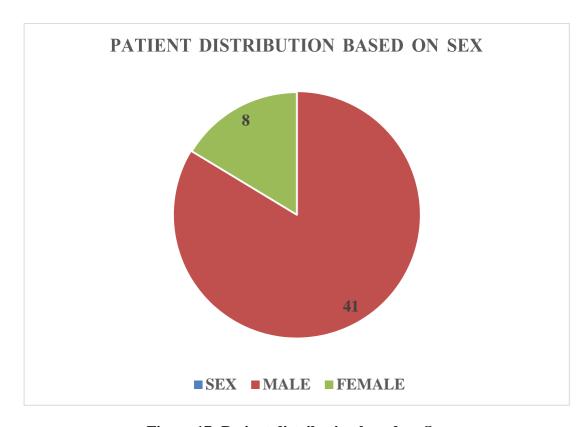


Figure 17: Patient distribution based on Sex

# Patient distribution based on mode of injury:

Road traffic accidents accounted for 95.9% of all injury cases in our study, followed by fallfrom height and assault (2.04% each) as shown in Table 3 and Figure 18.

Table 3: Patient distribution based on mode of injury:

Mode of Injury	Number (n)	%
Road Traffic Accidents	47	95.9
Fall from Height	1	2.04
Assault	1	2.04
Total	49	100%

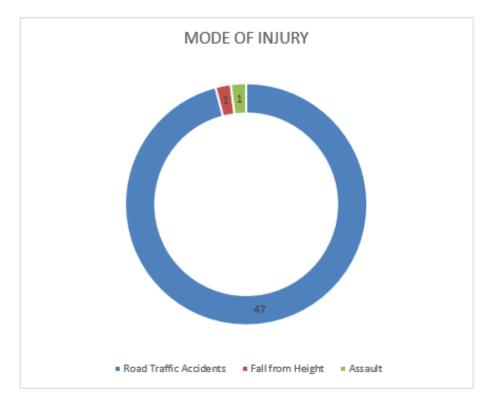


Figure 18: Patient distribution based on mode of injury

# Patient distribution based on type of fracture:

In our study we found that almost all facial bone fractures are assessed in axial, coronal, sagittal and 3D reformatted images to detect fractures in maxillofacial trauma.

Mandible fractures were found to be the most common (20 patients, 40.8%) followed by fracture of nasal bone (18 patients, 36.7%), pterygoid plate and maxilla fractures (14 patients, 28.6%), greater wing of sphenoid (12 patients, 24.4%), zygomatic bone and arch (11 patients, 22.4%), orbit fractures (10 patients, 20.4%) and lamina papyraceae fractures (9 patients, 18.36%). Incidence of frontal bone fractures was found to be the least (6 patients, 12.24%). This is shown in Table 4 and Figure 19.

Table 4: Types of bone fractures, incidence and fracture detection in various views.

FRACTURE	INCIDENCE	AXIAL	CORONAL	SAGITTAL	3D
Frontal	12.24%	6	6	6	6
Orbit	20.4%	10	10	10	10
Nasal	36.7%	18	18	18	18
Lamina papyracea	18.3%	9	9	0	0
Zygomatic bone	22.4%	11	11	11	11
Zygomatic arch	22.4%	11	11	11	11
Greater wing of sphenoid	24.4%	12	12	12	12
Pterygoid plate	28.5%	14	14	14	14
Maxilla	28.5%	14	14	14	14
Mandible	40.8%	20	20	20	20

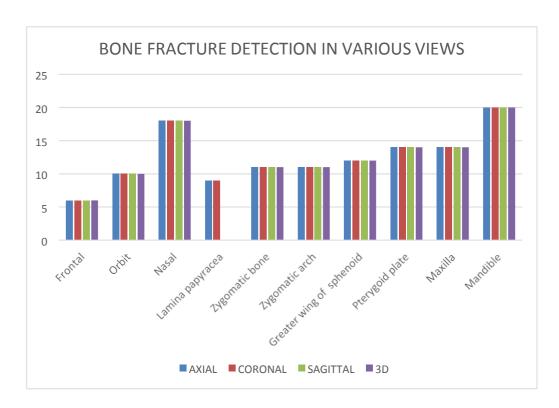


Figure 19: Bone fracture detection in various views

# **Frontal bone fractures**

Incidence of frontal bone fractures was found to be the least. (6 patients, 12.24%) as shown in Table 5 and Figure 20. All 4 views (axial, coronal, sagittal as well as 3D) were equally useful in detection of these fractures.

**Table 5: Frontal bone fractures** 

	Frontal Bone	Number (n)
	AXIAL	10
l View	CORONAL	10
Radiological View	SAGITTAL	10
Radio	3D	10

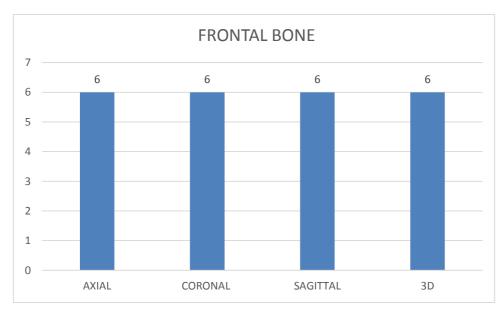


Figure 20: Frontal bone fractures

# **Orbital bone fractures**

In our study, there were 10 individuals with orbit fractures, with a 20.4% incidence in our study as shown in Table 6 and Figure 21. Even though these fractures were detected in all views, Axial & coronal images were found to be better forfractures of orbit fractures.

**Table 6: Orbital bone fractures** 

	Orbital Bone	Number (n)
	AXIAL	10
Radiological View	CORONAL	10
ologica	SAGITTAL	10
Radic	3D	10

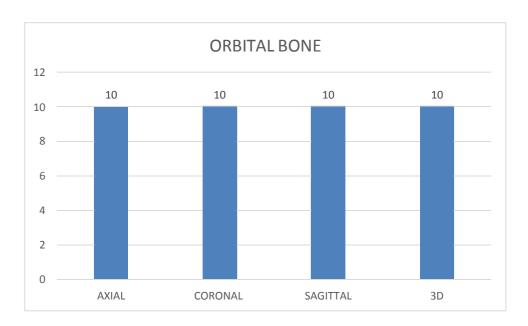


Figure 21: Orbital bone fractures

# **Nasal bone fractures**

Fracture of nasal bone was seen among 18 patients with an incidence of 36.7% in our study as shown in Table 7 and Figure 22. All 4 views (axial, coronal, sagittal as well as 3D) were equally useful in detection of these fractures.

**Table 7: Nasal bone fractures** 

	Nasal Bone	Number (n)
	AXIAL	18
View	CORONAL	18
Radiological View	SAGITTAL	18
Radio	3D	18

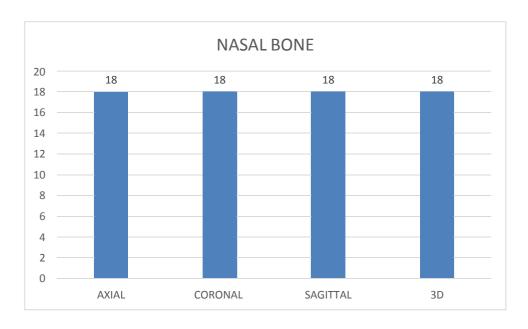


Figure 22: Nasal bone fractures

# **Lamina Papyracea fractures**

Lamina papyraceae fractures had an incidence of 18.36% as it was seen in 9 patients in our study as shown in Table 8 and Figure 23. We found that Lamina papyracea fractures are not assessed in sagittal and 3D images and are seen best in axial and coronal images.

Figure 8: Lamina Papyracea fractures

	Lamina Papyracea	Number (n)
View	AXIAL	9
	CORONAL	9
Radiological	SAGITTAL	0
8	3D	0

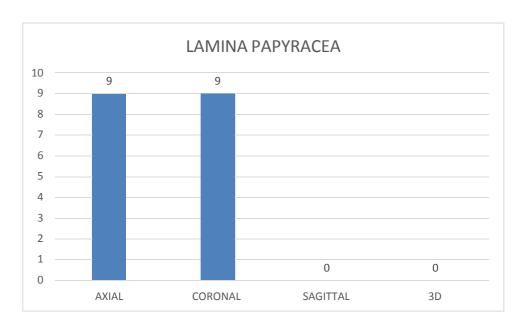


Figure 23: Lamina Papyracea fractures

# **Zygomatic bone fractures**

11 patients (22.4%) had zygomatic bone fractures in our study population as shown in Table 9 and Figure 24. They were assessed in all four views (axial, coronal, sagittal as well as 3D) with good accuracy.

