A CLINICAL STUDY OF MAXILLOFACIAL INJURIES IN ROAD TRAFFIC ACCIDENTS

A DISSERTATION SUBMITTED TO

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION & RESEARCH

TAMAKA, KOLAR, KARNATAKA

IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR AWARD OF THE DEGREE OF

MASTER OF SURGERY

IN

OTORHINOLARYNGOLOGY

BY

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LIST OF ABBREVIATIONS USED

RTA –	Road traffic accidents
CT-	Computed tomography scan
CR-	Closed reduction
ORIF-	Open Reduction and internal fixation
3D-	Three dimensional
CSF-	Cerebrospinal fluid
TMJ-	Temporomandibular joint
NOE-	Naso orbito ethmoid
ZMC-	Zygomatico maxillary complex
MCT-	Medial canthal tendon

ABSTRACT

Background and Objectives

Road traffic accident is reported to be the leading cause of maxillofacial fractures in developing countries. The large variability in reported incidence and aetiology is due to a variety of contributing factors, including environmental, cultural and socioeconomic factors. The study aims at describing the patterns of maxillofacial injuries in road traffic accidents by clinical and radiological methods and to study the various complications of these injuries.

Methodology

Our study included one hundred Road traffic accident patients with maxillofacial injuries. Patients were evaluated for any maxillofacial fracture by clinical assessement and correlating it radiographically, using plain radiographs or CT scan as indicated.

Results

Of the 100 cases, 58 had maxillary fractures which was the commonest. 13% had Le fort fractures, Le fort II being the commonest. Nasal bone fractures were the second commonest in 43% cases. Mandible was fractured in 33% cases, with parasymphysis being the commonest site (22%). The incidence of complications associated with maxillofacial fractures was 11%, malocclusion being the commonest.

Conclusion

Maxillofacial injuries are commonest in males in the third decade of life, with the incidence being maximum in two wheeler passengers. The commonest facial bone fractured as a result of road traffic accidents in our study is the maxilla followed by the nasal bone and the orbital bone. Malocclusion is the commonest complication following maxillofacial fractures.

Keywords- maxillofacial injuries, road traffic accidents, patterns of fracture, complications.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF CHARTS

LIST OF FIGURES

INTRODUCTION

Road traffic fatalities have been increasing at about 8% annually for the last ten years and are the leading cause of morbidity and mortality across the world.[1] Annually over 1 million people die and over 25 million are injured or permanently disabled from road traffic injuries. The primary cause of maxillofacial fractures throughout the world is road traffic accidents.[2]

Motorcycle crash injuries constitute a disproportionate number of motor vehicle crash-related deaths and hospital admissions each year. Among injuries sustained in motorcycle crashes, facial and head injuries contribute significantly to morbidity, mortality, disability, disfigurement, and costs of medical care. Immediate identification and management is important to reduce short and long term consequences of these injuries. Among the injuries caused by Road traffic accidents, head injury can lead to morbidity and mortality as compared to other injuries and most of these have associated Facial fractures.[3]

Maxillofacial region involves soft tissues and facial bones extending from frontal bone superiorly to the mandible inferiorly. Maxillofacial trauma refers to the injuries of the facial skeleton, soft tissues and visceral injuries of the face. It is also called as facial orthopedics.

The incidence of maxillofacial fractures varies widely between different countries. The large variability in reported incidence and aetiology is due to a variety of contributing factors, including environmental, cultural and socioeconomic factors.[4]

The maxillofacial fractures if not properly managed can give rise to complications such as malunion, infection, non-union, CSF leak, malocclusion and chronic sinusitis.

There are several studies related to maxillofacial injuries which include all the etiologies. But, there is a paucity of studies on patterns of maxillofacial injuries in road traffic accidents alone.

A high incidence of road traffic accidents has been reported from the patient drainage area to our institution which is a tertiary care centre located on the National Highway, NH-4. Ours being the only tertiary care centre in the district with specialists in Otorhinolaryngology, Maxillofacial surgery and Neurosurgery which also offers care to patients from the neighbouring districts and even across the state, has a significantly large patient load.

Management of facial fractures is spread across the disciplines of oral surgery, plastic surgery and otolaryngology. Because of the comprehensive training in head and neck anatomy and physiology, the otolaryngologist is uniquely prepared to best deal with these injuries.[5]

Hence, this study is contemplated to study the various patterns of maxillofacial injuries and their complications.

OBJECTIVES OF THE STUDY

1. To study the patterns of nasal, frontal, maxillary and mandibular injuries (Soft tissue and bone) in road traffic accidents by clinical and radiological methods.

2. To study the complications (if any) as a result of these injuries.

REVIEW OF LITERATURE

Maxillofacial region (MFR) involves tissues forming the face extending from frontal bone superiorly to the mandible inferiorly. The face being the most exposed part of the body is particularly prone to trauma. Trauma to the facial region causes injuries to skeletal components, dentition as well as soft tissues of the face. Injuries to the maxillofacial region are increasing in frequency and severity because of the heavy reliance on road transportation and the increasing socioeconomic activities of the population. Every 30 seconds someone dies on the world's roads. The primary cause of maxillofacial fractures throughout the world is road traffic accidents and assaults. In India, inspite of the great impact of maxillofacial traumatic injuries on the patient's quality of life, there is inadequate information about the epidemiological characteristic of this problem.[2]

Road traffic accident is reported to be the leading cause of maxillofacial fractures in developing countries.[6] India has a world`s highest fatality rate in RTAs, 20 times that of developed countries. In India, eight people get killed for every 100 vehicles, where as in developed countries like Britain, France, Germany, Italy, and USA, one person gets killed for every 1000 vehicles.[7]

The incidence of maxillofacial fractures varies widely between different countries. The causes, types, and sites of these fractures seem to change according to the geographic location.[8]

Males are at greater risk of maxillofacial injuries due to their greater participation in high risk activities which increases their exposure to risk factors such as driving vehicles, sports that involve physical contact, an active social life and drug use, including alcohol. [2,6,8,9]

The 21 to 30 years age group is at maximum risk of maxillofacial trauma. [2,6,8,9,10]

Injuries to the face can potentially lead to destruction of vital structures with devastating sequelae to the patient. Facial fractures, especially of the midface, are often complicated by ocular and head injuries.[11]

The commonest facial bone to be fractured in road traffic accidents is the mandible; according to the studies by Kapoor[12], Chalya[6] and Singh et al[13]. The mid third of the face is the most commonly fractured site according to the study by Subhashraj.[9]

Though the frontal bone is resistant to blunt impact, the frontal sinus is its weakest region, and fractures of the frontal sinus make up about 10% of all craniofacial fractures. Usually they are associated with additional craniofacial injuries and require a multidisciplinary approach. Potential complications of such fractures may be divided into aesthetic (disfigurement of the forehead silhouette), functional (frontal sinusitis or mucocele), and neurological (leak of cerebrospinal fluid (CSF), meningitis, abscess of the brain, or pneumocephalus.[14]

In a study quoted by Choi [15], the incidence of anterior table fractures of the frontal bone was 92.3% and posterior table was 7.7%. In other studies, the incidence of anterior table fractures of frontal bone was 66%.

The central position of the nose and its anterior projection on the face make it susceptible to injury, and therefore fractures of the nasal bones are the most common facial fractures and the third most common of the human skeleton.[16] In studies by Yilmaz[16] and Ondik et al[17], Type 2 fractures of the nasal bones were the commonest.

The zygoma due to its pivotal position in determining the facial contour tends to be involved in quite a large percentage of maxillofacial fractures. The Zygomatic region, due to its prominent position in the face bears the brunt of trauma in majority of the cases and has shown to have the highest incidence of fracture in the maxillofacial region in various studies.[18]

In a study on Zygoma fractures by Adam[19], the body of zygoma was most commonly fractured part of the zygoma (57.7%) followed by combined and isolated arch fractures.

Among the complex patterned fractures of the mid face, Le fort fracture is the commonest,with a 35.7% incidence according to a study by Subhashraj et al.[9]

Despite the mandible being the largest and strongest facial bone, it is fractured in up to three-quarters of patients with maxillofacial fractures. The site of mandibular fracture correlated with the cause. Interpersonal violence was most often associated with fractures of the angle while falls and road accidents were more commonly associated with condylar fractures.[20] In a study by Kapoor[12], the incidence of mandibular fracture was 63% . In a study by Singh, the incidence of mandibular fracture was 47.8% with Parasymphysis being the commonest part fractured (45.2%).[13]

Maxillofacial injuries can occur as an isolated injury or may be associated with multiple injuries to the head, chest, abdominal, spinal and extremities. Head injury accounts for the greater majority of associated injuries and contributed significantly to missed maxillofacial injuries.[6] This includes head traumas, intracranial haemorrhages, closed head traumas (brain contusion or laceration), or skull fracture. Generally, the presence of vomiting, loss of consciousness, or a low Glasgow Coma Scale (GCS) score are important findings for suspicion of a cranial injury.[21] In a study by Isik[21], 15.4% patients with maxillofacial trauma had experienced head trauma and it was observed that the risk of head injury increases in those with multiple facial fractures.

Maxillofacial trauma with head injuries demands special attention as airway compromise is invariably present and it is difficult to assess the neurological status always due to inebriated state and severity of head injury.[22] The complication rate of maxillofacial injuries ranges from 7 to 29%, and has been correlated to the severity of the fracture.[6] In a study by Chalya[6], surgical site infection was the commonest complication followed by malocclusion, keloids and chronic sinusitis. In a study by Ozkaya[9], the most common complication was malocclusion (53.8%) followed by infection and non union (23.3% each).

In a study by Furr[23] in which the complications after repair of mandible fractures were studied, it was concluded that, the antibiotic regimen has no effect on the incidence of complications; however, further studies providing more data on other relevant factors, such as alcohol and drug abuse, delay until treatment, type of treatment, location of fracture, adequacy of reduction, and type of antibiotic, are needed. Brasileiro[24], in his study on 1024 patients found maxillofacial fracture complications in 7.4% of patients, local infections being the major complication type, occurring in 3.7% of cases.

Computed tomography (CT) is an accurate screening tool for detecting non nasal mid facial fractures in trauma patients. An initial head CT alone may limit the need for a Waters view radiography or screening facial CT in detecting injuries.[25]

There are many treatment regimens in maxillofacial fractures, but the treatment chosen may differ depending on many factors like cost of treatment, affordability by the patient, feasibility in the hospital, doctor’s decision and skill, patient’s willingness to avail the treatment advised - all of which may vary from region to region.[6]

Regimens for the treatment of maxillofacial fractures include fixation with mini plates, wire fixation, intermaxillary fixation, and conservative treatment.[8] Open reduction and internal fixation remains the "gold standard" of treatment of maxillofacial fractures.[26]

ANATOMY OF MAXILLOFACIAL REGION

The maxillofacial region includes the facial skeleton, visceral and soft tissue structures. The facial skeleton is divided into three regions- Upper, Middle and Lower third. The upper third includes the frontal bones. Middle third comprising of Maxillae, Zygomas, Orbits and the Nose. Lower third is made up of the lower portions of the mandible.

UPPER THIRD

The frontal bone forms the contour of the forehead. It forms the junction between the cranium and the face and houses the frontal sinuses. They have an anterior and posterior wall. Supraorbital rims and roofs are a part of the frontal bones. The glabella is also a part of this region and is superior to the nasal bones. The thick glabellar bones protects the frontal outflow tracts and cribriform plates.[27]

MIDDLE THIRD

Mid third of the face includes the zygomas, maxillae, orbits and nose. The malar prominences determine the facial projection and contour. Zygomatic arches provide attatchment to the masseter muscles superiorly. The superior and medial projections of the zygoma form lateral and inferior orbital rims and inferolateral orbital walls.

Maxilla extends from the zygoma laterally to the nasal bones medially and forms the medial portions of the infraorbital rims and anterior orbital floors. Also they house the nasolacrimal ducts and maxillary sinuses. The infraorbital nerve exits through anterior surface of maxilla which provides sensation to medial cheek, lateral nose, upper lip, gingiva and teeth.

The paired nasal bones are situated in the midline and are supported by the frontal process of the maxillae and are attached inferiorly to the upper lateral cartilages.

Orbit is a complex bony structure with contributions from multiple facial and skull bones. The frontal, zygomatic , maxillary, Lacrimal bones form the orbit. The lacrimal fossa houses the lacrimal sac. The thin lamina papyracea of the ethmoid bone forms the medial orbital wall which is susceptible to fracture easily and leads to CSF rhinorrhea. Posterolateral wall is formed by the greater wing of sphenoid and optic canal by lesser wing. The `orbital apex` includes the area lateral to the optic canal through which cranial nerves III, IV, V, and VI pass to enter the orbit, which is considered part of the superior orbital fissure.

Midfacial structures are paired and the central bones are joined in the midline. The nasal bones and maxillae are joined vertically, and the hard palate forms the inferior horizontal bridge between the two maxillae. The upper horizontal bridge is formed by the anterior cranial base.[27]

LOWER THIRD

Mandible forms the lower third of the face. It contains the mandibular dentition, which interfaces with the maxillary dentition for mastication. Unlike the middle third, which is fixed to the skull, the mandible is mobile and swings, hinged to the skull base in two, bilaterally symmetric attachments. The hinges occur at the temporomandibular joints , which are true arthrodial joints that both swings and slides.

The condylar head of the mandible is housed within the TMJ and is connected to the vertical ramus by the relatively thin and weak condylar neck.

The condylar neck extends inferiorly into the vertical ramus, which is also relatively thin compared to the tooth-bearing body and symphyseal regions of the bone.[27]

ANATOMY OF UPPER THIRD

FRONTAL BONE

Frontal bone houses the frontal sinuses which develops separately either as an expansion of anterior frontoethmoidal air cells into the frontal bone or from superior extension of the frontal recess. The sinus is absent at birth and usually begins its development by 3 years of age. It continues to enlarge into adolescence and reaches its maximal size by the age of 16–18 years in boys and 12–14 years in girls. The average frontal sinus measures 28mm in height, 27mm in width, and 17mm in depth.

The volume of the frontal sinus varies tremendously and has implications with respect to trauma. Well-aerated sinuses require significantly less force to fracture than smaller, more contracted ones. The sinus is usually divided into two halves by an intersinus septum. Supernumerary septa may be present but are often incomplete.

The frontal sinus is pyramidal in shape with an anterior wall, posterior wall and floor. The base of the pyramid forms its floor. The convex anterior wall of the frontal sinus is formed by thick, dense bone. Its arched configuration distributes forces of impact efficiently across the brow and frontal bone. The posterior wall is much thinner and transgressed by bridging veins to the intracranial cavity. It is far more susceptible to fracture. Laterally, the sinus extends over the orbits. Here, the floor of the sinus contributes to the medial orbital roofs.

The central portion of the frontal sinus floor forms the roof of the nasal cavity anterior to the cribriform plate. Posteriorly, the sinus may extend, deep to the floor of the anterior cranial fossa, to the lesser wing of the sphenoid. Such significant posterior extension makes complete removal of sinus mucosa during obliteration procedures difficult. Fractures of the posterior wall often result in dural tears.