**Table 9: Zygomatic Bone fractures** 

	Zygomatic Bone	Number(n)
	AXIAL	11
View	CORONAL	11
Radiological View	SAGITTAL	11
Radio	3D	11

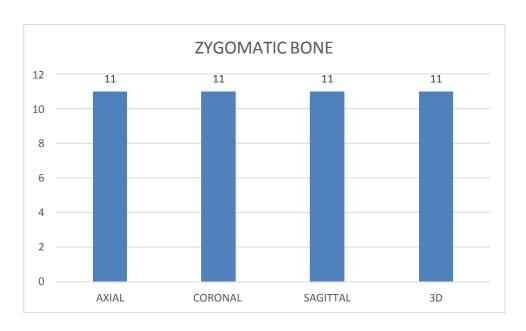


Figure 24: Zygomatic bone fracture

# **Zygomatic Arch fractures**

11 individuals had zygomatic arch fractures, with a 22.4% incidence as shown in Table 10 and Figure 25. For the purpose of detecting zygomatic arch fractures, 3D images were found to be superior to axial and coronal images.

**Table 10: Zygomatic Arch fractures** 

	Zygomatic Arch	Number(n)
	AXIAL	11
View	CORONAL	11
Radiological View	SAGITTAL	11
Radio	3D	11

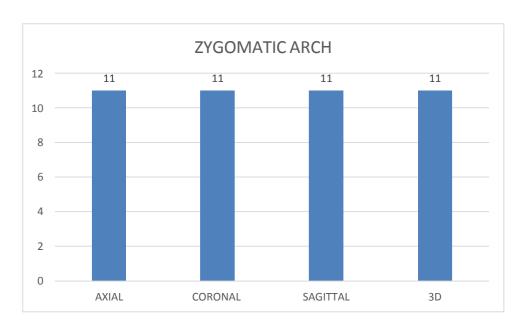


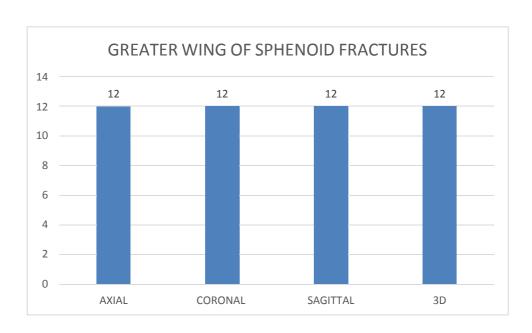
Figure 25: Zygomatic Arch fractures

# **Greater wing of Sphenoid Fractures**

12 individuals had greater wing of sphenoid fractures with a 24.4% incidence as shown in Table 11 and Figure 26. According to our study; axial, coronal, sagittal, and 3D views were quite effective at detecting these fractures.

**Table 11: Greater wing of Sphenoid Fractures** 

	Greater wing of Sphenoid Fractures	Number (n)
	AXIAL	12
View	CORONAL	12
Radiological View	SAGITTAL	12
Radiol	3D	12



**Figure 26: Greater wing of Sphenoid Fractures** 

#### Pterygoid plate fractures

14 individuals had pterygoid plate fractures with a 28.6 % incidence in our study as shown in Table 12 and Figure 27. We found that Axial & coronal images are better for fractures of pterygoid plates compared to sagittal and 3D images.

**Table 12: Pterygoid plate fractures** 

	Pterygoid plate	Number (n)
	AXIAL	14
/iew	CORONAL	14
Radiological View	SAGITTAL	14
Radiol	3D	14

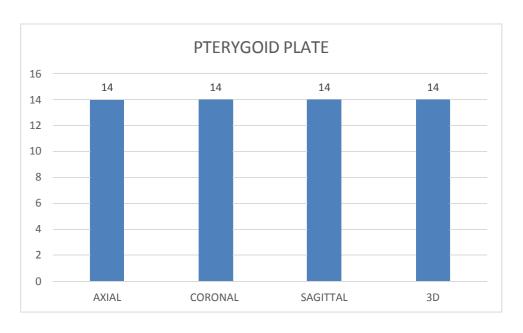


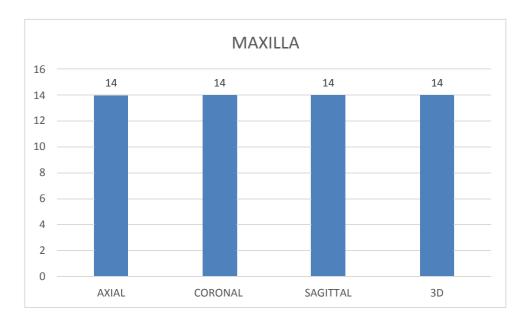
Figure 27: Pterygoid plate fractures

#### **Maxillary bone Fractures:**

14 individuals had maxillary bone fractures with a 28.6 % incidence in our study as shown in Table 13 and Figure 28. In our study we found that 3D images are much better for detection of fractures of maxilla compared to axial, coronal or sagittal views.

**Table 13: Maxillary bone Fractures:** 

	Maxilla	Number (n)
	AXIAL	14
lew	CORONAL	14
Radiological View	SAGITTAL	14
Radiole	3D	14



**Figure 28: Maxillary bone Fractures** 

#### **Mandible Fractures:**

20 individuals had mandible fractures with a 40.8 % incidence in our study as shown in Table 14 and Figure 29. For the detection of mandibular fractures, 3D images were found to be superior to axial, coronal and sagittal images.

**Table 14: Mandible Fractures** 

	Mandible	Number(n)
	AXIAL	20
View	CORONAL	20
Radiological View	SAGITTAL	20
Radio	3D	20

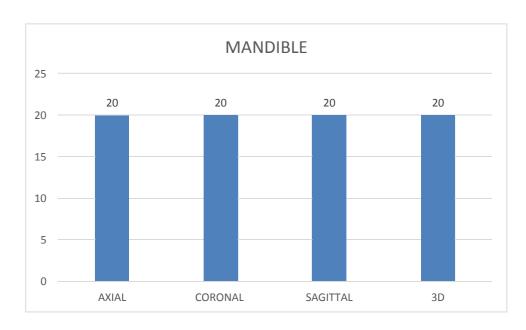


Figure 29: Mandible Fractures

Additionally, our study found that 3D images are superior to axial in assessing the extent and degree of displacement of maxillofacial fractures.

#### **Incidence of sinus fractures**

In our study maxillary sinus is the most common fractured sinus (19 patients, 38.7%), frontal sinus (3 patients, 6.1%) and sphenoid sinus fractures were the least common (2 patients, 4.08%). Table 15 and Figure 30 shows the incidence of various sinus fractures noted in patients of maxillofacial fractures in our study.

Table 15: Types of sinus fractures, incidence and fracture detection in various views

SINUS FRACTURE	INCIDENCE	AXIAL	CORONAL	SAGITTAL	3D
Frontal	6.1%	3	3	3	1
Sphenoid	4.08%	2	2	2	0
Maxillary	38.7%	19	19	19	10

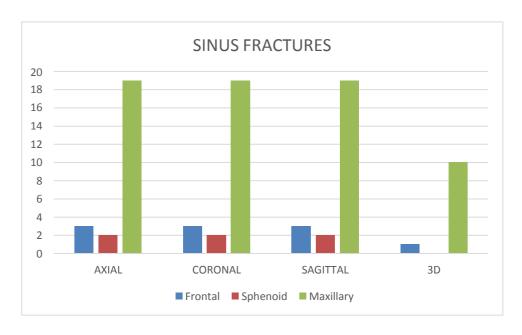


Figure 30: Detection of sinus fractures in various views

#### **Fracture of frontal sinus**

Three patients had frontal sinus fractures (6.1%), with only 2 (4.08%) being detected on all four views (axial, coronal, sagittal as well as 3D) as shown in Table 18 and Figure 31. Posterior wall fractures were not well visualized in 3D, but no such difficulty was encountered for anterior wall fractures. Comminuted displaced fractures were better visualized in 3D.

**Table 18: Frontal sinus fractures** 

	Frontal Sinus	LEFT
	AXIAL	3
ew	CORONAL	3
Radiological View	SAGITTAL	3
Radiolo	3D	2

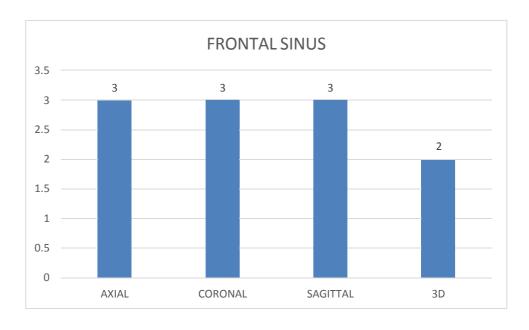


Figure 31: Frontal sinus fractures

#### **Sphenoid sinus fractures**

In our study sphenoid sinus fractures had the least incidence among the sinus fractures (seen in 2 patients, 4.08%). These fractures were seen well on axial, coronal as well as sagittal views, however they could not be visualized in 3D as shown in Table 16 and Figure 32.

**Table 16: Sphenoid sinus fractures** 

	Sphenoid Sinus	Number (n)
	AXIAL	2
View	CORONAL	2
Radiological View	SAGITTAL	2
Radio]	3D	0

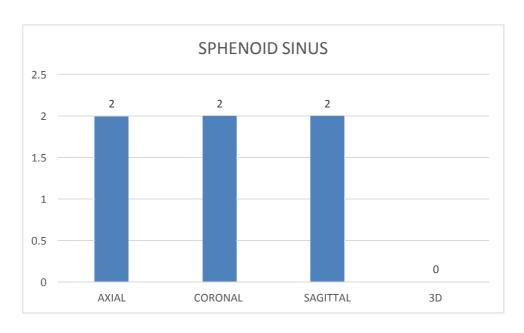


Figure 32: Sphenoid sinus fractures

#### **Maxillary sinus fractures**

In our study maxillary sinus is the most common fractured sinus (19 patients, 38.7%) as shown in Table 17 and Figure 33. These fractures were easily detected on axial, coronal and sagittal views, however it was observed that medial wall fractures cannot be well visualized in 3D, hence only 10 out of 19 cases were detected rightly on 3D images. On the contrary, it was noted that anterior & posterolateral wall fractures were better visualized in 3D. Comminuted displaced fractures were also better visualized in 3D.

**Table 17: Maxillary sinus fractures** 

	Maxillary Sinus N						
	AXIAL	19					
View	CORONAL	19					
Radiological View	SAGITTAL	19					
Radio	3D	10					

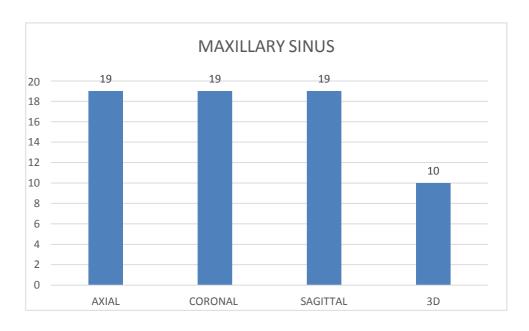


Figure 33: Maxillary sinus fractures



#### **CASE IMAGES**

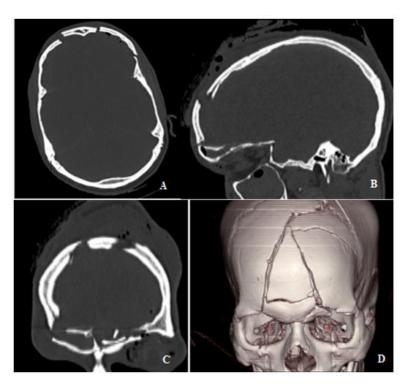


Figure 34: CT scan- Axial (A), Coronal (B) & Sagittal (C) sections bone window and 3D reformatted images (D) showing fracture of bilateral frontal bones

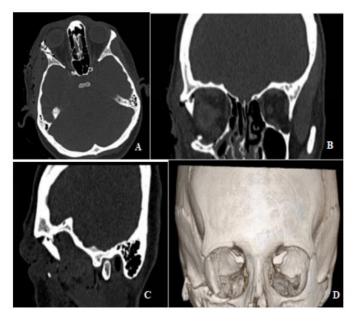


Figure 35: CT scan-Axial (A), Coronal (B) & Sagittal (C) sections bone window and 3D reformatted images (D) showing fracture of lateral wall of right orbit. On 3D reformatted image we can also appreciate orbital floor fracture and displacement of fracture fragments.

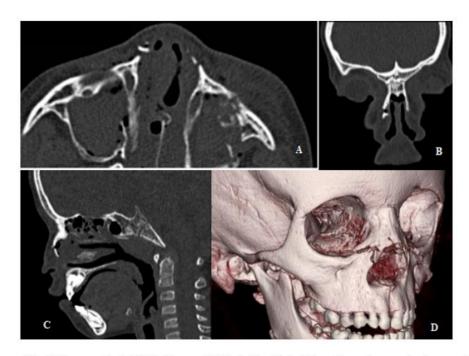


Figure 36: CT scan- Axial (A), Coronal (B) & Sagittal (C) sections bone window and 3D reformatted images (D) showing fracture of right nasal bone with displacement of fracture fragment.

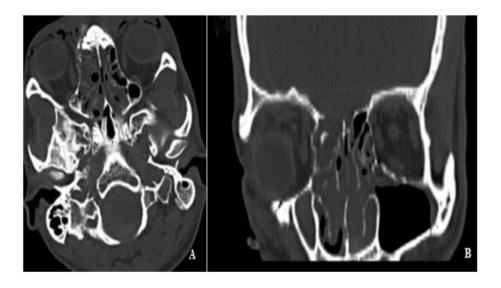


Figure 37: CT scan- Axial (A) & Coronal (B) showing comminuted fracture of the right lamina papyracea with ethmoid hemosinus.

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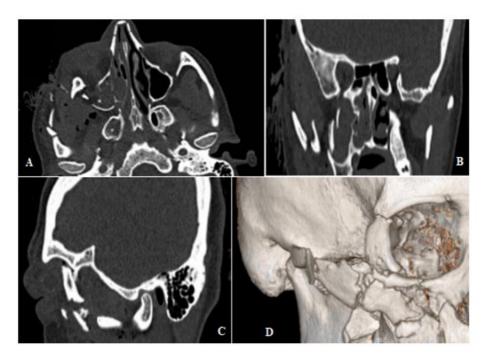


Figure 38: CT scan- Axial (A), Coronal (B) & Sagittal (C) sections bone window and 3D reformatted images (D) showing comminuted fracture of zygomatic bone and zygomatic arch on right side with displacement of fracture fragments



Figure 39: CT scan- Axial (A), Coronal (B) & Sagittal (C) sections bone window and 3D reformatted images (D) showing ffracture of greater wing of sphenoid on right side.

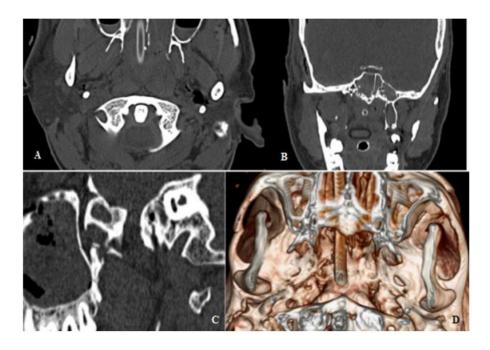


Figure 40: CT scan- Axial (A), Coronal (B) & Sagittal (C) sections bone window and 3D reformatted images (D) showing displaced fracture of medial left pterygoid plate.

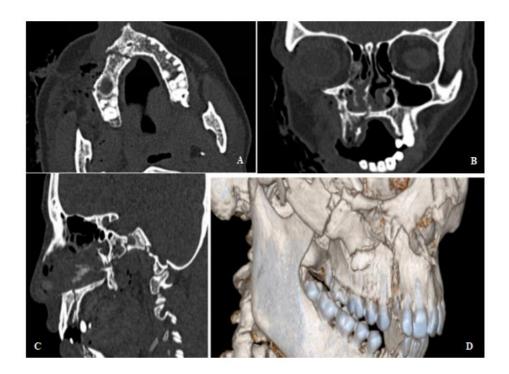


Figure 41: CT scan- Axial (A), Coronal (B) & Sagittal (C) sections bone window and 3D reformatted images (D) showing fracture of alveolar process of maxilla extending to hard palate on right side.