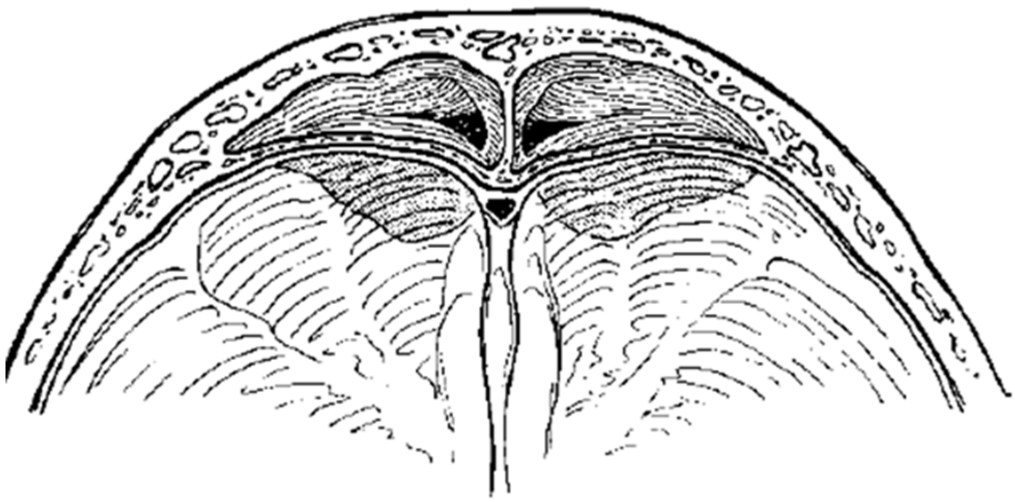


Fig 1- Frontal sinus in the axial plane

The sinus drains into the anterosuperior portion of the middle meatus through a true sinus ostium or through a nasofrontal duct. The duct is often surrounded by anterior ethmoid air cells commonly referred to as fronto-ethmoid cells. It opens into the anterosuperior portion of the infundibulum.

The blood supply to the frontal sinus is primarily from the internal carotid system via the supraorbital branch of the ophthalmic artery. The anterior ethmoid artery may also contribute. Venous drainage occurs through the anterior facial, angular, and superior ophthalmic veins, which communicate with the cavernous sinus. Alternate routes of venous drainage are valveless transosseous channels passing through the foramina of Breschet in the posterior table of the sinus. These venous channels pass directly into the subarachnoid space and serve as potential routes of spread for infection. Sensory innervations of the frontal sinus are by way of the supraorbital and supratrochlear nerves, branches of the ophthalmic division of the trigeminal nerve.[28]

ANATOMY OF MIDFACE

The midface connects the cranial base to the occlusal plane. It provides the foundation for anterior facial projection while contributing to protection of the critical skull base and acting as an anchor for facial ligament and muscle attachment. The skeleton of the midface consists of a series of thickened vertical, sagittal, and horizontal bony structural supports (buttresses) that envelop a system of aerated cavities (sinuses).[27]

BUTTRESSES OF THE FACE

Vertical Buttress

It has seven components, three paired pillars and one unpaired structure

a) Paired medial or Nasomaxillary buttress- Extends from anterior maxillary alveolus along the piriform aperture and medial orbit through the nasal and lacrimal bones to the frontal bone

b) Paired lateral, Zygomaticomaxillary buttress- extend from the lateral maxillary alveolus along the lateral maxilla to malar eminence of zygoma, then superiorly along the lateral orbital rim to the frontal bone. Also extend laterally to temporal bone via zygomatic arch

c) Paired Pterygomaxillary buttress- Extend posteriorly from maxilla to pterygoid plates of the sphenoid bone

d) Midline bony nasal septum- consists of vomer and perpendicular plate of the ethmoidbone, connects the palatine process of maxilla to the frontal bone.

Horizontal Buttress

Also described as antero-posterior buttresses. These include the frontal, zygomatic, maxillary, and mandibular buttresses.

a)Frontal Buttress is composed of the supraorbital rims and the glabellar region.

b)Zygomatic Buttress consists of the zygomatic arch, zygomatic body, and infraorbitalrim.

c)Maxillary And Mandibular Buttresses are composed of the basal bone of the maxilla and mandibular arches.[28]

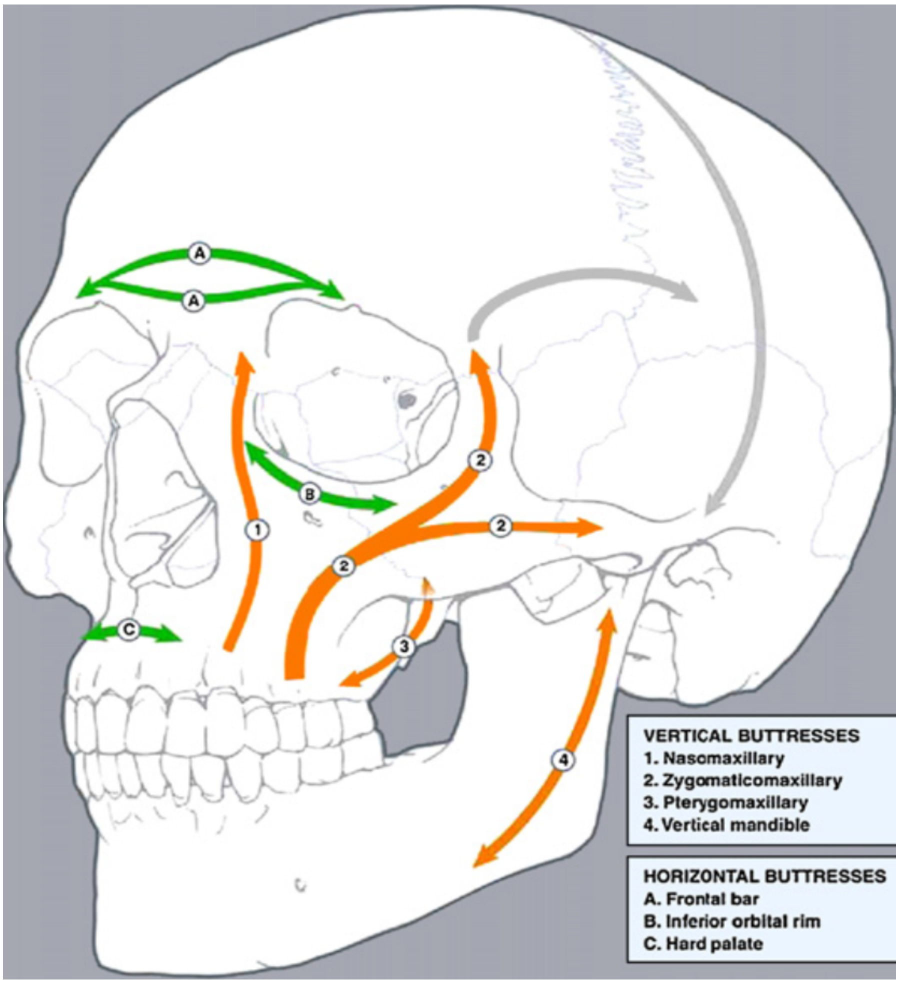


Fig 2- Buttresses of the Face

NASO ORBITO ETHMOID ANATOMY

The Nasoorbitoethmoid (NOE) region is the point of confluence between the nose, cranium, paranasal sinuses, inferior midface, and bony orbits. The junction of nine bones are involved in this area—the bilateral nasal bones, maxillae, ethmoids, and lacrimals as well as the frontal bone.

ANATOMY OF NOSE

The external framework of the nose comprises of the nasal bones and cartilages. The bone structure of the nasal pyramid comprises the nasal bones and the frontal process of the maxilla. Most fractures occur in the lower half of the nasal bones.

Nasal bones

The nasal bones are two small oblong bones, varying in size and form in different individuals; they are placed side by side at the middle and upper part of the face, and form, by their junction, "the bridge" of the nose. Each has two surfaces and four borders.

The outer surface is concavo convex from above downward, convex from side to side; it is covered by the Procerus and Compressor naris, and perforated about its center by a foramen, for the transmission of a small vein. The inner surface is concave from side to side, and is traversed from above downward, by a groove for the passage of a branch of the nasociliary nerve.

The nasal bone articulates with four bones: the frontal bone, ethmoid bone, the opposite nasal bone and the maxilla and inferiorly with the upper lateral cartilages.[29]

Cartilages of the nose

The cartilages of the external nose are Upper lateral and Lower lateral cartilage (Alar cartilages) and lesser alar cartilages. The upper lateral cartilages are curved, triangular structures with bases that articulate in the midline. They also articulate with the under surface of the nasal bones superiorly and are vulnerable to dislocation from the nasal bones. They also articulate with the quadrangular cartilages of the septum and with the lower lateral cartilages. The upper cartilages define the nasal appearance according to size, shape, position and symmetry. The articulation between upper and lower lateral cartilages is a complex fibrous joint that also functions as the nasal valve which modulates the flow of inspired air.

The paired Lower lateral or alar cartilages are gull shaped with lateral segments that expand as they curve superiorly and laterally. The medial crus of each lower cartilage have a fibrous articulation with the caudal margin of the quadrangular cartilage of the septum. The lower cartilage support the tip and defines tip contour and shape and size of the nostrils. The sesamoid cartilages lie in the fat pad between the lower cartilages and the margin of the piriform aperture of the maxilla.[29]

Nasal Septum

The nasal septum comprises the vomer inferiorly, perpendicular plate of ethmoid bone posteriorly and quadrangular cartilage anteriorly. The septum is lined with mucoperiosteal and mucoperichondrial soft tissues that is easily torn when septal fracture or dislocation occurs.

Two regions of the quadrangular cartilage are important in nasal injury. In the inferior aspect, the fibrous articulation of the caudal margin of the cartilage can be disrupted and displaced, the cartilaginous margin being displaced to one side. In the superior aspect, a C shaped fracture can occur and involve the bony and cartilaginous septum.

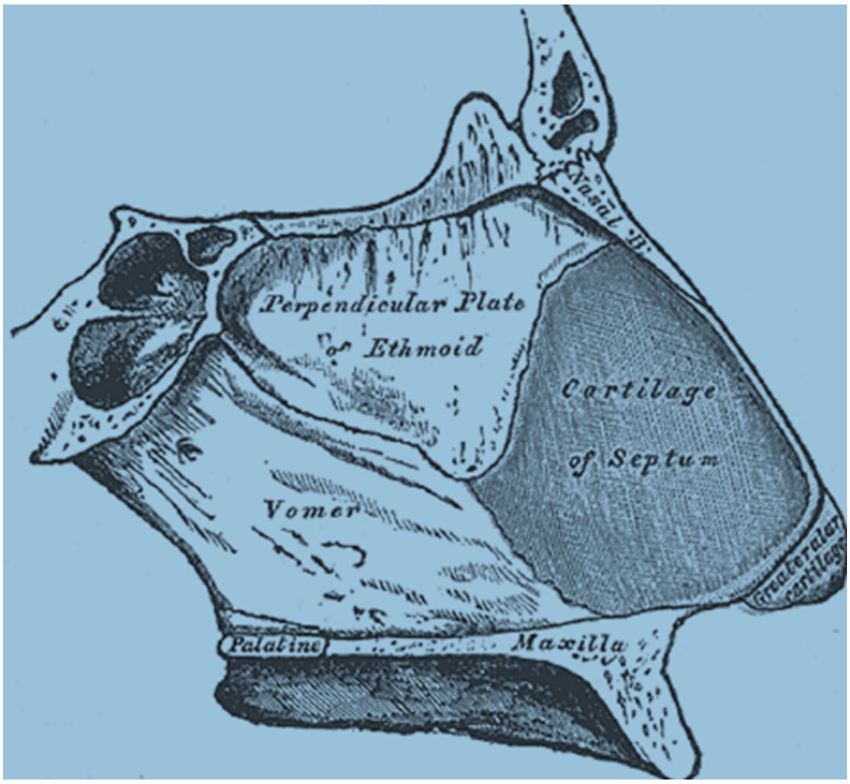


Fig 3- Nasal septum

The upper third of the nose is rigid and static, and the lower two thirds are dynamic and mobile. Lateral force can fracture the nasal spine of the maxilla, an anterior projection that articulates with the quadrangular cartilage and the medial crura of the alar cartilages. [29]

ANATOMY OF THE ORBIT

The orbit is composed of seven bones.the frontal bone,the zygoma, the maxilla, the ethmoid bone, the sphenoid bone, the palatine bone, and the lacrimal bone.

The frontal bone constitutes the orbital roof. A horizontal component of the frontal bone forms the supraorbital rims. Between the supraorbital ridges, the frontal bone becomes the galabella and then projects caudally to articulate with the nasal bones and maxillae. The nasofrontal ducts are located along the posterior floor of the frontal sinus and are vulnerable to disruption and obstruction with trauma to the NOE area.

The outer rim of orbit, which faces the external environment, is composed of only three bones: the frontal bone superiorly, the zygomatic bone inferolaterally, and the maxilla inferomedially. Each bone is covered by periosteum, which is continuous with that lining the skull.

The floor of the orbit is formed mainly by the maxilla with contributions from the zygomatic and palatine bones. It separates the orbital contents from the more caudal maxillary sinus. The shape of the floor is concave anteriorly and convex posteriorly.

The inferior orbital fissure runs between the floor and the lateral wall. Through this fissure, the infraorbital nerve is transmitted. It runs anteromedially along the floor and exits through the infraorbital foramen in the maxilla.

The roof of the orbit is formed almost entirely from the frontal bone with a portion of the lesser wing of the sphenoid contributing to its posterior aspect. The bones in this region are thin and serve to separate the orbit from the anterior cranial fossa and more medial frontal sinus.

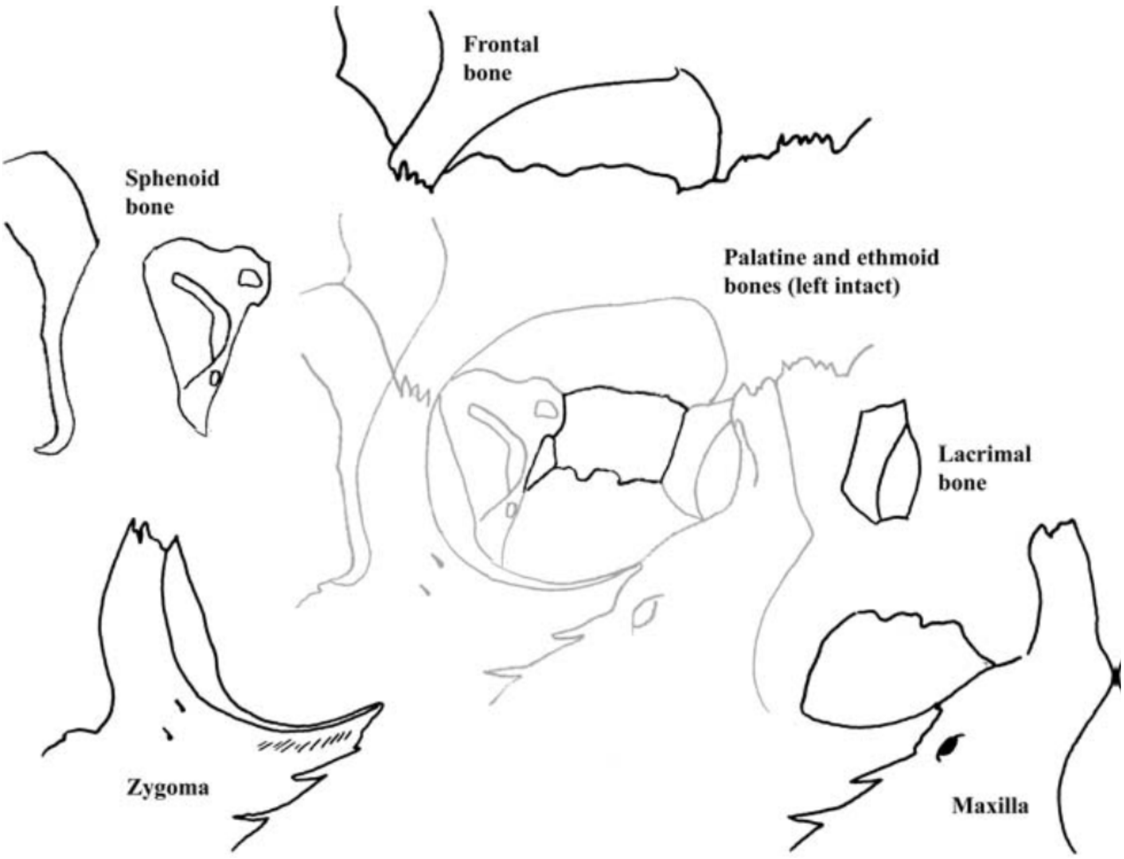


Fig 4- Seven bones forming the orbit

The medial wall is the thinnest portion of the orbit. It is a paper-thinplate formed by four bones: the frontal bone supero anteriorly, the lacrimal bone inferoanteriorly, the sphenoid bone posteriorly, and the lamina papyracea of the ethmoid bone centrally. It separates the orbit from the more medial ethmoidal air cells and midline nasal cavity. In the anterior portion of the medial wall, a vertical groove houses the lacrimal sac and nasolacrimal duct and is formed anteriorly by the maxilla and posteriorly by the lacrimal bone. The structures in this area are vulnerable to injury when the medial wall is fractured. The nasolacrimal duct terminates in the inferior conchal recess within the nasal cavity.