Figure 42: CT scan- Axial (A), Coronal (B) & Sagittal (C) sections bone window and 3D reformatted images (D) showing fracture of symphysis menti of mandible extending to parasymphysis on right side.

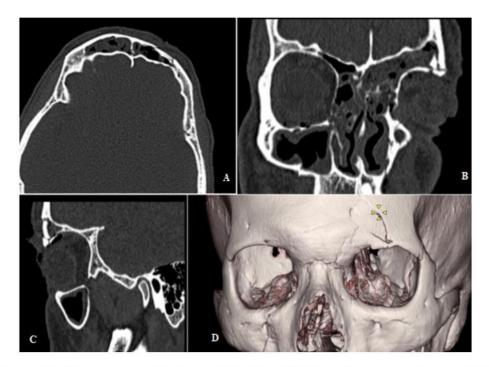


Figure 43: CT scan- Axial (A), Coronal (B) & Sagittal (C) sections bone window and 3D reformatted images (D) showing fracture of outer & inner tables of left frontal sinus with hemosinus.

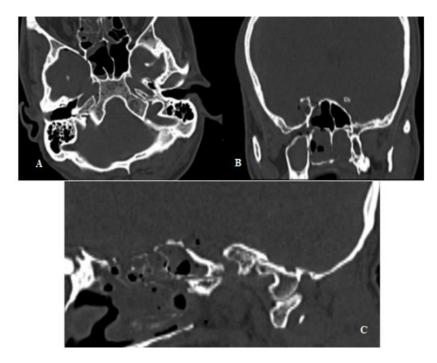


Figure 44: CT scan- Axial (A), Coronal (B) & Sagittal (C) sections bone window showing

Fracture of lateral wall of right sphenoid loculus with hemosinus.

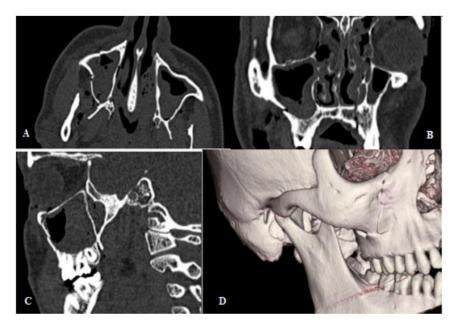


Figure 45: CT scan- Axial (A), Coronal (B) & Sagittal (C) sections bone window and 3D reformatted images (D) showing fracture of anterior and postero-lateral walls of the right maxillary sinus.

#### **POST-OPERATIVE IMAGES**

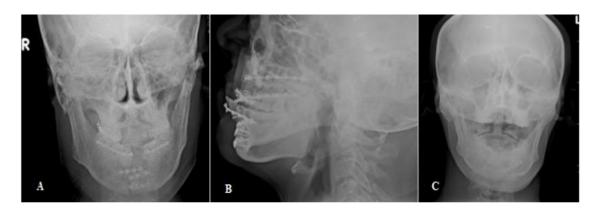


Figure 46: Surgical fixation device (plate & screws) in the superior & inferior alveolar process of maxilla and symphysis menti (A and B); and in the body of mandible on left side (C).



#### **DISCUSSION**

49 patients were included in this cross-sectional descriptive study referred to Department of Radiodiagnosis at R.L. Jalappa Hospital and Research Center (attached to SDUMC, Kolar) over a period of 18 Months from January 2021 to June 2022. Patients with maxillo-facial injuries underwent multislice CT examination and the results were analyzed.

Multi detector CT provides views in 3 different planes along with high quality 3D reconstruction which provides excellent visualization and helps in interpretation of the fracture segments whether comminuted or displaced, even in case of complex fractures. This makes it easier for maxillofacial surgeons to plan surgeries efficiently.<sup>81</sup>

In our study, 84% of the patients were male and majority of patients (43%) were in the age range of 21 to 30 years. The mean age of the patients was 31.04+/-10.9 years and the male to female ratio is 5.12:1.

The results are consistent with studies by Tomich G et al<sup>12</sup>, Chandra Shekar BR et al<sup>82</sup>, and Subhashraj K et al<sup>83</sup>, in which the majority of patients were males between the ages of 21 and 30, and road traffic incidents were the most frequent cause of maxillofacial trauma. In the study by Tomich G et al, maxillofacial trauma was prevalent in subjects between the ages of 15 and 35.<sup>12</sup>

In our study, Road traffic accidents accounted for 95.9% of injury cases and assault & fall from height coming in at 2.04% each. In a similar vein, Singh V. et al. and other authors have reported that the incidence of maxillofacial fractures is continuously increasing due to uncontrolled traffic and overpopulation, with road traffic accidents being the primary etiological factor in these fractures as noted in their study.<sup>80</sup>

Chandra Shekar BR et al also had similar findings in their study. Maxillofacial fractures in males between the ages of 11 and 40 were primarily caused by road traffic accidents. <sup>82</sup> Almost all facial bone fractures are accurately assessed in axial, coronal, sagittal and 3D reformatted images to detect fractures in maxillofacial trauma in our study.

Fractures of the mandible were found to be most common (20 patients, 40.8%) followed by fracture of nasal bone (18 patients, 36.7%), pterygoid plate and maxilla fractures (14 patients each, 28.6%), greater wing of sphenoid (12 patients, 24.4%), zygomatic bone and arch (11 patients each, 22.4%), orbit fractures (10 patients, 20.4%) and lamina papyraceae fractures (9 patients, 18.36%). Incidence of frontal bone fractures was found to be the least.(6 patients, 12.24%). All 4 views (axial, coronal, sagittal as well as 3D) were equally useful in detection of these fractures.

In the study by Subhashraj K et al<sup>83</sup> mandibular fractures were most common and fractures of zygomaticomaxillary region followed closely. Hwang K et al<sup>85</sup> also conducted a study on patients who sustained maxillofacial fractures but found the nasal bone to be the most affected. Zygomatico- maxillary fractures were also quite common in their study (14%); however, in our study fractures of the nasal bones came in second.

The nasal bone was found to be the most often fractured bone, closely followed by naso-ethmoidal and zygomatic-maxillary complex fractures, according to Hwang K et al and Patil S et al<sup>84</sup>.

Axial & coronal images were found to be better for fractures of orbit fractures. All 4 views (axial, coronal, sagittal as well as 3D) were equally useful in detection of nasal, zygomatic bone and greater wing of sphenoid fractures. We found that Lamina papyracea fractures are not assessed in sagittal and 3D images and are seen best in Axial and coronal images.

3D and axial images were found to be better than axial and coronal sections for detection of fractures of zygomatic arch. Axial & coronal images are better for fractures of pterygoid plates compared to sagittal and 3D images.

3D images are much better for detection of fractures of maxilla and mandible compared to axial, coronal or sagittal views. Furthermore, our analysis found that 3D images are superior to axial images in assessing the extent and degree of displacement of maxillofacial fractures.

In our study maxillary sinus is the most common fractured sinus (19 patients, 38.7%), followed by frontal sinus (3 patients, 6.1%) and sphenoid sinus fractures were the least common (2 patients, 4.08%).

Maxillary sinus fractures were easily detected on axial, coronal and sagittal views, however it was observed that medial wall fractures cannot be well visualized in 3D, hence only 10 out of 19 cases were detected rightly on 3D images. On the contrary, it was noted that anterior & posterolateral wall fractures were better visualized in 3D. Communited displaced fractures were also better visualized in 3D.

Frontal sinus fractures were seen in 3 patients (6.1%), with only 2 (4.08%) being detected on all four views (axial, coronal, sagittal as well as 3D). Posterior wall fractures were not well visualized in 3D, but no such difficulty was encountered for anterior wall fractures. Communited displaced fractures were also visualized in 3D.

These findings coincide with those of Fox LA et al<sup>86</sup> who reported that 3D images in MDCT scans are rapid and provide better view thereby aiding detection of maxillofacial fractures, especially those of the zygomatic bone. They also found that medial wall fractures in case of maxillary fractures were seen better on axial CT, but there was no difference between the medial and lateral maxillary sinus fractures. They also found axial scans to be more superior than coronal in detecting zygomatic arch fractures. This is another finding that has been

substantiated by an author of a similar study, Tanrikulu R et<sup>87</sup>, concluded that axial CT is better for zygomatic arch fractures.

Our study found that detection of maxillofacial fractures, especially displaced & communited ones can be detected ideally by 3D images. Bernard LM et al<sup>88</sup> seem to be in agreement to this finding, according to whom, When compared to axial CT, coronal CT offers the better detection of mandibular fractures.

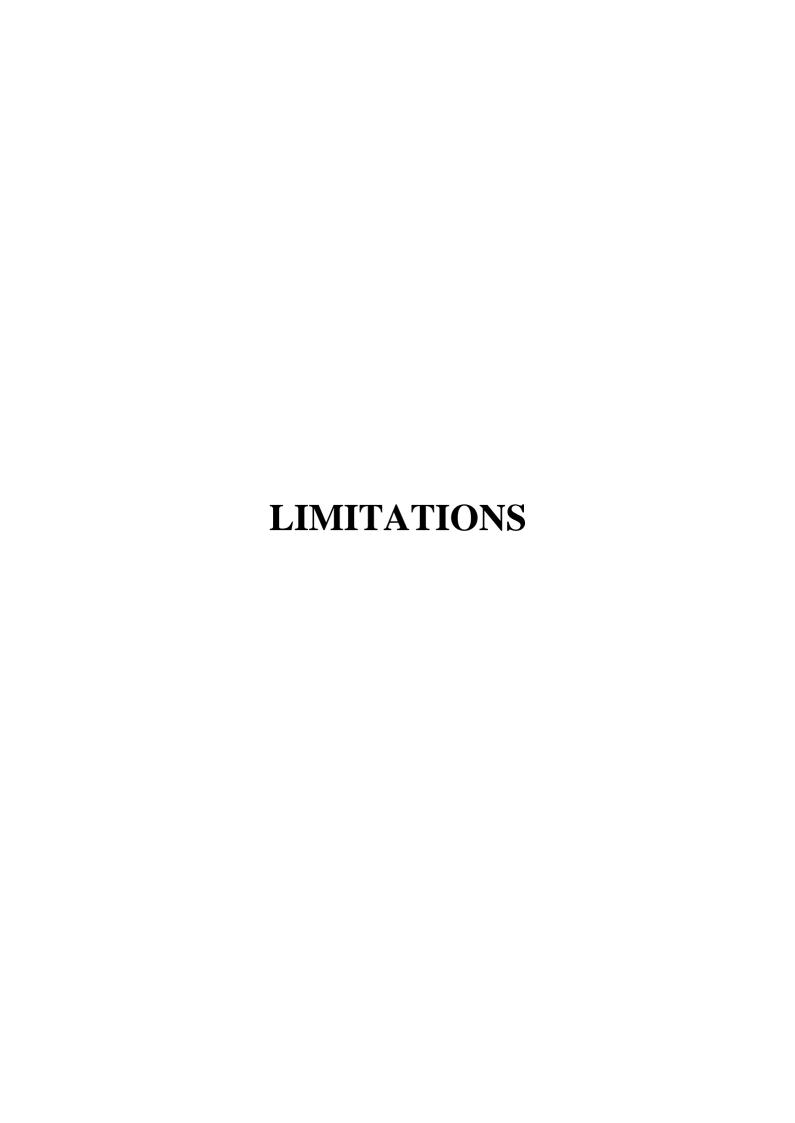
When compared to axial and coronal images, 3D CT images were found to be less reliable than axial imaging in the detection, extent and displacement of orbital fractures byFox LA et al<sup>86</sup>.

CT findings were found to be correlating with the operative findings in most types of fractures in our study.



### **CONCLUSION**

MDCT with multiplanar & 3D reformation is highly accurate in identification of fractures and assessing the extent & degree of displacement of fractures; hence it is the investigation of choice in maxillo-facial trauma patients.



## **LIMITATIONS**

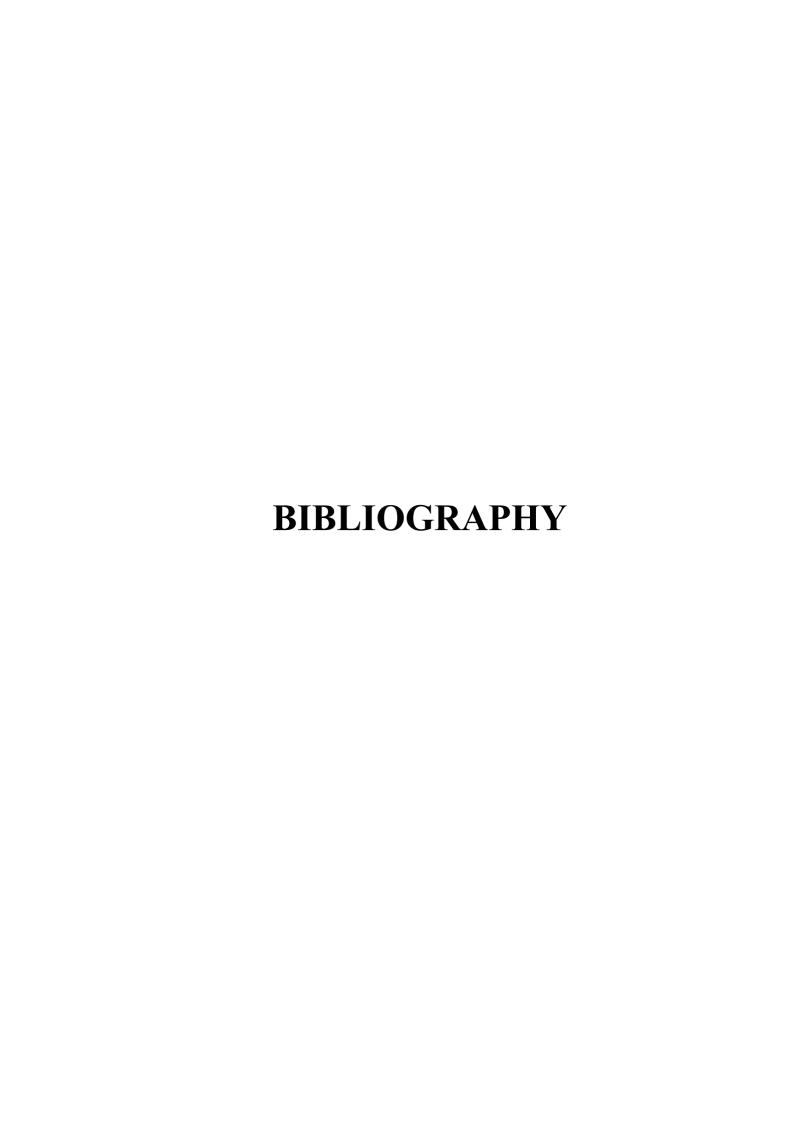
A larger sample size may have provided better statistical results with greater validity.



#### **SUMMARY**

- 1. 49 subjects were included in the study.
- 2. Highest number of cases were in the age group of 21-30 years.
- 3. The subjects mean age was 31.04+/-10.9 years.
- 4. The age group of 51-60 years was found to be least affected.
- 5. 41 patients were male and formed the majority of the study population.
- 6. The ratio of men to women was 5.12:1.
- 7. Road traffic accidents were the most common cause of injury.
- 8. The most common fractured bone was mandible (20 patients, 40.8%) followed by fracture of nasal bone (18 patients, 36.7%).
- 9. Incidence of frontal bone fractures was found to be the least (6 patients, 12.24%).
- 10. Axial & coronal images were found to be better for fractures of orbit fractures.
- 11. All 4 views (axial, coronal, sagittal as well as 3D) were equally useful in detection of nasal bone fractures.
- 12. Lamina papyracea fractures are not assessed in sagittal and 3D images and are seen best in Axial and coronal images.
- 13. Zygomatic bone fractures are assessed in all four views (axial, coronal, sagittal as well as3D) with good accuracy.
- 14. 3D images were found to be superior to axial and coronal images in detection of zygomatic arch fractures.
- 15. Axial & coronal images are better for fractures of pterygoid plates compared to sagittal and 3D images.
- 16. 3D images are much better for detection of fractures and degree of displacement of maxilla and mandible compared to axial, coronal or sagittal views.