Two neurovascular foramina are associated with the medial orbital wall. The anterior ethmoidal artery and nasociliary nerve emerge from the anterior ethmoid foramen, encountered in the frontoethmoid suture line. The posterior ethmoid foramen, transmits the artery and nerve of the same name. The optic foramen and nerve are found at a distance of 4–7mm from the posterior arterial branch within the lesser sphenoid wing. Skeletal disruption of this region may produce traumatic shearing of these structures, leading to orbital hematoma and blindness. The medial canthal tendon is the critical soft-tissue structure within the NOE region which provides support to the globe as an integral component of an enveloping sling system.

The lateral wall is the thickest portion of the orbit. It is formed by the frontal process of the zygomatic bone and the greater wing of the sphenoid bone. It separates the orbit from the middle cranial fossa posteriorly and temporal fossa anteriorly. The superior orbital fissure runs between the roof and the lateral wall. It communicates with the middle cranial fossa and is a conduit for several vital structures including: the oculomotor nerve (CNIII), the trochlear nerve (CN IV), the abducent nerve (CN VI), branches of the first division of the trigeminal nerve (ophthalmic nerve, CN V1), and the superior ophthalmic vein.

The apex of the orbit is the posterior termination of the bony orbital pyramid. While the medial walls lie parallel to each other, the lateral walls taper from lateral anteriorly to medial posteriorly. The lateral orbital walls form a 90 degree angle to one another, while the medial and lateral walls form a 45 degree angle. The optic canal at the apex of the pyramid transmits the optic nerve and ophthalmic artery from the brain.[28]

Ethmoid bone

The ethmoid bone separates the nasal cavity from the brain. It is located at the roof of the nose, between the two orbits. The cubical bone is light weight due to a spongy construction. The ethmoid bone is one of the bones that make up the orbit of the eye. The ethmoid has three parts: the cribriform plate, the ethmoidal labyrinth, and the perpendicular plate. Between the orbital plate and the conchae are the ethmoidal sinuses or ethmoidal air cells, which are a variable number of small cavities in the lateral mass of the ethmoid.

The perpendicular plate of the ethmoid partitions the nasal cavity into left and right cavities. Extension of this midline structure for a variable distance intracranially is termed the crista galli. Bisecting the perpendicular plate in a horizontally is the cribriform plate, through which the delicate second-order neurons of the olfactory nerve pass via bony fenestrations.

The ethmoid articulates with fifteen bones:

- The frontal and the sphenoid
- Two Nasal bones, two maxillae, two lacrimals, two palatines, two inferior nasal conchae, and the vomer

Drainage of these sinuses is to the middle meatus for the anterior cell grouping and to the superior meatus for the cells located posterior to the ground lamella, the thickened wall of bone separating the groups. Significant traumatic forces applied are translated to this area, result in obliteration of the normal sinus architecture, with pulverization of the labyrinth and creation of a cavity filled with blood, bony spicules, and mucosal debris.[28]

ANATOMY OF MAXILLA

The maxillae are paired bones, two halves of which are fused at the intermaxillary suture to form the upper jaw and each containing a hollow body, the maxillary sinus or antrum. Projections from the maxillary body extend superiorly and medially to the frontal and nasal bones and laterally to the zygoma. Inferior and medial process, the palatine process of maxilla forms the bulk of the hard palate. The alveolar process of the maxilla extends inferiorly and holds the upper teeth. The lateral wall of the maxillary antrum includes a wedge of thicker compact bone.

Each maxilla assists in forming the boundaries of three cavities: the roof of the mouth, the floor and lateral wall of the nasal antrum, the wall of the orbit. Each maxilla also enters into the formation of two fossae: the infratemporal and pterygopalatine, and two fissures, the inferior orbital and pterygomaxillary fissures.

Each half of the fused maxillae consists of:

- The body of the maxilla
- Four processes- The zygomatic process, frontal process of maxilla,alveolar process, palatine process
- Infraorbital foramen
- The maxillary sinus

Each maxilla articulates with nine bones:

- two of the cranium: the frontal and ethmoid
- seven of the face: the nasal, zygomatic, lacrimal, inferior nasal concha, palatine, vomer, and the adjacent fused maxilla.

Sometimes it articulates with the orbital surface, and sometimes with the lateral pterygoid plate of the sphenoid.[30]

ANATOMY OF THE ZYGOMA

The zygoma is a cornerstone of facial anatomy and its integrity is mandatory for normal facial width, adequate prominence of the cheek, and a normal orbit. The zygoma articulates with the maxilla, the frontal bone, and the greater wing of the sphenoid bone within the orbit.

The temporal process of the zygoma joins the zygomatic process of the temporal bone to form the zygomatic arch. Several muscles attach to the zygoma and produce significant deforming forces, an important factor in displacement after fracture. These include the zygomaticus minor and major and the orbicularis oculi. The masseter muscle attaches to the lateral aspect of the zygomatic arch, and can produce significant displacement force if a fracture occurs.

The zygomaticomaxillary buttress connects the lateral alveolus to the zygomatic process of the temporal bone. Because of the zygoma's intrinsic strength fractures usually occur at the suture lines of the zygoma and rarely of the body.The temporal and zygomatic branches of the seventh nerve supplies the facial muscles; the zygomaticotemporal and zygomaticofacial branches of the fifth nerve provide sensation to the malar region; the supraorbital and infraorbital branches of the fifth nerve supply sensationto the forehead, eyelid, nose, and upper lip. All must be elucidated carefully during surgery to avoid paresis and paresthesias.[28]

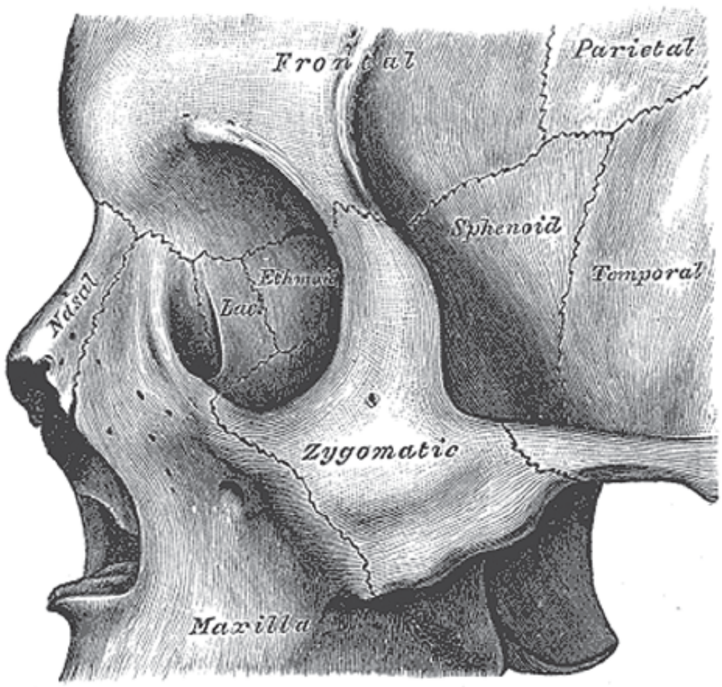


Fig 5- Relations of the zygoma

ANATOMY OF THE MANDIBLE

Mandible is the largest bone of the face. It is a horse shoe shaped bone.

The following are the parts of the mandible

1.Condylar process and subcondylar region (neck)

2.Coronoid process

3. Ramus

4.Angle

5.Body (includes symphysis and parasymphysis)

6.Alveolar process

The condyle is the portion extending from the mandibular notch to the condylar head, which articulates in the glenoid fossa. The coronoid process is the anterior superior extension of the mandibular ramus projecting above the mandibular notch into the infratemporal fossa. Below the mandibular notch is the ramus. The angle is a non–tooth-bearing portion of the mandible between the ramus and the body.

The parasymphyseal region is composed of the anterior arch of the mandible and is bounded by the two mental foramina. The bodies and the parasymphyseal areas are where the teeth are found. The alveolar ridge or process is composed of thin cortical bone that encompasses the teeth. The inferior alveolar nerve enters on the medial (lingual) aspect of the mandibular ramus and passes through its own canal to the mental foramen.

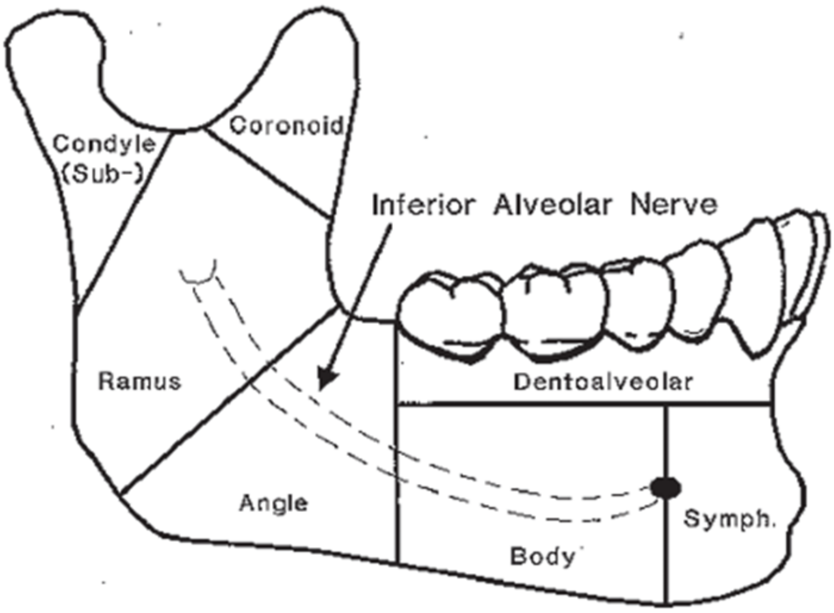


Fig 6- Anatomic regions of mandible

The muscles of mastication inserting on the mandible include the temporalis, internal pterygoid, external pterygoid, and masseter. These muscles contribute to the movement of the temporomandibular joint. The floor of the mouth and extrinsic tongue muscles tend to displace fractures posteriorly and inferiorly.[5]

MAXILLOFACIAL INJURIES

Maxillofacial injuries include soft tissue injuries and fractures of the facial bones.

Soft Tissue Injuries

They include abrasions, lacerations, contusions and avulsions. Abrasions are partial thickness disruptions of the epidermis as a result of sudden forcible friction. Lacerations are full thickness disruption of the epidermis. Contusions are bruises caused by blunt trauma. Avulsion injuries may be partial or complete and are associated with loss of tissue.

FRONTAL BONE FRACTURES

They comprise about 5% to 15% of maxillofacial fractures.

Classification of Frontal fractures:

These fractures are generally classified by involvement of the anterior wall (anterior table) or posterior wall (posterior table). In addition, fractures of either wall may be comminuted or non-comminuted, and displaced or non-displaced.

Involvement of either the nasofrontal duct or the anterior cranial fossa dura has important implications for the clinical management of these fractures. The importance of the radiologic diagnosis of frontal sinus fractures is underscored by the fact that before the advent of routine CT scanning forehead trauma, 50% of frontal sinus fractures were not identified until after the patient had left the emergency room. The frontal bone is the strongest of the facial bones, and a large amount of force is required to fracture the frontal sinuses. The presence of frontal sinus fractures may therefore be considered an indicator of a high-force injury, and other injuries must be searched for. Additional craniofacial injuries are present in 56% to 87% of patients with frontal sinus fractures. An associated cerebrospinal fluid (CSF) leak is present in 13%to 33% of patients with frontal sinus fractures. Mortality secondary to other associated injuries has been reported at rates of approximately 9% of patients with frontal sinus fractures.[28]

Structures involved

Each wall of the frontal sinus serves a dual function. The anterior wall of the frontal sinus, formed by the frontal bone, is responsible for the aesthetic contours of the forehead and the superior orbital rims. In addition, this structure serves as the frontal bar, one of the key horizontal buttresses of the facial skeleton. The frontal bar helps to maintain the horizontal dimension of the face and to provide a stable foundation for the vertically oriented facial buttresses that support the forces of mastication. Fractures of the anterior table may be clinically important either by disrupting the aesthetic contour of the forehead or by destabilizing the frontal bar from which the other facial bones are suspended. The posterior wall of the frontal sinus forms the anterior wall of the anterior cranial fossa, and serves to separate the sinus contents from the cranial vault. Posterior table fractures are therefore skull fractures, and must be recognized and managed as such. The floor of the frontal sinus forms the medial orbital roof; it also houses the ostium to the nasofrontal duct in its posteromedial aspect. The nasofrontal duct forms the drainage pathway of the frontal sinus into the nose, so obstruction of this pathway can lead to mucocele, mucopyocele, osteomyelitis, and epidural or subdural abscess.[28]

Variables affecting treatment

There are three main variables to consider when assessing the need for surgical intervention for frontal sinus fractures. These are involvement of the anterior table, disruption of the nasofrontal duct, and involvement of the posterior table. When assessing the involvement of the anterior or posterior tables, the degree of fracture displacement and comminution are also important. An additional factor involved when assessing the posterior table is the likelihood of dural penetration or nasofrontal duct disruption.[28]

Patient Evaluation

Patients with frontal sinus injuries frequently have other serious injuries. Patients with severe, compound, comminuted fractures have intra cranial injuries. Laceration over the forehead skin reveals the interior of the sinus and foreign material may be found. CSF leaks may be found in 13 to 33% patients. Fracture of superior orbital rim can be present, and the globe can be displaced or trapped. Fracture of NOE complex can manifest as flattening of the pyramid and telescoping of the nose. Pain, swelling and parasthesia of the forehead may be seen.

Initial assessment includes ruling out injury to the cervical spine. Axial and coronal CT should be done including the face and skull. Closed fractures are not life threatening, but can cause intra cranial infection. These patients need head and neck and neurological examination , and exclusion of cervical spine injury. Palpation may reveal a depressed, mobile anterior table fracture. Vision status and possibility of CSF rhinorrhea need to be assessed. Treatment depends on clinical findings and radiologic assessment.[28]

Radiological Evaluation

Before CT became widespread, plain radiographs in different views were used. Now, CT is the mainstay of diagnosis of anterior skull base fractures. CT helps to identify complex fractures and also evaluate soft tissues. CT may also reveal a pneumocephalus.

Fine axial sections are useful for evaluating anterior and posterior table fractures of the frontal sinus and intracranial injuries. Coronal sections provide good details of the floor of the frontal sinus, frontonasal outflow tract and cribriform plate.[28]

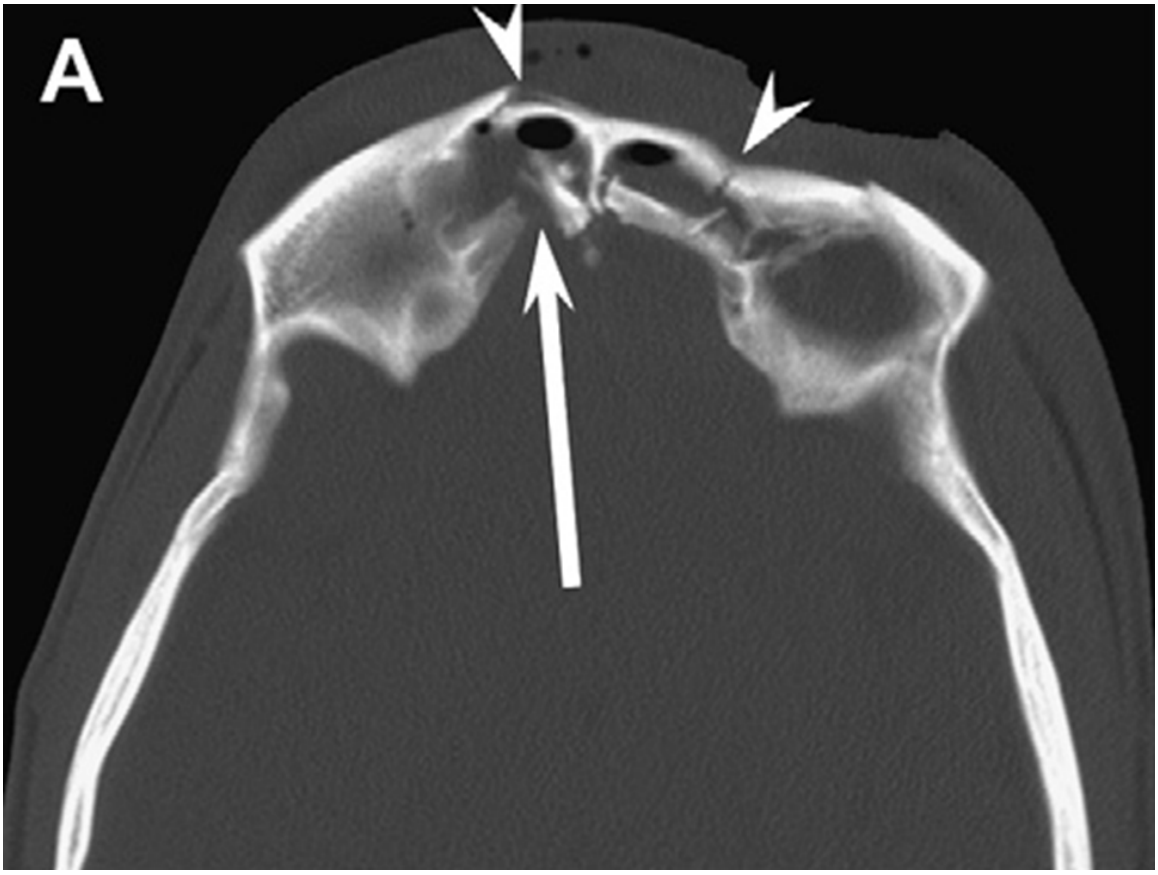


Fig 7- Axial CT scan showing fractures of both anterior and posterior tables of the frontal sinuses.

Treatment

Concepts in the management of frontal fractures:

1. Prevention of intracranial sepsis
2. Prevention of sinusitis and mucocele
3. Cosmetically acceptable outcome

Nondisplaced Anterior Table Fractures:

They can be managed conservatively. Persistent opacification of the frontal sinus cavity raises the possibility of frontonasal outflow tract obstruction or CSF leak and warrants exploration.

Displaced Anterior Table Fractures:

Aesthetically acceptable reconstruction of the anterior table is the aim of surgery in displaced anterior table fractures. Surgical access is by a bicoronal or supraorbital brow incision. Reduction of the fracture fragments and stabilization with wires or microplates is done in nonfragmented or minimally displaced fragmented fractures. In severely comminuted fractures with bone loss, bone is preserved as much as possible. Endoscopic reduction and fixation is also undertaken in selected cases. Titanium mesh is also used for reconstruction in anterior table fractures.

Nondisplaced Posterior Table Fractures:

Asymptomatic Linear nondisplaced fractures of the posterior table without CSF leak is managed by observation and prophylactic antibiotic treatment.

Displaced Posterior Table Fractures:

All displaced fractures of the posterior wall necessitate exploration. Many patients present with CSF leak. Reduction of the displaced fracture is recommended if no posterior bone loss is found. Obliteration of the sinus is done in injuries with frontonasal outflow tract obstruction to prevent intracranial spread of infection. Cranialization of the frontal sinus involves excision of the posterior wall. The dura is allowed to come forward to the anterior table of the sinus. Intracranial complications of these procedures include, meningitis, CSF leak and brain abscess.[31]

NASAL FRACTURES

Relatively little force is required to fracture the nasal bones. Young men are twice as likely to sustain a fractured nose as women. The peak incidence is in the 15to 30 year age group. Compound and comminuted fractures are more common in the elderly who are prone to falls.

Grading of nasal bone fractures

A five-point grading system has been developed for the extent of lateral deviation of the nasal pyramid:

• Grade 0: bones perfectly straight;

• Grade 1: bones deviated less than half of the width of the bridge of the nose;

• Grade 2: bones deviated half to one full width of the bridge of the nose;

• Grade 3: bones deviated greater than one full width ofthe bridge of the nose;

• Grade 4: bones almost touching the cheek.

CLASSES OF NASAL FRACTURES

Class I fractures

Mechanism- Low moderate degree of force.

The simplest form of a class I fracture is the depressed nasal bone. The fractured segment usually remains in position due to its inferior attachment to the upper lateral cartilage which provides an element of recoil. The nasal septum is generally not involved.

In the more severe variant, both nasal bones and the septum are fractured. The fracture line runs parallel to the nasomaxillary suture ipsilateral to the side of the applied force to a point approximately two-thirds along the length of the nasal bone, where the bone becomes much thicker. The fracture line then connects across to the contralateral side and runs parallel to and just below the dorsum. The cartilaginous septum is fractured approximately 0.5 cm below the dorsum and this aspect of the injury may extend posteriorly into the bony septum, through the perpendicular plate of the ethmoid and skull base. Also called Chevallet fracture, class I fractures tend not to cause gross lateral displacement of the nasal bones and may not even be perceptible. In children, these fractures may be of the 'greenstick' variety and significant nasal deformity may only develop at puberty when nasal growth becomes accentuated.

Class II fractures

These are the result of greater force and are often associated with significant cosmetic deformity. In addition, the frontal process of the maxilla and septum are also involved. If the nasal dorsum is deviated laterally greater than half the width of the nose (grade 2 or greater fracture), then a septal fracture must also be present.

Mechanism- The pattern of deformity is determined by the direction of the force applied. A frontal impact tends to comminute the nasal bones and cause gross flattening and widening of the dorsum; while a lateral impact produces a high deviation of the nasal skeleton. What may appear to be a simple dislocation of the quadrangular cartilage from the bony septum is in reality a complex 'C-shaped' fracture that extends from the quadrangular cartilage beneath the nasal tip, posteriorly through to the perpendicular plate of the ethmoid, to the anterior border of the vomer and then forward through the lower part of the perpendicular plate of the ethmoid into the inferior part of the quadrilateral cartilage. Also called Jarjavay fracture.

Class III fractures

Class III fractures are the most severe nasal injuries

Mechanism- They result from high velocity trauma. They are also termed naso-orbito-ethmoid fractures and often have associated fractures of the maxillae. The external butresses of the nose give way and the ethmoid labyrinth collapses on itself. This causes the perpendicular plate of the ethmoid to rotate and the quadrilateral cartilage to fall backwards. These movements cause a classic, 'pig-like' appearance to the patient, with a foreshortened saddled nose and the nostrils facing more anteriorly, like the snout of a pig. There is also telecanthus, which may be exaggerated further by disruption of the medial canthal ligament from the crest of the lacrimal bone.

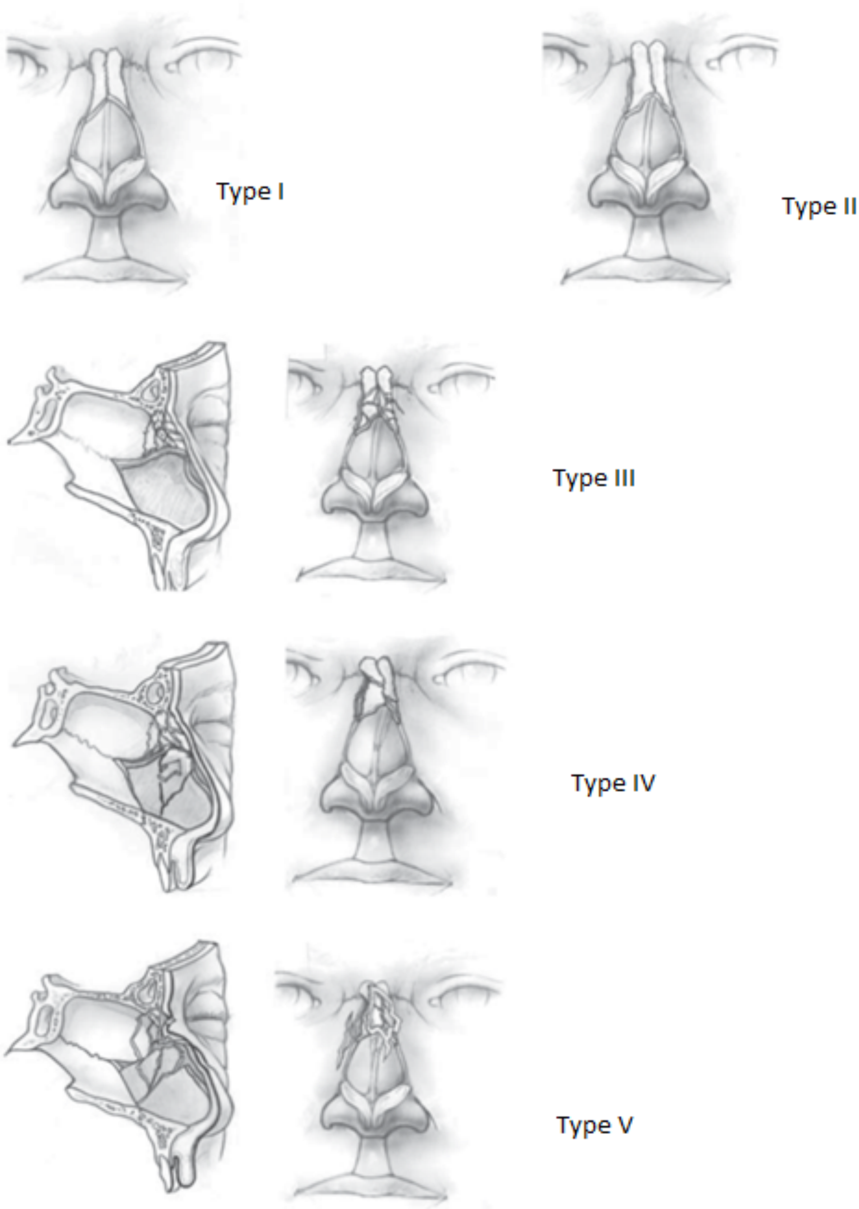
Two categories of naso-orbito-ethmoid fractures have been recognized by Raveh. In the first type, the anterior skull base, posterior wall of the frontal sinus and optic canal remain intact. In the second type, there is disruption of the posterior frontal sinus wall, multiple fractures of the roof of the ethmoid and orbit that may extend posteriorly to the sphenoid and parasellar regions. Multiple dural tears, cerebrospinal fluid leaks, pneumocranium and cerebral herniation may complicate this type of injury.[32]

The logical classification of nasal bone fractures with regards to the line of management was described by Ondiket al.[17] (Table 1 and Fig 8)

Type	Description	Characteristics
Type I	Simple straight	Unilateral or bilateral displace fracture without resulting midline deviation
Type II	Simple deviated	Unilateral or bilateral displaced fracture with resulting midline deviation
Type III	Comminution of nasal bones	Bilateral nasal bone comminution and crooked septum with preservation of midline septalsupport;septum does not interfere with bony reduction
Type IV	Severely deviated nasal and septal fractures	Unilateral or bilateral nasal fractures with severe deviation or disruption of nasal midline, secondary to either severe septal fracture or septal dislocation. May be associated with comminution of the nasal bones and septum, which interfere with reduction of fractures.
Type V	Complex nasal and septal fractures	Severe injuries including lacerations and soft tissue trauma, acute saddling of nose, open compound injuries, and avulsion of tissue

Table 1- Types of nasal bone fractures[17]

Fig 8- Types of nasal bone fractures[17]



Treatment of Nasal bone fractures

80% of nasal bone fractures do not require any active treatment. The treatment options for nasal bone fractures are closed or open reduction. The best opportunity for successful management is during first 3 hours after injury. If this is not possible, reduction is performed within 3 to 7 days.

Closed Reduction

Indications of closed reduction:

a) Unilateral or bilateral fracture of nasal bones- Class one and most class 2 fractures

b) Fracture of nasal septal complex with nasal deviation less than one half of the width of the nasal bridge.

Principle of closed reduction- Closed reduction aims at mobilizing the fragments by increasing and then decreasing the degree of deformity.

Procedure of Closed reduction

It can be done under Local anaesthesia or General Anaesthesia. Nose i**s** packed with 4% lignocaine and adrenaline and infiltration is given with 2% lignocaine and adrenaline. Preferred instruments for closed reduction are Freers, Hills or Howarths elevators, Asch or Walsham forceps, or a large Kelly forceps with rubber tubing.

Open Reduction

Open reduction is warranted in:

a)Extensive fracture- dislocation of the nasal bones and septum

b)Nasal pyramid deviation exceeding one half of the width of the nose.

c)Fracture dislocation of the caudal septum

d)Open septal fractures

e)Persistent deformity after closed reduction f)Septal hematoma, inadequate bony reduction , combined deformities of the septal and alar cartilages are also indications for open reduction.

The septum can be approached through a hemi transfixation incision on the side of the dislocation. Further access to the fracture lines is gained through bilateral inter cartilaginous incisions. The dorsal skin is elevated off the upper lateral cartilages, and the periosteum is elevated from the nasal bones. Incisions in the piriform aperture provides access to the lateral fracture lines. Common findings are dislocation of the quadrangular cartilage off the maxillary crest or C-shaped fracture of septal cartilage and bone.

The cartilaginous segments are exposed and reduced. Sometimes a segment of cartilage is resected adjacent to the the fracture. A Cottle elevator or Ballenger swivel knife is used to excise small strips of cartilage. Radical resection of cartilage or bone is avoided. Rasping is not to be attempted near fracture fragments. Antibiotic coverage and packing and splinting are given as for closed reduction. Cold compress is given for 24 to 48 hours to reduce edema.[29]

NASO-ORBITO-ETHMOID (NOE) FRACTURES

The nasal bones lie in close apposition to the ethmoid sinuses and the medial orbital walls. Low-force nasal trauma often remains limited to the nose, resulting in isolated nasal bone fractures. By contrast, high-force trauma is often transmitted through the nasal bones to also involve the underlying ethmoid sinuses and orbit. Because of the intimate physical and functional relationship of the bony structures in this area, it is useful to consider the nasal-orbital-ethmoid region as a single unit when dealing with high-velocity facial trauma.

Structures involved

The nasal bones articulate superiorly with the nasal process of the frontal bone, laterally with the frontal process of the maxilla, and medially with one another. Just deep to the nasal bones lie the thin bones and air spaces of the ethmoid sinuses. The lateral boundary of the ethmoid sinuses is the medial orbital wall, which is formed by contributions from the frontal process of the maxilla as well as the lacrimal, frontal, ethmoid, sphenoid, and palatal bones. High-velocity trauma to this area is generally transmitted to involve all of these bones to varying degrees. Evolutionarily, there is great advantage to the design of these thin bones and air-filled spaces: they form a low-resistance ''crumple zone'' that allows the traumatic force to be dissipated.

The critical structures such as the brain and optic nerve lie within stronger bone behind this crumple zone and are thus relatively protected from injury.

Despite the protective nature of this design, significant cosmetic and functional deficits may arise from high-force NOE injury. Mid face retrusion and nasal shortening occur as a result of the nasal bones telescoping inwards into the crumple zone. The medial canthal tendon (MCT) inserts on the anterior and posterior lacrimal crests and the frontal process of the maxilla.