- 17. In general, our study found that 3D images are better than axial in assessing extent and degree of displacement of maxillofacial fractures.
- 18. Maxillary sinus is the most common fractured sinus (19 patients, 38.7%).
- 19. Sphenoid sinus fractures were the least common (seen in 2 patients, 4.08%).
- 20. CT findings are correlating with the operative findings in most types of fractures.



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#### **PROFORMA**

# "ROLE OF MULTIDETECTOR COMPUTED TOMOGRAPHY IN THEEVALUATION OF MAXILLOFACIAL TRAUMA".

Name:									
Age: Address:									
Clinical History:									
CT findings:									
Bone involved:									
FRACTURE	AXIAL	1	CORO	NAL	SAGIT	ΓAL	RE	VOLUME ENDERED MAGES	
	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	
Frontal									
Orbit									
Nasal									
Lamina papyracea									
Zygomatic bone									
Zygomatic arch									
Greater wing ofsphenoid									
Pterygoid plate									

#### Sinus involved:

Maxilla Mandible

SINUS	AXIAL		CORONAL		SAGIT	TAL	3D VOLUME RENDERED IMAGES		
	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	
Frontal									
Sphenoid									
Ethmoid									
Maxillary									

Operative findings:

#### **INFORMED CONSENT FORM**

# STUDYTITLE: "ROLE OF MULTIDETECTOR COMPUTED TOMOGRAPHY IN THE EVALUATION OF MAXILLOFACIAL TRAUMA"

**PRINCIPAL INVESTIGATOR:** Dr. BUCHIPUDI SANDEEP REDDY

<u>CHIEF RESEARCH</u>	ER/ PG GUIDE'S NAME: Dr. DEEPTI NAIK
I Mr. /Mrs	have been explained in my own understandable language,that
I will be included in	a study which is "ROLE OF MULTIDETECTOR COMPUTED
TOMOGRAPHY IN	THE EVALUATION OF MAXILLOFACIAL TRAUMA"
I have been explained	that my clinical findings, investigations, postoperative findings will be
assessed and documen	ted for study purpose.
•	my participation in this study is entirely voluntary, and I can withdraw as and this will not affect my relation with my doctor or the treatment for
my ailment.	- und und (1.1.1 1.00 und 0.1.1) 10.00.001 (1.1.1 1.1.1 und 0.1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1.1 1
I have been explained	about the interventions needed possible benefits and adversities due to
interventions, in my o	wn understandable language.
I have understood that	t all my details found during the study are kept confidential and while
publishing or sharing o	of the findings, my details will be masked.
I have principal invest	igator mobile number for enquiries.
I in my sound mind gi	ve full consent to be added in the part of this study.
Signature of the patier	nt: Name:
Signature of the witner	ss: Name:
Relation to patient:	
Date:	

Place:

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND

RESEARCH, TAMAKA, KOLAR, KARNATAKA

PATIENT INFORMATION SHEET

Principal Investigator: Dr. Buchipudi Sandeep Reddy / Dr. Deepti Naik

**STUDY SITE:** R.L Jalappa Hospital and Research Centre, Tamaka, Kolar. This is to inform

you that, you require CT PARANASAL SINUSES (PNS) for

Making treatment plan for you condition that is maxillofacial trauma. The CT PNS is required

for the making the diagnosis of the disease extent of the disease and for planning of the

treatment

We are conducting this study to predict the onset and severity of this condition.

If you are willing you will be enrolled in this study and we will do CT PNS and other

relevant investigations which are required for surgical procedures.

You will receive the standard care pre and post operatively

This will facilitate identifying maxillofacial trauma and its complications (if any) in an early

stage and treating it. It will also benefit other patients with maxillofacial trauma undergoing

surgery in future. You are free to opt-out of the study atany time if you are not satisfied or

apprehensive to be a part of the study. Your treatment and care will not be compromised if you

refuse to be a part of the study. The study will not add any risk or financial burden to you if

you are part of the study. In case of any complication during surgery patient will be treated

accordingly.

Your identity and clinical details will be confidential. You will not receive any financial benefit

for being part of the study. You are free to contact Dr. BUCHIPUDI SANDEEP REDDY or

any other member of the above research team for any doubt or clarification you have.

Dr. BUCHIPUDI SANDEEP REDDY

Mobile no: 7795199799

E-mail id: buchipudisunny@gmail.com

Name and Signature of the Principal Investigator

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## ಸಮ್ಮತಿ ಪತ್ರ

ನಾನು ಮಿಸ್ಟರ್ / ಮಿಸ್ಟರ್ ಅನ್ನು ನನ್ನ ಸ೦್ವತ ಅರ್ಥವಾಗುವ ಭಾಷೆಯಲ್ಲಿ
ವಿವರಿಸಲಾಗಿದೆ, ಇದನ್ನು
"ಮ್ಯಾಕ್ಸಿಲೊಫೇಶಿಯಲ್ ಟ್ರಾಮಾ ಮೌಲ್ಯಮಾಪನದಲ್ಲಿ ಮಲ್ಟಿಡೆಟೆಕ್ಟರ್ ಕಂಪ್ಯೂಟೆಡ್ ಟೊಮೊಗ್ರಫಿ
ಪಾತ್ರ" ಎಂಬ ಅಧ್ಯಯನದಲ್ಲಿ ಸೇರಿಸಲಾಗುವುದು.
ಈ ಅಧ್ಯಯನದ ಉದ್ದೇಶ, ಅಧ್ಯಯನದ ಸಂದರ್ಭದಲ್ಲಿ ನೀಡುವ ಮತ್ತು ಸಂಗ್ರಹಿಸುವ
ಮಾಹಿತಿಯಗೋಪ್ಯತೆಯ ಬಗ್ಗೆ ನನಗೆ ನನ್ನ ಸ್ಥಳೀಯ ಭಾಷೆಯಲ್ಲಿ ಓದಿ ಹೇಳಲಾಗಿದೆ/ವಿವರಿಸಲಾಗಿದ
ಮತ್ತು ನಾನು ಇದನ್ನು ಅರ್ಥ ಮಾಡಿಕೊಂಡಿರುತೇನೆ. ಈ ಅಧ್ಯಯನದ ವಿವಿಧ ಅಂಶಗಳ ಬಗ್ಗೆ
ಪ್ರಶ್ನೆಗಳನ್ನು ಕೇಳುವ ಅವಕಾಶವನ್ನು ನನಗೆ ನೀಡಲಾಗಿದೆ ಮತ್ತು ನನ್ನ ಪ್ರಶ್ನೆಗಳಿಗೆ ತೃಪ್ತಿಕರವಾದ
ಉತ್ತರಗಳು ದೊರೆತಿರುತವೆ. ಈ ಅಧ್ಯಯನದ ಮೂಲಕ ಸಂಗ್ರಹಿಸಿರುವ ಮಾಹಿತಿಯನ್ನು ಸಂಶೋಧನೆಯ
ಉದ್ದೇಶಕ್ಕೆ ಮಾತ್ರ ಬಳಸತಕ್ಕದ್ದು.
ಈ ಅಧ್ಯಯನದಿಂದ ಯಾವುದೇ ಸಂದರ್ಭದಲ್ಲಿಹಿಂದೆ ಸರಿಯುವ ಸ್ವಾತಂತ್ರ್ಯ ನನಗಿದ
ಎಂಬುದನ್ನೂ, ಈ ಅಧ್ಯಯನದಲ್ಲಿ ಪಾಲ್ಗೊಳ್ಳುವುದರಿಂದ ನನಗೆ ಯಾವುದೇ ಹೆಚ್ಚುವರಿ ವೆಚ್ಚ
ತಗಲುವುದಿಲ್ಲವೆಂಬುದನ್ನು ತಿಳಿದಿರುತ್ತೆನೆ.
ರೋಗಿಯಸಹಿ:
ಹೆಸರು:
ಸಾಕ್ಷಿಯಸಹಿ:
ಹೆಸರು:
ರೋಗಿಗೆಸಂಬಂಧ:
ದಿನಾಂಕ:

## ರೋಗಿಯ ಮಾಹಿತಿ ಪತ್ರ

<u>ಅಧ್ಯಯನದ ಶೀರ್ಪಿಕೆ</u>: "ಮ್ಯಾಕ್ಸಿಲೊಫೇಶಿಯಲ್ ಟ್ರಾಮಾ ಮೌಲ್ಯಮಾಪನದಲ್ಲಿ ಮಲ್ಟಿಡೆಟೆಕ್ಟರ್ ಕಂಪ್ಯೂಟೆಡ್ ಟೊಮೊಗ್ರಫಿ ಪಾತ್ರ"

<u>ಅಧ್ಯಯನ ಸ್ಥಳ</u>: ಆರ್.ಎಲ್ ಜಾಲಪ್ಪ ಆಸ್ಪತ್ರೆ ಮತ್ತು ಸಂಶೋಧನಾ ಕೇಂದ್ರ, ಟಮಾಕಾ, ಕೋಲಾರ.