Telecanthus arises from displacement of the MCT fragment or disruption of the MCT from its bony insertions. Epiphora is another frequent complication of fractures in this area. The lacrimal drainage pathway extends from the lacrimal puncta at the medial canthus through the canaliculi, nasolacrimal sac, and nasolacrimal duct. These structures are closely related to the lacrimal and maxillary bones as well as to the medial canthal tendon; disruption of any of these related structures places the lacrimal drainage pathway in danger of obstruction. Persistent post traumatic epiphora has been reported in 5% to 31% of patients with NOE fractures. Damage may also occur to the frontonasal duct .[28]

Classification of NOE fractures

Markowitz and colleagues classified NOE fractures based on the status of the medial canthal tendon and the degree of comminution of the fragment of bone to which it remains attached.

Type I - Fracture lines leave a central segment of bone with the medial canthal tendon attached. These are the simplest to reconstruct, as this central segment can be plated to the surrounding facial bones.

Type II- Fracture involves comminution of the central fragment, but the MCT remains firmly attached to a definable segment of bone.

Type III- Severe central fragment comminution with disruption of the MCT insertion sites.

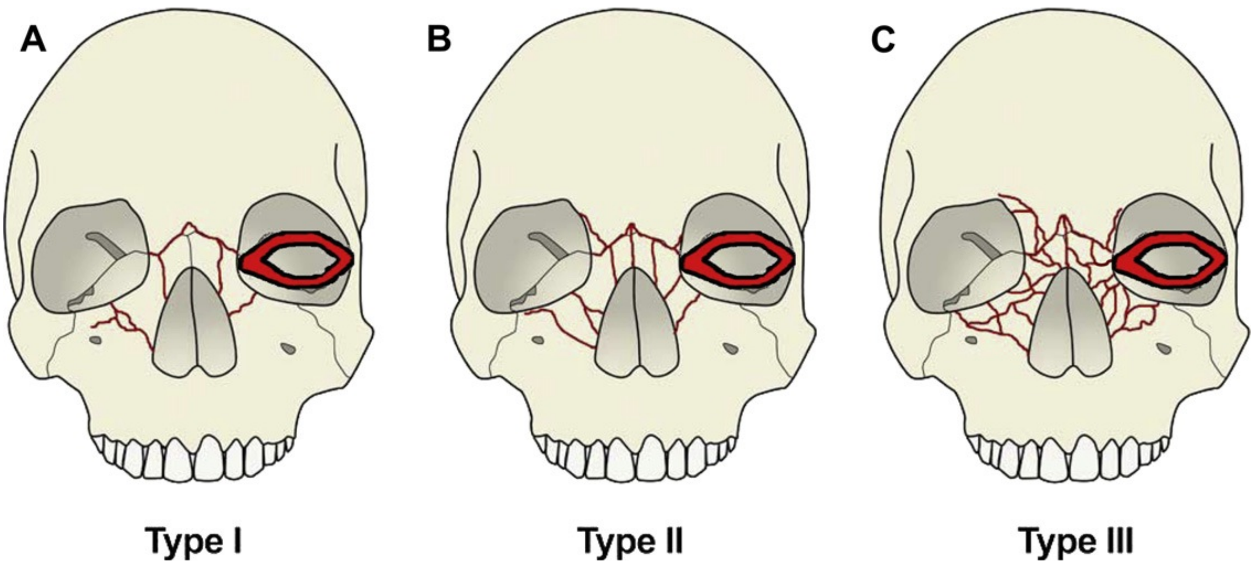


Fig 9- Types of NOE fractures[33]

Type II and III injuries are the most difficult to repair, and require transnasal wiring of the medial canthal tendon-bearing bone fragments (Type II) or the MCT (Type III). Clinically, identification of these injuries is often difficult because of the presence of soft tissue edema. Thus, it is critically important to identify displacement or comminution of the medial canthal tendon insertion radiographically.[28]

ZYGOMATICO MAXILLARY COMPLEX (ZMC) FRACTURES

The malar eminence of the zygoma is the most anterior projection of the lateral face. This prominent position makes the zygoma susceptible to trauma. The central portion of the zygomatic bone is sturdy, and contributes to the vertical buttress system of the midface; however, the projections of the zygoma by which it articulates with the surrounding facial bones, and the articulating bones themselves, are weaker.

This results in fracture of the zygoma at its suture lines, also called the ‘‘tripod’’fracture in reference to the three anterior suture lines that are fractured: the zygomaticfrontal (ZF), zygomaticotemporal (ZT), and zygomaticomaxillary (ZM) sutures. The zygoma has a fourth articulation site with the sphenoid bone, which is also fractured, and radiographically, five distinct fractures are demonstrated (lateral orbital wall, orbital floor, anterior maxillary wall, lateral maxillary wall, and zygomatic arch). Thus, the name‘‘tripod fracture’’ is technically inaccurate. Another reason to avoid the term ‘‘tripod fracture’’ is because it fails to recognize that this fracture complex is intermediate on a spectrum of injuries that range from an isolated, nondisplaced fracture limited to the zygomatic arch to severe displacement and comminution of the zygoma and surrounding bones. This spectrum of fractures all have similar mechanisms of injury, but differ in the amount of force applied and therefore in the degree of bone loss and displacement. For this reason, it is preferable to classify this entire spectrum of fractures together as zygomaticomaxillary complex (ZMC) fractures.[28]

Treatment of Zygomatic fractures

Principle- Reconstruction of the two main external arcs of contour. Restoration of horizontal arc re-establishes anterior ard lateral projections of the check and restoration of the vertical arc re-establishes height of malar prominence in relation to the middle third of face.

Reduction of the fracture is done after 5 – 7 days to allow resolution of soft tissue edema.

Techniques- Gillies operation with or without trans zygomatic Steinman pin fixation. Approach is through a sublabial incison. Subperiosteal dissection is done to allow evaluation of alignment of infraorbital rim and anterior wall of antrum. Reduction is achieved by placement of screws into body of zygoma and maxilla. Other approaches are done via a frontotemporal flap.[30]

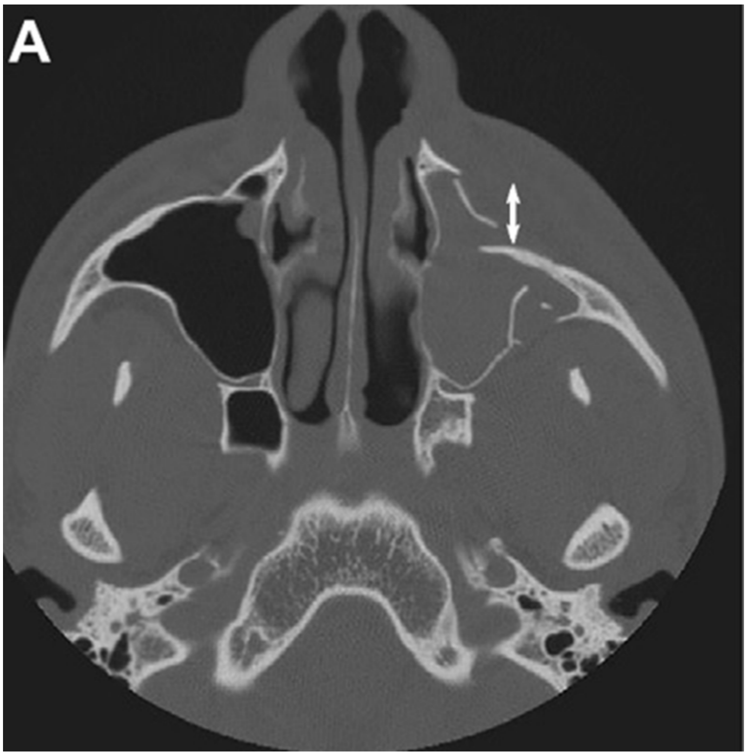


Fig 10 -Axial CT showing ZMC fracture

LE FORT FRACTURES

More than 100 years ago, Rene Le Fort devised a classification system for mid face fractures. This classification scheme is based on his finding that blunt trauma tends to cause fractures along three particular lines of weakness inherent in the design of the facial skeleton. Le Fort based his system on his observation of experimental fractures made in cadavers.

Fractures occurring in 21st-century, real-life situations (in particular, high-velocity motor vehicle accidents) often deviate from this classification system, and ‘‘pure’’ Le Fort fractures are rare. Nevertheless, the Le Fort classification system is widely known, and it provides a method for concise communication of fracture patterns between clinicians and radiologists.

Classification of Le Fort fractures

There are three types of Le Fort fractures. Each Le Fort level describes not an isolated fracture, but rather a pattern of fractures involving multiple facial bones. The most consistent and uniting feature of the Le Fort fractures is the presence of bilateral pterygoid fractures. Pterygoid fractures are found in all three classes of Le Fort fractures, and are the key to establishing the diagnosis. If a CT reveals bilateral pterygoid fractures, a Le Fort fracture should be suspected. Conversely, if the CT scan does not reveal pterygoid fractures, the Le Fort fractures can be excluded.

The Le Fort I fracture is a horizontal fracture through the maxilla, cephalic to the maxillary dentition. Bones fractured in a Le Fort I pattern include the lower nasal septum, the inferior portion of the piriform apertures, the canine fossae, both zygomaticomaxillary buttresses, the posterior maxillary walls, and the pterygoid plates. Also called Guerin`s fracture.

The Le Fort II fracture is described as being pyramidal in shape. It traverses the nasofrontal junction and extends laterally across the medial orbital wall, orbital floor, infraorbital rim, and then through the zygomaticomaxillary suture line. It also proceeds posteriorly through the nasal septum and pterygoid plates.

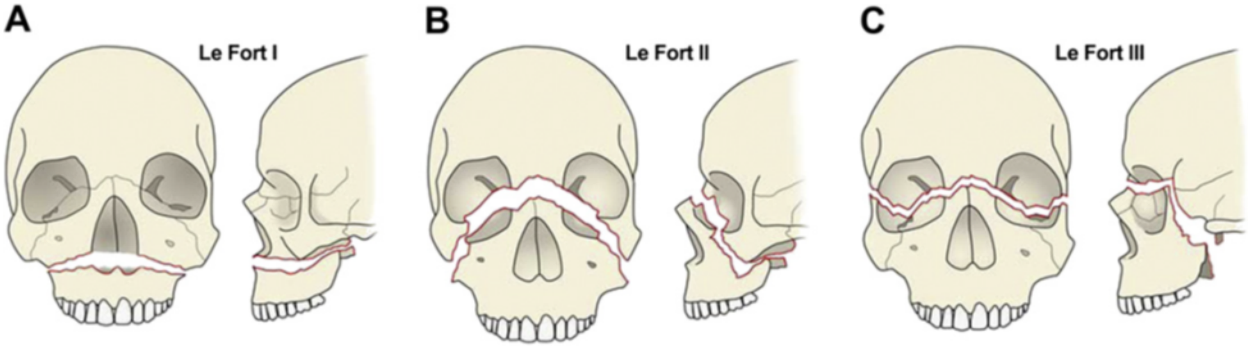


Fig 11- Le fort fractures[38]

The Le Fort III fracture is a complete craniofacial separation, resulting in separation of the facial bones from the cranium along the line of the nasofrontal and zygomaticofrontal suture lines. As in Le Fort II fractures, the fracture transverses the nasofrontal junction and extends laterally through the orbit; however, Le Fort III fractures involve not only the medial and inferior orbital walls but also the lateral orbital wall, zygomaticofrontal suture line, and zygomatic arch. As with the other Le Fort fractures, the fracture line also extends posteriorly through the nasal septum and pterygoid plates.

Each Le Fort fracture pattern has at least one unique component fracture that is easily recognizable and separates it from the other Le Fort fractures. Rhea and Novelline recently used these unique identifying fractures to design a simple method for identifying and classifying facial fractures. Only the Le Fort I fracture involves the lateral aspect of the piriform aperture. Only the Le Fort II fracture involves the inferior orbital rim and zygomaticomaxillary suture line.

Finally, only the Le Fort III fracture involves the zygomatic arch and the lateral orbital wall. When mid facial fractures are present and a Le Fort fracture pattern is suspected, it is recommended to first look at the pterygoid plates. If there is a bilateral pterygoid fracture, a Le Fort fracture is likely present. The next step is to inspect the three defining fractures discussed above: the lateral piriform apertures, the inferior orbital rim, and the zygomatic arch. The presence or absence of each of these fractures determines whether a fracture of that type is present or absent .

For example, the absence of a lateral piriform fracture rules out a Le Fort I; the presence of a zygomatic arch fracture makes is likely that a Le Fort III fracture is present. The final step is then to look systematically for fractures of the other bones that are involved in the Le Fort levels. This is important because it is possible to have a Le Fort fracture on one side and an isolated ZMC or NOE fracture on the other side. The presence of the key indicator fractures does not definitively diagnose the Le Fort level; instead, it serves to alert the radiologist to the high likelihood of a particular Le Fort fracture.

The other associated fractures must still be identified. Finally, it is possible to have more than one Le Fort level on a single side of the facial skeleton. For this reason, all three key indicator fractures must be examined, allowing each Le Fort level to be ruled in or ruled out, regardless of whether there is a coexisting Le Fort fracture of a different level.[28]

Treatment of Maxillary fractures

The care of airway is important in the treatment of maxillary fractures. A displaced Le fort fracture can compromise the airway, and a tracheostomy is generally preferred.

Temporary inter maxillary fixation is done before the definitive repair of the fractures.

Surgical approaches

Incisions used to approach midfacial fractures vary according to the location. Le fort 1 fractures are usually approached by extended sub labial incision which allows exposure of the zygomaticomaxillary buttresses and piriform apertures bilaterally.

Le fort II fractures are approached by trans conjunctival-lateral canthotomy or subciliary incision. In extensive Le fort II fractures, external Lynch incision or extended coronal incision is used. The incisions used depend on the location and extent of the fractures. Most Le Fort fractures do not manifest as the original description but are combinations of complex fractures of the midface and require knowledge of multiple surgical approaches. In patients with dentition, arch bars and intermaxillary fixation are initially applied to re-establish occlusion. In edentulous patients, splint or denture containing an arch bar is fixed to the mandible or maxilla with circum-mandibular wires or drop wires from the piriform rim or zygoma to re-establish appropriate skeletal relationships. If midfacial fractures are displaced, disimpaction of fractures may be required by use of the Rowe-Killey disimpaction forceps before placement of intermaxillary fixation. After the occlusal relationship is re-established, all fracture sites are fully exposed. The facial skeleton should then be reconstituted in three dimensions: height, -width, and depth. The vertical zygomaticomaxillary and nasomaxillary buttresses should be carefully reduced and fixated to re-establish vertical facial height.

For a Le Fort I fracture, a two-point stabilization at the nasomaxillary and zygomaticofacial buttresses is established on each side. Titanium low profile mini plates in an "L," "X," or square configuration are placed on the anterior buttresses and usually an "L"-shaped plate on the undercurve of each zygoma onto the maxilla bilaterally.

Le Fort II fractures require fixation at the infraorbital rim and the zygomaticomaxillary buttresses. If the nasal bones are comminuted, microplates are used on the nasal bones. The infraorbital rims will be fixed with micro plates as well.

Le Fort III fracture is usually accompanied by cerebral trauma. It is advised to have a staged type of treatment in which the neurosurgeon controls the intracranial injury and the management of the facial component is limited to the performance of a tracheostomy and the application of arch bars and interdental elastic bands. The treatment of the maxillary fracture is delayed until the patient's neurologic status has stabilized.[30]

MANDIBULAR FRACTURES

CLASSIFICATION

Mandibular fractures can be simple and compound. Simple when both the external skin and oral mucosa are intact or compound (open) when a laceration in the skin or intraoral mucosa is present. If the fracture is incomplete and involves only one cortex, it is termed "greenstick." The comminuted mandible fracture is one with several fragments of bone. The most frequent location of fractures of them Mandible is the condylar-subcondylar region. Other common sites include the body and mandibular angle. The coronoid process is rarely fractured. Mandibular fractures can also be classified adentulous, edentulous, or pediatric.

MECHANISM OF FRACTURE

The final classification may be made according to the stability of the fracture. Vertical instability results from the pull of the temporalis, masseter, and pterygoid muscles. The angle of pull of these muscles will tend to impact a jaw fracture that is obliquely inclined from distal to mesial. If the inclination is the opposite direction, then the forces of these muscles will distract the distal segment in a superior and medial direction. A fracture becomes horizontally unstable by virtue of its obliquity in the occlusal plane. A fracture with an angulation running from the buccal to the lingual surface in a posterior to anterior direction is favorably aligned, whereas that in the opposing obliquity is unstable by virtue of the pull of the mylohoid muscle.[5]

Biomechanics of the Mandible

Mandible is considered as a cantilever beam, suspended at two points, the TMJ attatchments. The muscles of mastication produces forces that acts on the beam, and teeth acts as fulcrums. In the mandibular body and angle, the forces produce zones of relative tension distraction along the superior border and compression along inferior border. Stress distribution of mandible vary depending on the magnitude and point of force application.

Fractures are considered favourable when muscles tend to draw the fragments toward each other, thus, reducing the fracture. Fractures are unfavourable when the fragments tend to be displaced by muscular forces. All fractures of the angle are horizontally unfavourable, the masseter, medial pterygoid, temporalis contribute to superior and medial displacement of the proximal segment. Vertically unfavourable angle fractures result in medial displacement of proximal segment by medial and lateral pterygoids. Vertically unfavourable fractures often involve body and are distracted by mylohyoid and suprahyoid musculature.

DIAGNOSIS

History and physical examination, along with plain radiographic films, fully delineate the large majority of fractures to the mandible. Patient may complain of malocclusion or pain in the region of the fracture. Painful opening of the jaw, or trismus, is a common complaint. Painful swallowing and sneezing may also occur. Numbness of the lower lip, from an avulsed or badly contused inferior alveolar nerve.

Physical examination confirms malocclusion. If the fracture is in a tooth-bearing area, loose or missing teeth may be noted. Ecchymosis of the gingival can be seen. Gross displacement of the fragments may be seen. The maxilla-mandibular occlusal relationships are documented. Soft tissue swelling over the point of contact is often found.

Radiographic evaluation can be used to confirm the physical findings and assess the severity of the fracture. When there is one fracture in the mandibular arch,there may be an occult fracture in the contralateral ramus or condyle. The panoramic radiograph, or Panorex film, is excellent for viewing fractures of the ramus, angle, and body.

A modified Towne’s view visualizes fractures of the condyles . If a strong suspicion of subcondylar fracture exists, a CT scan will delineate the degree of fragment overlap or displacement into the infratemporal fossa. If a parasymphyseal or symphyseal fracture is
suggested clinically, but not visualized on plainradiographs, the CT scan will demonstrate it. Dental fractures are best diagnosed with dental occlusal films.

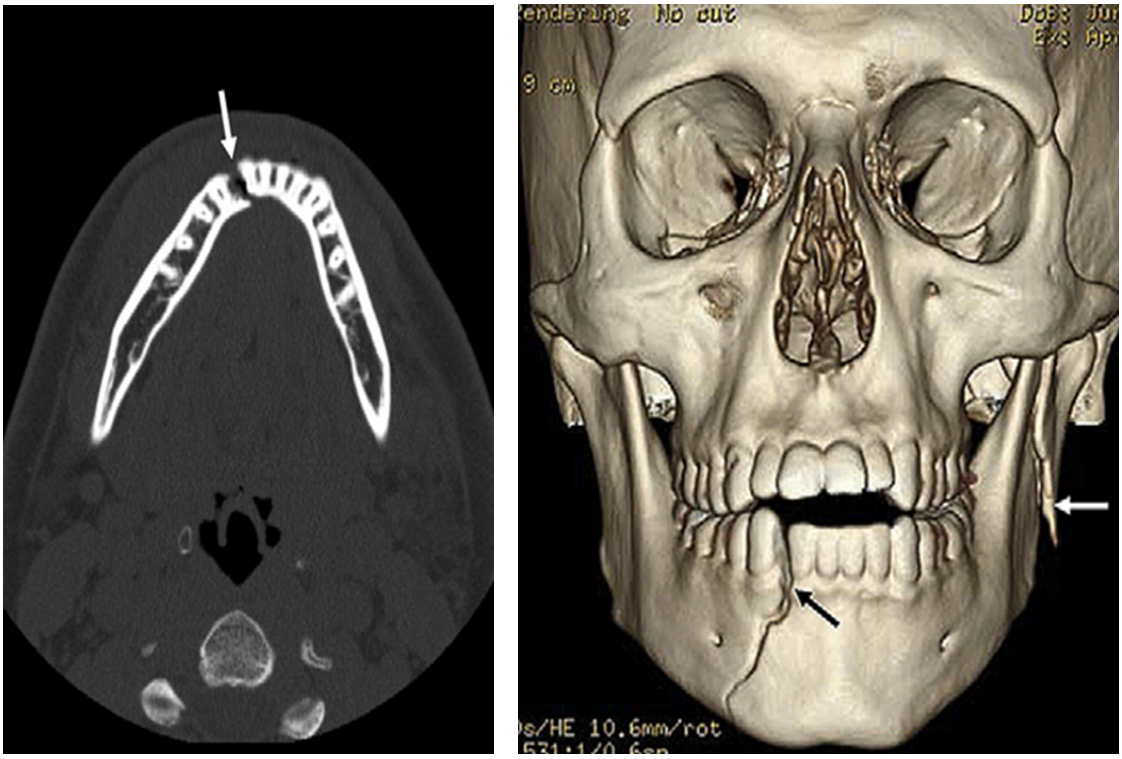


Fig 12- Axial and 3D reconstruction view of fracture mandible

TREATMENT

Surgical intervention is recommended as early as possible to prevent infection, there is no conclusive evidence for this. To decrease the incidence of infection, administer preoperative antibiotics. Surgery is done as soon as possible. Some fractures of the mandible do not require surgical intervention. Most commonly, non-displaced ramus fractures, as well as some subcondylar fractures, when there is no complaint of malocclusion can be treated conservatively.

The cornerstone of facial fracture repair is still intermaxillary fixation. This method of repair entails the ligation of the teeth of each arch to those that oppose it. Intermaxillary fixation began by separately wiring each tooth of the maxillary and mandibular arches and then connecting these wires one by oneas the teeth were brought into occlusion.

Eyelet Wires The eyelet wire is best used for subcondylar fractures, greenstick fractures, and favourably aligned non comminuted mandibular fractures. The eyelet wire may also be used as temporary fixation until definitive fixation is done. The wire is constructed by taking a half-length of No. 26 gauge wire, bending it in half, and twisting in a small loop. The idea of the eyelet wire is to capture two independent teeth on each side of a mandibular fracture and then fix these to two adjacent pairs of maxillary teeth. The ends of the wire are directed from the buccal side through the interdental space below the contact point and close to the gum between the pair of mandibular teeth distal to the fracture. Gunning splints and Arch bars also may be used.

Fractures of the Parasymphyseal Area

These fractures tend to occur in an oblique line, sometimes even approaching the midline from the mental foramen. The mental foramen is the most commonly involved site and ipsilateral or contralateral fracture of the angle, ramus, or condyle often accompanies unilateral parasymphyseal fractures. Posteriorly displaced bilateral parasymphyseal fractures constitute an airway emergency and emergency tracheostomy or cricothyrotomy is indicated.

Treatment includes intermaxillary fixation and stabilizing the fractures with interosseous wires, plate, or a lingual splint. Open reduction of these fractures can be either intraoral or external.

Fractures of the Body and Angle of the Mandible

Fractures of the mandibular body in patients with good dentition have the advantage of strong articulating mandibular and maxillary teeth. Intermaxillary fixation stabilizes many of these fractures sufficiently, alleviating the need for open reduction. The forces generated by the pterygo masseteric sling may distract these fractures, requiring open reduction. Once closed reduction is accomplished by means of arch bars, a decision can be made whether the repair is stable. If not, an open reduction can be approached by means of a gingivobuccal incision intraorally. Rarely, an extraoral approach will be necessary, and a modified Risdon incision is made with care taken to preserve the marginal mandibular branch of the facial nerve. Angle fractures may be treated the same way as body fractures. If the oblique line of fracture is in a favorable direction, closed reduction is adequate and when there is an "unfavorable" fracture, open reduction is necessary.

Fractures of the Condylar Process and Ramus

Subcondylar fractures are usually handled by closed reduction. Fractures of the mandibular ramus can be treated in a similar fashion to condylar fractures, if there is displacement of the fractures and malocclusion results, closed reduction is needed. If there is a massive comminution, severe telescoping, or displacement that is not adequately reduced by closed reduction, open reduction should be undertaken.

An incision in the preauricular area extending into the temporal hairline, going deep to the temporalis fascia. A flap of superficial temporalis fascia should be raised and the root of the zygoma followed down to the fracture site. The trunk of the facial nerve is avoided by staying on the zygomatic process of the temporal bone, tracking down to the glenoid fossa. With a gentle retraction of the superior parotid tissues, the fossa can be exposed and the fracture reduced by means of either a wire or a miniplate with screws.

Surgical Approaches

Intraoral approaches have the advantages of scar camouflage and a more direct approach to fracture reduction and fixation. These approaches require more elaborate instrumentation to allow precise fracture fixation.

Incision and approach chosen for a given fracture of the mandible depend on several factors. These include the location and type of the fracture, the available instrumentation and technology, and, most important, the surgeon's comfort with the given approach. The choice for fractures of the symphyseal and parasymphyseal region is intraoral. Linear posterior fractures may be approached intraorally, whereas more comminuted fractures or fractures with significant bone loss usually require an extraoral approach. The approach chosen should allow adequate exposure to diagnose, reduce, and immobilize the given fracture.

The symphyseal and parasymphyseal regions of the mandible are easily approached through either an intraoral or an extraoral route. The intraoral incision is made from canine tooth to canine tooth, leaving an adequate mucosal cuff for closure of the incision. Subperiosteal dissection is made, identifying and preserving the mental nerves. The symphyseal and parasymphyseal regions are also easily approached through an external submental incision.

Intraoral approaches to the body and angle are best performed by making a gingivobuccal incision immediately adjacent to the fracture. The extraoral approach to fractures of the mandibular body, angle, or ramus is made through a transcervical incision two fingerbreadths below the angle of the mandible.

The goals of mandible fracture reduction include anatomic and functional stability of the mandible. Reduction and stabilization of any mandibular fracture should result in a pain-free function of the mandible without any eventual changes in the temporomandibular joint.

The former techniques used wire fixation with interosseous wiring. This method allows the bone to heal indirectly. If interosseous wiring is used, intermaxillary fixation should also be used for 6 weeks for stable bone repair.

Open reduction and internal fixation is done with monocortical plates and screws. The plates are 0.9 mm thick and have either 4 to 6 holes or 8 to 16 holes. The diameter of the screw holes is 2.1 mm, and the holes are bevelled at 30 degrees.[5]

APPROACH TO A PATIENT WITH MAXILLOFACIAL TRAUMA

As with all traumas, basic advanced trauma life support principles should be applied to the initial assessment of the casualty. This must include a primary and secondary survey. It is only after the secondary survey that definitive care begins. Though a majority of accident cases with maxillofacial trauma have raised blood alcohol levels and maybe in a disoriented state, it is also to be remembered that confusion may be secondary to head injury or hypoxia. There is a 10–15% chance of cervical spine injury in an unconscious patient with severe maxillofacial trauma.

Airway breathing and ventilation

The main cause of death in severe facial injury is airway obstruction. This may be because of the tongue falling back and obstructing the hypopharynx in an unconscious patient or may be secondary to uncontrolled haemorrhage causing aspiration. Assess the patient for airway obstruction. Agitation suggests hypoxia, obtundation suggests hypercarbia, and cyanosis suggests hypoxemia secondary to inadequate oxygenation. Look for evidence of injury to the larynx and trachea, including crepitus of the soft tissues. Clinically the patient may have noisy breathing, snoring, gurgling, or croaking. Hoarseness, subcutaneous emphysema, and a palpable fracture are suggestive of laryngeal fracture. Check that the trachea is central.

Establish and maintenance of the airway

Good suction is essential. Remove the debris (broken teeth, dentures) from the mouth with a finger sweep, yankauer suction. The chin should be pulled forward either through chin lift or jaw thrust procedures. The jaw thrust and chin lift relieves soft tissue obstruction by pulling the tongue, anterior neck tissues, and epiglottis forward.

The jaw thrust has the advantage that it can be performed by one clinician who can simultaneously stabilize the cervical spine. In a bilateral fractured mandible, the central portion of the mandible and attached tongue may fall backwards obstructing the airway. Pulling the anterior part of the mandible forward may clear the airway.

In severe midface fractures the maxilla may be pushed backwards towards the spine causing an airway obstruction. To relieve this, the maxilla must be pulled forward to disimpact the fracture. If the airway still cannot be established by these methods, use a laryngoscope to check that there is no foreign body, such as denture impacted in the vocal cords, which has to be removed. If the foreign body cannot be removed quickly it should be left and a surgical airway performed. If no foreign body is visible an endotracheal tube should be inserted. Endotracheal intubation with a cuffed tube will secure the airway.

If the vocal cords cannot be adequately visualised or endotracheal intubation is not possible then a surgical airway should be performed. A cricothyroidotomy is the preferred way to establish a surgical airway in the emergency setting. A 5 or 6 mm tube cuffed tracheostomy tube should be inserted through the cricothyroidotomy incision. A needle cricothyroidotomy is advised in children less than 12 years of age as there is a high risk of damaging the cricoid cartilage. In a child the cricoid cartilage is the only circumferential supporting structure that maintains patency of the upper trachea.

Tracheostomy is indicated in upper airway obstruction and in head injury patients in whom prolonged intubation is expected. Tracheostomy may be done as an emergency procedure in patients in whom endotracheal intubation is not possible or as an elective procedure once the patient is stable.

Circulation with haemorrhage control

If there is no evidence of damage to the major vessels of the neck or middle third of facial fractures blood loss is usually insufficient to cause hypovolemic shock problems, but may cause problems with establishing and maintaining an airway. Bleeding from the soft tissues of the head and neck may be controlled with direct pressure on the bleeding site. Once the bleeding has ceased the wound should not be probed.

Scalp lacerations may bleed profusely but are unlikely to cause hypovolemic shock with a reduction in blood pressure in an adult. However, large scalp lacerations may be life threatening in children. Any arterial source of bleeding in the scalp can be safely clipped off and further hemostasis may be achieved by approximating scalp tissues with large sutures. Intra oral bleeding may be controlled by getting the patient to bite on a swab.

A conscious patient with maxillofacial injuries is usually more comfortable sitting upright as this allows blood and secretions to drain out of the mouth. Bleeding from a tongue laceration can be torrential and direct pressure may not be enough to control the bleeding; in such cases deep sutures across the laceration are advised to achieve hemostasis.

Bleeding from fractured mandible ends may be arrested by manually reducing the fracture, although a bridle wire is usually required to maintain this reduction. Torrential bleeding from the region of the nasopharynx following trauma to the middle third of the facial skeleton can be difficult to control. Merocil nasal packs and conventional nasal packs are the options for anterior nasal bleeds. Foley catheters may be used in posterior bleeds. If the bleeding is not controlled by anterior or posterior nasal packing, External carotid artery ligation may be done. [34]

CLINICAL EVALUATION OF MAXILLOFACIAL TRAUMA

After evaluating the patient for head injury, securing the airway and hemodynamics taken care, cervical spine injuries should be ruled out.

The following must be seen in the Maxillofacial region:

1. History of diplopia, oral or nasal bleed
2. Soft tissue injuries- Abrasions, Lacerations, Periorbital oedema
3. Numbness/ Paraesthesia on face
4. Mouth opening
5. Occlusion
6. Palpate for any deformities of facial bones

The clinical evaluation must include soft tissues, nerves, skeleton and dentition.