<u>ಪ್ರಿನ್ಸಿಪಲ್ ಇನ್ವೆಸ್ಟಿಗೇಟರ್</u>: ಡಾ. ಬುಚಿಪುಡಿ ಸಂದೀಪ್ ರೆಡ್ಡಿ/ ಡಾ. ದೀಪ್ತಿ ನಾಯಕ್

ಇದು ನಿಮ್ಮ ಗಮನಕ್ಕಾಗಿ

ನಾನು, ಶ್ರೀ ದೇವರಾಜ್ ಅರಸು ವೈದ್ಯಕೀಯ ಕಾಲೇಜಿನಲ್ಲಿ ರೇಡಿಯೊ ಡಯಾಗ್ನೋಸಿಸ್ ವಿಭಾಗದಲ್ಲಿ ಸ್ನಾತಕೋತ್ತರ ವಿದ್ಯಾರ್ಥಿ ಡಾ. ಬುಚಿಪುಡಿ ಸಂದೀಪ್ ರೆಡ್ಡಿ. ನಾನು "ಮ್ಯಾಕ್ಸಿಲೊಫೇಶಿಯಲ್ ಟ್ರಾಮಾ ಮೌಲ್ಯಮಾಪನದಲ್ಲಿ ಮಲ್ಟಿಡೆಟೆಕ್ಟರ್ ಕಂಪ್ಯೂಟೆಡ್ ಟೊಮೊಗ್ರಫಿ ಪಾತ್ರ" ಎಂಬ ಶೀರ್ಷಿಕೆಯ ಅಧ್ಯಯನವನ್ನು ನಡೆಸಲಿದ್ದೇನೆ.ಈ ಅಧ್ಯಯನವು ರೇಡಿಯೋ-ಡಯಾಗ್ನೋಸಿಸ್ ವಿಭಾಗದ ಪ್ರಾಧ್ಯಾಪಕೀ ಡಾ. ದೀಪ್ಪಿ ನಾಯಕ್ಅವರ ಮಾರ್ಗದರ್ಶನದಲ್ಲಿ ನಡೆಸುತ್ತಿದ್ದೇನೆ.

ನೀವು ಈಅಧ್ಯಯನದ ಭಾಗವಾಗಲುಒಪ್ಪಿಗೆ ಹೊಂದಿಲ್ಲದಿದ್ದರೆ. ನೀವು ಯಾವಾಗ ಬೇಕಾದರೂ ಅಧ್ಯಯನದಿಂದ ಹೊರಗುಳಿಯಲು ಮುಕ್ತರಾಗಿದ್ದೀರಿ. ನೀವು ಅಧ್ಯಯನದ ಭಾಗವಾಗಲು ನಿರಾಕರಿಸಿದರೆ ನಿಮ್ಮ ಚಿಕಿತ್ಸೆ ಮತ್ತು ಕಾಳಜಿಗೆ ಧಕ್ಕೆಯಾಗುವುದಿಲ್ಲ

ನಿಮ್ಮ ಗುರುತು ಮತ್ತು ವೈದ್ಯಕೀಯವಿವರಗಳು ಗೌಪ್ಯವಾಗಿರುತ್ತದೆ. ಅಧ್ಯಯನದ ಭಾಗವಾಗಿರುವುದರಿಂದ ನೀವು ಯಾವುದೇ ಆರ್ಥಿಕ ಲಾಭವನ್ನು ಪಡೆಯುವುದಿಲ್ಲ.

ನೀವು ಹೊಂದಿರುವ ಯಾವುದೇ ಅನುಮಾನ ಅಥವಾ ಸ್ಪಪ್ಟೀಕರಣಕ್ಕಾಗಿ ನೀವು ಡಾ. ಬುಚಿಪುಡಿ ಸಂದೀಪ್ ರೆಡ್ಡಿ ಅಥವಾ ಮೇಲಿನ ಸಂಶೋಧನಾ ತಂಡದ ಯಾವುದೇ ಸದಸ್ಯರನ್ನು ಸಂಪರ್ಕಿಸಬಹುದು

ಡಾ. ಬುಚಿಪುಡಿ ಸಂದೀಪ್ ರೆಡ್ಡಿ ಮೊಬೈಲ್ ಸಂಖ್ಯೆ: 7795199799

#### **KEY TO MASTERCHART**

Sl no : Serial number

UHID : Unique Hospital Identification

H/O : History

RTA : Road Traffic Accident

A : Axial

C : Coronal

S : Sagittal

3D : 3 dimensional

Y : Yes

N : No

OP : Operative Findings

## MASTERCHART

Sl.no	UHD NO		SEY	H/O	Ħ	ONTAL	L		ORB		віт		NASAL BONE		ΙE		LAMI	NAPAP		8	DOY O	F ZYG	OMA		ZYGOMATIC ARCH		н	G	WSPHENOID		PTERYGOIDPL		DPLATE		М	WILL	A		MANDIBLE			FRONTAL		SINUS		ETHMOID SINUS		JS	591	SPHENOIDS		s	M	AXILLA	RYSINU	is o	OP FINDINGS				
Si.no	UNUNU		n/o	A C	s	30	A	c	s	30	A	c	s	30	A	c	s	30	A	c	5	30	A		5		10	A	c s	5 3	30	A	c s	30	) A	c	5	30	A	c	s	30		ı c	s	30	A	c	s	30	A	c	s s	30	A	c	s 9	30			
1	900661	18 N	4	RTA	N N	N	N	N	N	N	N	N	N	N	N	N	N	N N		N	N b	I N		N	N	N	N		Y Y	Y	Y	N	N N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N D		N I	4 N	N	Y	1	Y Y	Y	L	ZMCARCH.RTPS	
2	936189	18 N	4	RTA	N N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N N		N	N N	I N		N	N	N	N		Y Y	Y	Y	N	N N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N D	1	N I	N N	N	Y	1	Y Y	Y		ZMC	
3	890073	19 N	4	RTA	N N	N	N	N	N	N	N	Y	Y	Y	Y	N	N	N N		N	N b	I N		N	N	N	N		N B	I N	N	Y	Y Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N B	1	N I	N N	N	Y	1	Y Y	N	#	RLEFORTILLZMC	
4	927147	19 N	4	RTA	N N	N	N	N	N	N	N	N	N	N	N	N	N	N N		N	N N	I N		N	N	N	N		Y Y	Y	Y	N	N N	N	N	N	N	N	N	Y	Υ	Y	Y	N	N	N	N	N	N	N D	1	N I	N N	N	N	4 1	N N	N	9	MPHYSIS,LT COND	DYLE
5	43040	19 N	4	RTA	N N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N N		N	N D	I N		N	N	N	N		N B	I N	N	N	N N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N B	1	N I	N N	N	N.	4 1	N N	N	a.	L ZMC	
6	77735	19 N	4	RTA	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N N		Y	Y Y	Y				Y				I N			N N	N	N	Y	Y	Υ	Y	N	N	N	N	Y	Y	Y	N	N	N	N D	1	N I	N N	N	Y	1	Y	Y	#	LT LEFORT II, RT.	ZMC &800Y
7	904460	20 N	4	RTA	Y Y	Y	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	N N		N	N b	I N		N	N	N	N		Y Y	Y	Y	N	N N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N B	1	N I	N N	N	Y	1	Y Y	N	Li	EFORT III	
8	37338	20 N	4	RTA	N N	N	N	N	N	N	N	Y	Y	Y	Y	N	N	N N		N	N N	I N				N			Y Y	Y	Y	Y	Y Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N D			N N			1	Y	Y	#	R PARASYMPHYSI	S,L BODY
9	897581	21 N	4	RTA	N N	N	N	N	N	N	N	Y	Y	Y	Y	N	N	N N		N	N b	I N				N			N B	l N	N	N	N N	N	N	N	N	N	N	Y	Υ	Y	Y	N	N	N	N	N	N	N B	1	N I	N N	N	h	4	N N	N	LI	T PARAYMPHYSIS,	BL CONDY
10	939925	21 N	4	RTA	N N	N	N	N	N	N	N	N	N	N	N	N	N	N N		N	N N	l N			_	N			N B	l N	N		N N			N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N D		N I	N N	N		4	N N	N	_	IGHT PARAIOP2	
11	950256	21 N			N N			-	-		N	-			N	-		N N			N N					N				Y			Y Y			-	Y	-	Y	N	N	N	N				N	-		N D		_		N		-	Y Y	_		R DENTOALVEOLA	
12	935749	22 N			N N			N	N	N	N	Y	Y	Y	Y			N N		N	N N	l N				N				I N		N	N N	N	N	N	N	N	N	_		Y	Y		N		N	N	N	N D		-		N		, ,	Y	N		LTZMCWITARCH	
13	99766	22 N			N N	-			N			Y	Y	Y		-		N N			Y Y					Y			-	Y	_		Y Y	_	-	-	_	N		N	N	N	N		N			N						N	_	-	Y	_		LEFORT II	
14	928975	23 N			N N				N			-		Y		_		N N				I N				N				l N				N			Y		Y		_	N	N			N	N	-	N					N	_	_	N N			T PARASYMPHYSI	8
15	902300	24 N			/ Y	-		_	N			N				-		N N			N N					N			-	l N	_		N N	_	-	_	_	N	_	Y	_	Y	v	_	N	-	N	N		N D			_	N	_	-	N N	_		LT BODY	
16	875957	25 N			Y				N			Y		Y		-		N N			N N					N				l N		_	-	N			-	-		N	-	-	N		N		N	N		-	_	-	-	N	_	-	N N			TZMC#	
17	881117	25 N			N N			_	N			+		N		-		N N			Y Y					Y				Y				N	-	_	_	Y	_	-	_	-	v		_		N	N					-	N	_	-	Y Y	_		TZMC, Leforti	
18	931818	25 N			N N			_	N			N				-		N N	_		N D		_			N				ı N			N N			N			-	Y	Y	٧	v	_	N	-	-	N		-				N		_	N N			PS,R BODY	
19	108794	25 N			N N	-		_	Y			Y				-		N N			Y Y	_				Y				Y			Y Y		-		_	Y		_	_	N			Y	-		N					_	N	_	-	Y Y			RT ZMC & LT LER	ORTH
20	112722	25 F			N N				N			N						N N			N D		_		_	N				ı N			YY					N		_		Y			N			N						N	_	_	N N			MANDIBLE	WINT III
21	890946	26 N			N N	-		Y	_	Y		N				-		N N			Y Y	_	_			Y			_	N		_	N N	_	_		N	_		_	_	_	Y		N	-		N					_	N	_	-	N N			TZMC.RTSUBCON	OM E
22	107710	26 N			N N				N	-		N				-		N N			N D		_			N				Y			YY					N	-	-	-	N	-		N			N			_	-	-	N	_	-	N N		_	RT PS & LT CON	
23	882815	27 N			N N	-		_	N			Y				-		N N			N N	_				N				ı N		_	YY					Y		-	_	N	-					N						N		-	N N			EFORT II	UTLE
24	119764	28 N		Assault				Y	-	Y		Y				N		N N			N D					N				l N			YY	_		_	Y		-	Y			Y				N	N				_		N			Y			MID FACE	
25	79184	29 N			N N			-	N			-		N							_	l N				N				l N		_	N N	_	_	-	-	-	-	-	-	Y			N			100						N		-	N N			RT PARASYMPH	
26	914004	30 N			N N				N			N N						N N			N N Y Y					Y				l N			N N					N		Y		N	•		N			N N						N			N N			EFT PARASYMPHY	eie
27		30 N			-	-			_			_				-		N N			N N	_				N							Y Y				_	Y		Y	_	_	Y		_			_					_		_	_					
	66673 42798	30 F			N N				N N		N N	N N			N	-		N N			N N					N				I N				N	_	_	Y	T V	T W	-	-	-	N		N N		N	N N	N N			_		N			N N			Symphysis, alveol R DENTOALVEOLA	
28		30 F			N N				N			N						N N			N D					N				l N			Y Y					Y	T v			Y	-		N			N			•			N			N N			BL P.S & LT ZMC	W.
30	82588					-		-	-	-						-																			-	_	-	-	-	-	-	-	-	_	-	-		-										-			H.E.
	139757	32 N			N N			IN .	N			N N				N		N N		V V	N N	_	_			N				l N		Di N	N N		_		N		_	N Y	N .	N	N			N		N				_		N		-	Y			LT ZMC7 MANDIS	
31	897510	35 F			N N			1	-	Y					N	-		N N		•		Y				Y N				N N		1		-		_	Y	-		-	T V	Y	T V	_			N	-	N					N			Y Y N N			TZMCARCH & MA STMPHYSIS & BL	
32	53876	35 F			N N				N			N				_		N N			N N	_			_	_				l N		_	Y		_					+	-	-			N			N				_		N		_				LEFORT I	CONDICE
	82769	35 N			N N			-	N			Y				-		N N			N N					N				N N			N N			-	_	N	-	-		N	N	_	Y	-		N		-				N			Y				
34	110055	35 N			N N				N			N				N		N N			N N	_				N				l N			N N				N		_		-		-		N			N						N			N N			RT & LT PS MANDIBLE	
35	121421	35 N			Y			-	Y			Y						N N			N N		-			N				N N		_	Y	_	_			N		N			-	-		N		N		N 1	_			N		_	N N				4.15
36	64071	38 N			N N				N			N						N N			Y Y					Y				l N			N N					N			_	N	_		N			N						N			Y			Symphysis,#I con	
37	947489	39 N			N N				N			N						N N			N N					N				I N			N N					N		-	-	Y	-		N			N						N		_	N N			R MANDIBLE ,	PIRTGOID
38	945850	40 F			N N	_			N	-			N			-		N N	_		N N	-				N				Y	_		N N				N			N	-		N	_			N		N	-	_			N	_	-	N N			RT BODY	numer of the second
39	41124	40 F			N N			-	N			N						N N			Y Y	-				Y				l N			N N					N		-	-	N	-	-	N	-		N		-				N		-	N N		_	SEHMENTAL SYM	rimsis
40	100642	40 F			N N				N			N				_		N N			N N	_				N				l N			N N					N	1	+	-	Y	-		N			N			_			N	_	_	N N			SYMPHYSIS	
41	110084	40 N			N N			-	N			Y		Y				N N			N N	-				N				I N			N N				-						Y				N	N				N I					N N			RT BODY & LT PS	•
42	103534	43 N			N N	_			N			_			N			N N			N N	_				N				Y			N N			N			N		_		N	N			N	_		N 1		γ γ			_	_	N N			RT BODY	
43	900994	44 N			Y	-		-	N					N		-		N N			YY					Y				l N			N N					N	-				N		N	-		N						N		-	N N	-		RZMCA,LLEFORT I	0.071
44	916848	45 N			N N			-	+	-		_	-	N				N N		Y					_	Y				l N				N				N	N		-		N	N			N		N	-	_			N		-	Y			T ZMCARCH, LEF	OKTII
45	903294	47 N			N N		N				N_		-		N			N N				l N				N			-	l N	_	N			N	N		N	N			N	N	N		N	N			N D	_		N N			-	N N	-		TZMC#	
46	89055	47 N			N N				N	-	-	Y	_	_				N N		-	N N	-			_	N				l N		_	N N					N			N		N	_		N	-	N	-	-				N	_	-	Y			LT BODY	
47	939013	48 N			N N			-	N			-	N					N N			N N					N				l N				N		_	_	_	-	Y	_		Y	_		-	N	-	N					N			N N			RT SYMPHYSIS	
48	904309	56 N			N N			_	N			Y				N		N N			N N	_				N				l N			N N					N		_		N				N		N				_		N		_	Y			TSEG MANDIBLEA	
49	124947	60 N	4	RTA	N N	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N N		N	N N	I N		N	N	N	N		N D	I N	N	N	N N	N	N	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N D	1	N I	N N	N	N	1	N N	N	A.	MANDIBLE	