IMAGING INVESTIGATIONS IN MAXILLOFACIAL TRAUMA

Plain Radiographs

Though much modern investigations have come, X rays are still the primary investigation modality in maxillofacial trauma.

The following views are the commonest radiological views-

. Water`s view

. Caldwell view

. Axial view for nasal bones

. Lateral view for nasal bones

. A-P and Lateral views of Mandible

McGregor& Campbell lines-

Four lines which cover most of the sites of injury-

First line- runs across the zygomatico frontal sutures, the frontal sinuses and the superior margins of the orbits.

Second line- runs along the zygomatic arches, the inferior margins of the orbits and the inferior margins of the orbits and the nasal bones.

Third line- runs across the mandibular condyles, the coronoid processes and the maxillary sinuses.

Fourth line- runs along the occlusal plane of the teeth.

Trapnell`s line- a fifth line which runs along the occlusal plane of the teeth.

These lines are followed on the X ray to make out the fracture lines.

Other views - which are also taken for Orbital fractures are fronto- occipital view, A-P and lateral view of skull, Reverse water`s view, Hertz`s view (submento vertical view)

CT SCAN

CT has replaced other forms of radiographic imaging for the assessment of maxillofacial injuries. With the availability of modern high speed, high resolution CT scanners, most maxillofacial trauma surgeons have abandoned plain radiographic imaging of middle and upper third facial bones, even as a screening tool. The numerous overlapping shadows make it easy to miss fractures that would be found on a CT scan, and the presence of a fracture would necessitate a CT scan. The exception is for simple nasal fractures that are routinely assessed by plain radiographs.

Technique

High resolution CT scan is required for assessment, management and during post-operative follow up. 0.65 mm narrow slice thickness should be used. And the field should include structures from the frontal sinus to the mandible. Axial images should be reconstructed in both bone bone and soft tissue algorithm. Reconstructed coronal and sagittal images should also be obtained. [33]

Axial orientation of CT scan was best for visualizing most frontal fractures as well as NOE , Zygomatic arch fractures and vertical orbital walls. Coronal orientation was better for the orbital roofs and floors and the pterygoid plates. In general, as would be predicted, vertical structures were better seen on axial scan and horizontal structures were better seen on coronal scans.

Three dimensional reconstruction is very helpful but, a scan performed at a resolution of less than 1.5 mm should not be used to make three dimensional reconstructions, because the "fill-in" algorithms used by the computer programs created too many misrepresentations.

In general, three- dimensional reconstructions create an overview picture that may help the surgeon visualize the over facial architecture; however they contain potential inaccuracies that are not present in directly obtained scans.[25]

COMPLICATIONS OF MAXILLOFACIAL INJURIES

Complications of soft tisue injuries

The complications in the soft tissue include- Tissue loss, Ischemic wounds, scars, keloids and contractures of the skin. Fascitis may occur. Ischemia and necrosis of muscles or contractures may occur. Injury to major vesssels may also occur causing haemorrhage.

Complications of Frontal Sinus fractures-

The common complications include Headache, Sinusitis and frontal sinus mucocele. Intracranial complications include CSF leak, Meningitis and brain abscess. Cosmetic deformity and ophthalmic complications such as diplopia or telecanthus may also occur.[31]

Complications of nasal fractures-

Early complications include- Edema, ecchymosis, epistaxis, hematoma , infection and CSF leak.

Late complications include**-** Airway obstruction, fibrosis, contracture, saddle nose, septal perforation and synechiae.[29]

Complications of midface fractures

Facial asymmetry, non-union and malocclusion are the common complications encountered even after fracture reduction.

Others include- epiphora, enophthalmos, ptosis and trismus.[30]

Complications of mandible fractures

40% incidence of complications has been reported in mandibular fractures. The infection rate is around 10%, the incidence of osteitis is around 3%. Malocclusion rate was around 1%. Other complications include malunion, non-union, trismus, Temporomandibular joint dislocation and ankylosis. Rare complications include sensory disturbances of inferior alveolar nerve and facial nerve injury.[5]

MATERIALS AND METHODS

Methodology:

One hundred patients with maxillofacial injuries following a road traffic accident presenting to the Emergency Room and managed in the department of Otorhinolaryngology and Oral & Maxillofacial surgery of R.L Jalappa Hospital and Research Centre from December 2011 to June 2013 were included in the study.

Sample Size: 100 patients were included in the study

Study Design: Descriptive study

Study Period: December 2011 – June 2013

Inclusion criteria:

Road traffic accident patients with maxillofacial injuries.

Exclusion criteria:

1. Patients with previous history of maxillofacial injuries.
2. Patients who had no radiological evidence of maxillofacial fractures.
3. Patients who were referred to a higher center during the course of treatment.

Method of Collection of Data:

All patients presenting to the Emergency Room and Department of Otorhinolaryngology with suspected maxillofacial fractures, were stabilized and after obtaining consent, were included in the study and were assessed on the following parameters.

Mode of accident was enquired into; whether the patient was a pedestrian, two wheeler rider or four wheeler rider at the time of the accident. In two wheeler riders, it was also enquired about the usage of helmet at the time of the accident.

Clinical history was taken pertaining to symptoms of maxillofacial injuries.

- Altered bite
- Inability to open the mouth
- Double vision
- Nasal or oral bleed
- Paresthesia over face

Clinical Examination: All patients then were thoroughly examined to rule out associated injuries. A detailed examination for any facial soft tissue injury, epistaxis, oral bleed were performed. A storz nasal telescope 0^o was also used when it was difficult to examine with a speculum. Facial skeletal framework was examined for any deformity, bony crepitus. Oral and nasal cavity were examined in detail and all positive findings were documented.

- Facial soft tissue injuries- Abrasions / Lacerations / Swelling
- Nasal examination-
    - External framework
    - Anterior Rhinoscopy
    - Posterior Rhinoscopy

- Oral cavity-
    - Mouth opening
    - Occlusion
    - Loss of dentition
    - Soft tissue injury
- Facial skeleton
    - Crepitus
    - Bony discontinuity
- Ocular
    - Periorbital edema, ecchymosis
    - Continuity of Infraorbital rim, Supraorbital margin
    - Diplopia
    - Visual acuity
    - Ocular movements
    - Subconjuntival haemorrhage
    - Proptosis / enophthalmos

All patients underwent radiographical evaluation either by plain radiograph or computerized tomography scan of the Head and Face or both to study the patterns of maxillofacial fractures.

Figure 13: Laceration over the lower lip extending to the gingival margin

Figure 14: Laceration over the right cheek extending to the right orbit

Figure 15: Laceration extending from the roof of the orbit to the upper and lower lip with associated maxillary and mandibular fractures

Figure 16: Fracture bilateral maxilla

Figure 17: Fracture of the Frontal bone

Figure 18: Fracture of bilateral nasal bone with saddling

Figure 19: Naso orbito ethmoid complex fracture – Lefort III

Computerized Tomography Scan:

All CT scans in the study was performed using 16 slice spiral 3rd generation CT scanner.

CT Protocol consisted of the following:

- Non Contrast axial 16 slice helical series
- Beam collimation of 5mm (brain), 3mm (face)
- Detector configuration of 16 x 1.2 (brain), 16 x 0.625 (face)
- Pitch of 1.375:1
- Tube current of 200mAs
- Voltage of 120kV
- Total exposure time of 6.5 s

CT Technique:

Proper immobilization and positioning of the head was achieved in all patients. The Gantry tilt was given in the range of 0-20 degrees, so as to parallel the scan plane to the orbito-meatal line. The obtained images were studied at brain and bone window settings.

The fracture detected on CT examination was classified according to the region involved.

These were assessed in 7 regions:

1. Frontal bone fractures
2. Zygomatic bone fractures
3. Nasal bone fractures
4. Orbital fractures
5. Maxillary fractures
6. Mandibular fractures
7. Complex fractures/ Le Fort Fractures

Frontal bone fractures were classified into-

- Anterior table fractures

- Posterior table fractures
- Both table fractures

Nasal bone fractures were classified into five types

- Type 1- Simple straight
- Type 2- Simple deviated
- Type 3- Communition of nasal bones
- Type 4- Severely deviated nasal and septal fractures
- Type 5- Complex nasal and septal fractures

Orbital fractures were classified based on the involvement of

- Orbital Roof
- Medial wall of orbit
- Lateral wall of orbit
- Orbital Floor

Fractures of the zygoma were classified as

- Zygomatic arch fractures
- Zygomatic body fractures
- Combined fracture

Maxillary fractures were described according to the region involved

- Anterior wall of maxillary sinus
- Posterior wall of maxillary sinus
- Lateral wall of maxillary sinus
- Medial wall of maxillary sinus
- Floor of maxillary sinus

Mandible fractures were classified based on their location as

- Condylar fractures
- Sub-Condylar fractures
- Ramus fractures
- Fractures of angle of mandible

- Fractures of body of mandible
- Para-symphyseal fractures
- Symphyseal fractures

Complex mid facial fractures were classified according to the Le Fort system:

- Le Fort I
- Le Fort II
- Le Fort III

X- RAY

Patients who had suspicion of only isolated maxillofacial fractures, those who could not afford CT scan and few patients who required intervention and as an adjuvant to CT scan, had X-rays taken and also during their follow up. Digital plain radiographs was taken for all patients using the 500mA X-ray machine operating at 4-12 mA with a peak tube potential of 60-80kV on Fuji computed radiography screens.

X-ray paranasal sinus- Occipitomental (Water's) View :

The patient sits facing the bucky support with the chin resting against it. The median sagittal plane was aligned to the midline. The mouth is supported wide open with a transradiant bite block. Baseline was adjusted to make an angle of 45 degrees with the film. Central ray of the x-ray was passed horizontally to the middle at the level of the inferior margins and to the center of the film.

X-ray Mandible – Lateral Oblique View:

The patient sits with side of the head to be x-rayed nearest to the cassette holder. The cassette is placed and collimated to the format. The head is tilted inwards

15 degrees towards the cassette. The X-ray tube points towards the face from a straight lateral position. The central beam is focused on the angle of mandible.

X-ray Nasal Bone – Lateral View:

The patient sits facing a cassette mounted on a vertical bucky. The head is turned so that the median sagittal plane is parallel with the cassette and the inter-pupillary line is perpendicular to the cassette. A horizontal central ray is directed through the center of the nasal bones and collimated to include the nose.

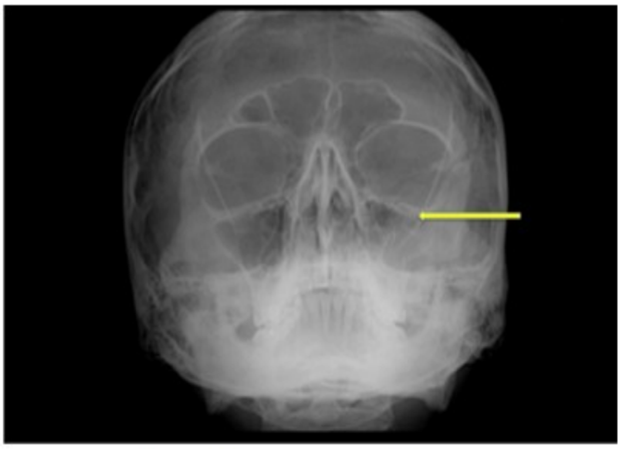


Figure 20: Fracture of the floor of orbit and lateral wall of maxilla

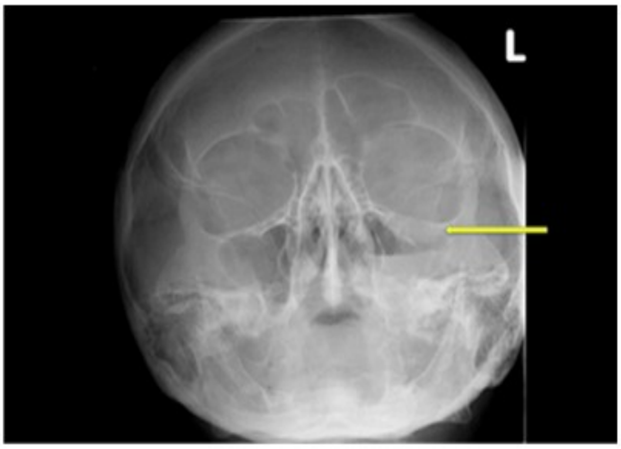


Figure 21: Orbital blowout fracture

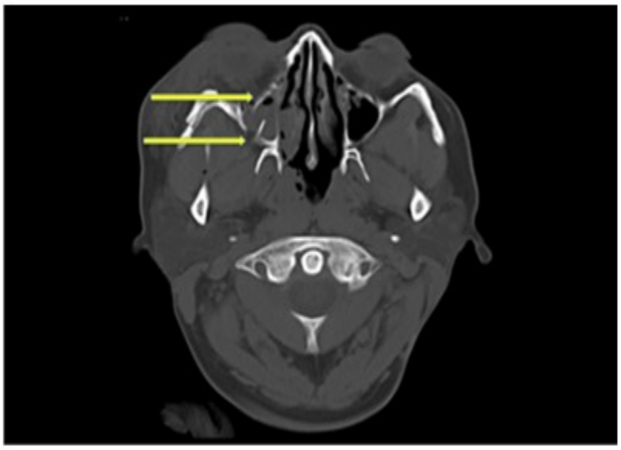


Figure 22: Fracture of anterior and posterior wall of maxilla

Figure 23: Intacranial Hemorrhage

Figure 24: X-ray nasal bone showing a minimally displaced fractured segment

Figure 25: X-ray showing fracture of the body of mandible

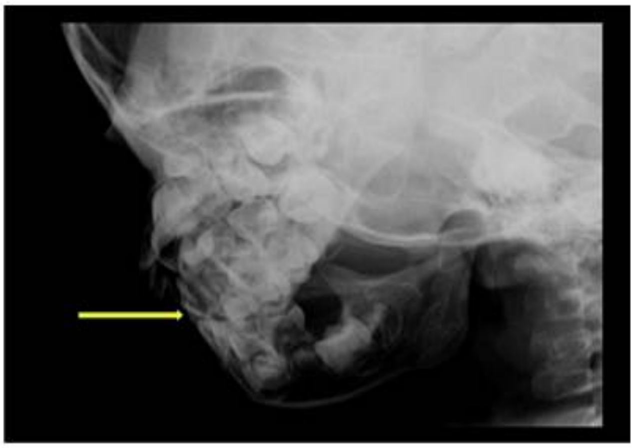


Figure 26: X-ray mandible – lateral oblique view with fracture parasymphysis

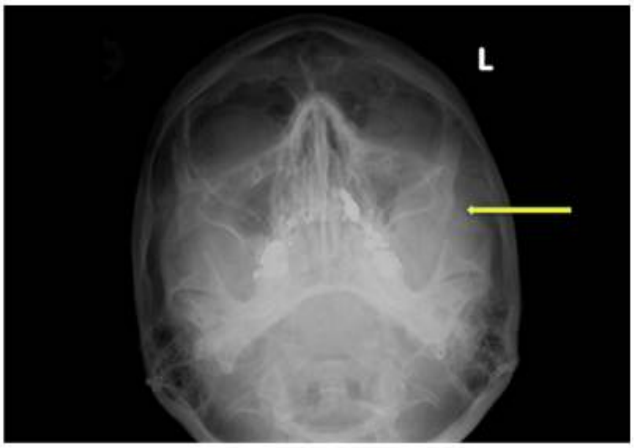


Figure 27: X-ray paranasal sinuses with a fractured zygomatic arch

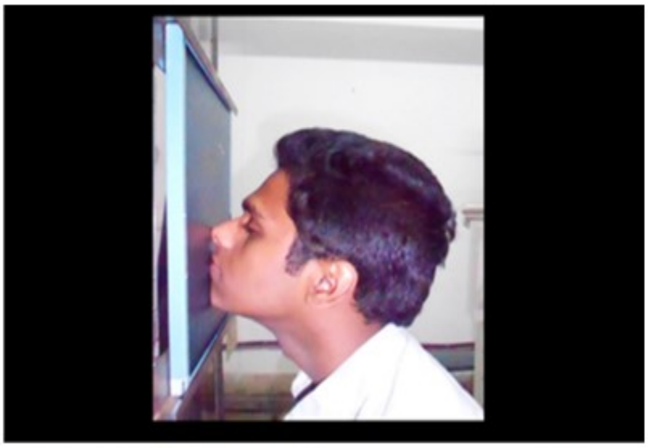


Figure 28: X-ray paranasal sinus – Occipitomental View (Waters View)

Figure 29: Waters View in a supine patient

Figure 30: X-ray Mandible – Lateral oblique view

Figure 31: Computerised Tomography of Head and Face

Treatment:

All patients received were resuscitated and stabilized with regards to airway, haemorrhage and shock. Airway was secured in patients who had airway compromise by endotracheal intubation or tracheostomy.

Bleeding was controlled and volume expansion accomplished by blood transfusion, blood substitutes or i/v fluids as indicated. Tetanus toxoid (TT), Antibiotics and analgesics were administered to all patients. All contaminated wounds were thoroughly irrigated and cleaned with antiseptic solutions. Soft tissue injuries were managed appropriately by simple wound dressings or suturing. Tissue loss was addressed by local advancement flaps or skin grafting.

Epistaxis, which could not be managed conservatively, was treated by anterior or posterior nasal packing depending on the site of bleed. Anterior nasal packing was done either by using povidone iodine impregnated ribbon gauze packs or merocel nasal packs. Posterior nasal bleeds were controlled using a foley's catheter. The packs were removed after a period of 48 hrs.

Inter maxillary fixation was used as a temporary stabilization technique in maxillary and mandibular fractures. Nasal bone and septal fractures were reduced using Walsham's forceps and Asch's forceps under local or general anesthesia. Nasal splint was used to immobilize the reduced fragments.

Displaced fractures of the maxilla, zygoma, frontal bone and mandible were managed by open reduction and internal fixation with Titanium mini plates and screws depending on the location and severity of the fractures.

Figure 32: Fracture of Mandibular body and Ramus fixed with Titanium mini plates

Figure 33: Sublabial approach to maxilla for fracture fixation

Figure 34: Fracture of Body of Mandible

Figure 35: Fixation of Symphyseal fracture with Titanium mini plates

Following discharge all patients were evaluated on a regular basis for a period of 3 months. Patients were evaluated either clinically or radiologically or both for complications such as

- Secondary wound infection
- Malocclusion
- CSF rhinorrhea
- Anosmia
- Non-union

The data collected was analyzed by SPSS 12 software.

Figure 36: Malocclusion following intermaxillary fixation

Figure 37: Malaligned molar cusps in malocclusion

Figure 38: Depressed fracture of the frontal bone

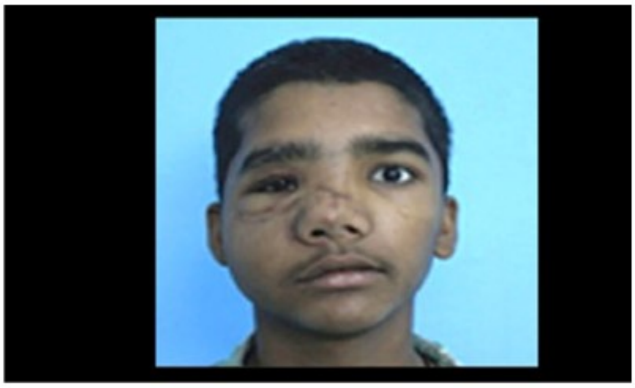


Figure 39: Telecanthus

OBSERVATIONS & RESULTS

The present study was conducted from December 2011 to June 2013. During this period 100 road traffic accident patients with maxillofacial injuries were studied.

Age Distribution:

In our study the maximum number of patients were adults in the age group of 21-30yrs (45%) with a mean age of 32.08 yrs. The age distribution in our study is as given in Table 2.

N	Mean	Std. Deviation	Std. Error Mean
100	32.08	11.178	1.118

Age distribution	**n=100**
0-10	0
11-20	14
21-30	45
31-40	22
41-50	10
51-60	8
61-70	1

Table 2- Age distribution

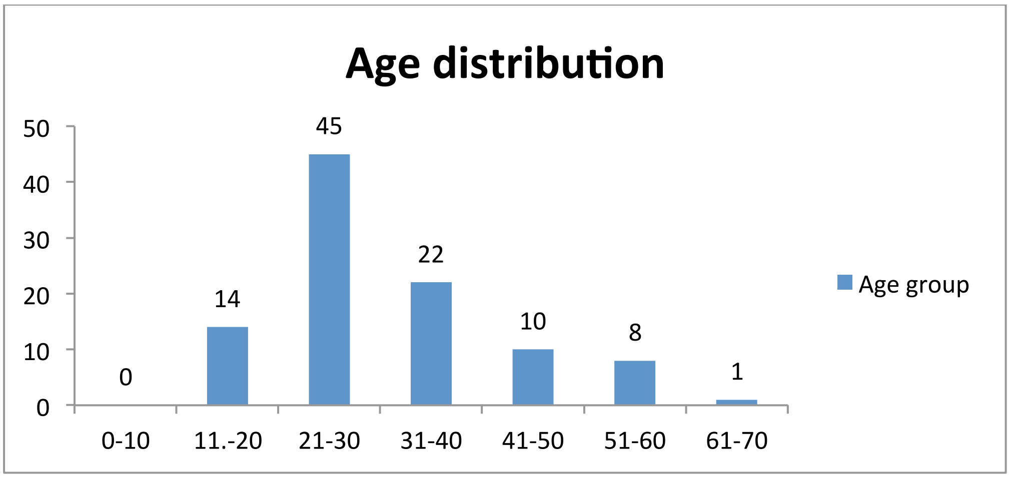


Chart 1/Bar chart showing age distribution

Sex Distribution:

Our study included 91 males and 9 females. Male to female ratio is 9: 1

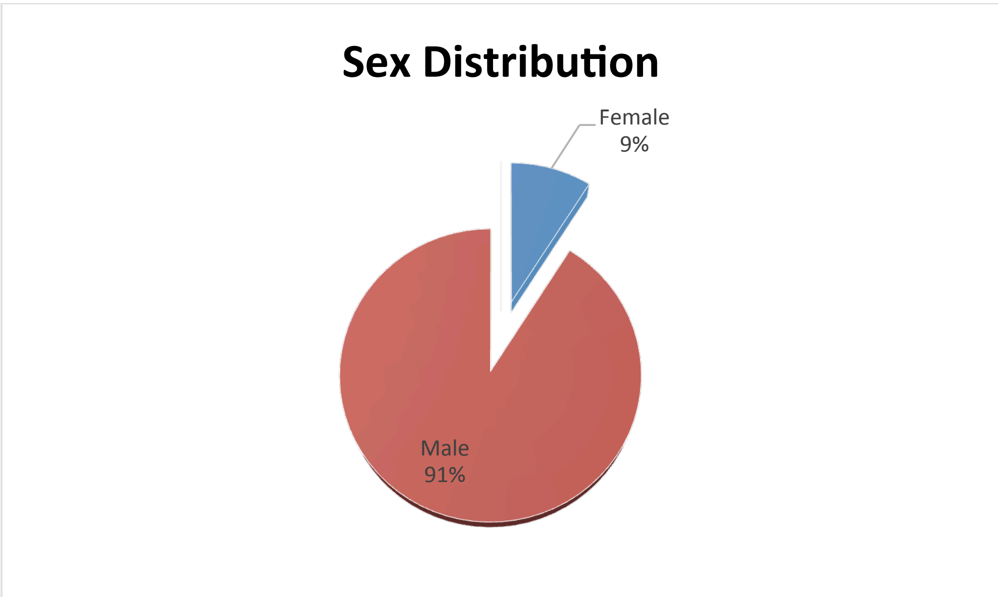


Chart 2/Pie Diagram of Sex Distribution

Mode of injury

The patients were sub grouped based on the type of vehicle they drove, rode or travelled in.

Group	n=100
2 wheeler rider	65
2 wheeler pillion	16
3 wheeler driver	1
3 wheeler passenger	4
4 wheeler driver	2
4 wheeler passenger	4
Public transport	4
Pedestrian	4

Table 3- Mode of injury

The two wheeler riders were the most commonly affected group (65 patients) followed by pillions (16 patients). 4 patients were pedestrians who were hit by other vehicles and 4 were passengers in a public transport.

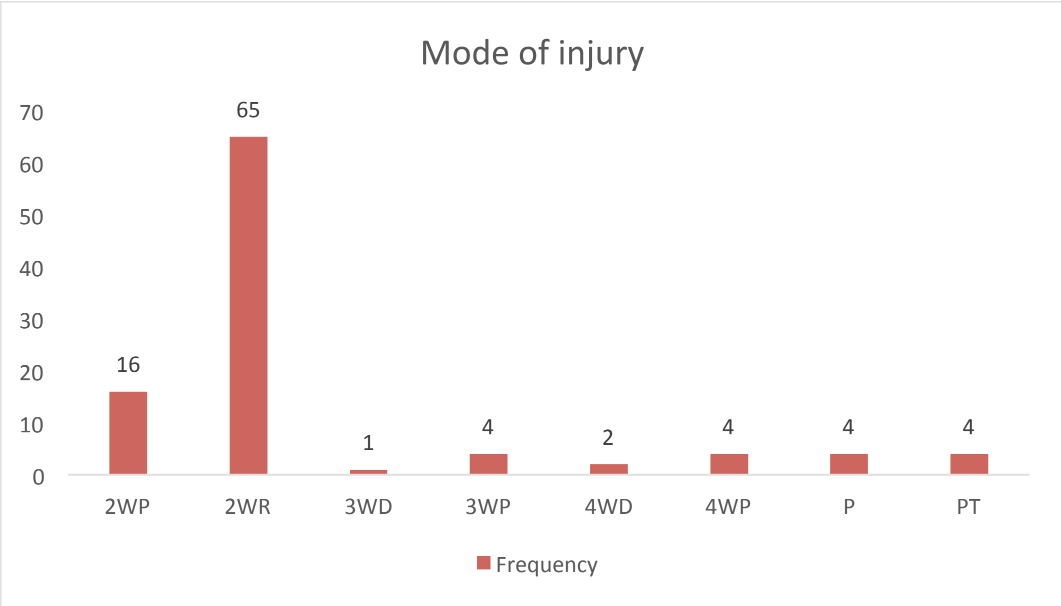


Chart 3/ Bar chart showing mode of injury

Oral and Nasal bleed

45 patients presented with Oral bleed and 75 patients with nasal bleed most of which stopped spontaneously. 7 patients required nasal packing to control the bleeding. Rest, were managed conservatively.

	No of patients
Oral bleed	45
Nasal bleed	75

Table 4- Oral & Nasal bleed

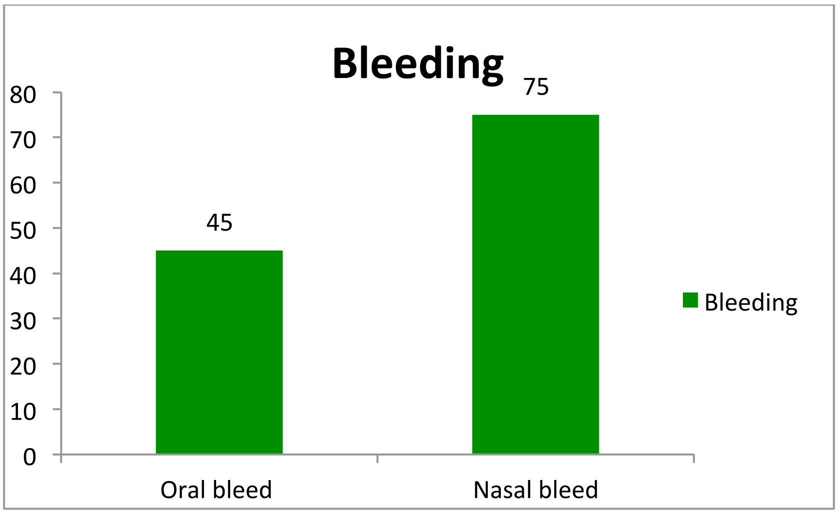


Chart 4/Bar chart showing oral and nasal bleed

Upper Airway Obstruction

10 patients had upper airway obstruction due to mandibular fracture and gross soft tissue edema for which tracheostomy had to be done.

Soft tissue injuries

Most of our study population had associated soft tissue injuries, commonest was facial oedema/swelling in 71 patients, abrasions in 64 patients and lacerations of varying severity in 63 patients.

Type of soft tissue injury	No of patients
Abrasion	64
Laceration	63
Swelling/Oedema	71

Table 5- Soft tissue injury

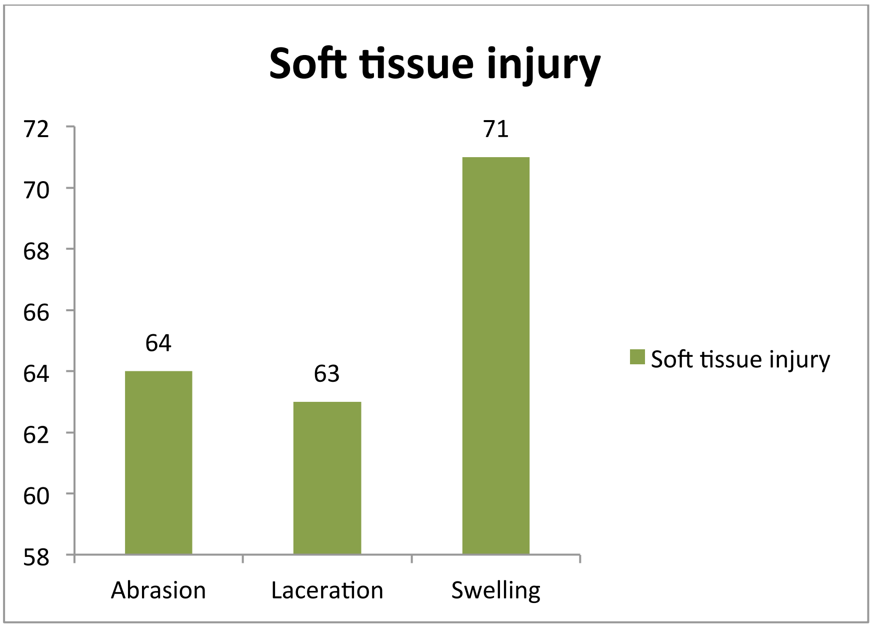


Chart 5/Bar chart showing incidence of soft tissue injuries

Radiological Evaluation

76 patients included in our study were evaluated by CT scan of the head and facial skeleton and the pattern of fractures of maxillofacial fractures were studied. In addition to CT scan, plain radiographic evaluation was used in selected patients such as those who had suspicion of only isolated maxillofacial fractures, those who could not afford CT scan and few patients who required intervention and as an adjuvant to CT scan before surgical intervention as shown below:

Type of X ray	Numbers
Nasal bones (Lateral view)	7
Paranasal sinuses (Water`s view)	22
Mandible (Lateral oblique view)	34

Table 6- Evaluation by plain radiograph

In 7 cases nasal bone fractures were evaluated using X ray nasal bones lateral view.

X ray of the mandible (lateral- oblique) was used in 34 patients with mandibular fractures before surgical intervention. X-ray paranasal sinuses, Waters view was used to evaluate 22 patients with mid face fractures.

Fractures

64% of our patients suffered multiple facial fractures. Among the 100 patients studied, only 36 had isolated bone fractures. The commonest facial bone fractured was the maxilla (58%), followed by nasal bone and orbit.

Fracture	**No of patients**
Frontal bone	26
Nasal bone	43
Orbit	41
Zygoma	37
Maxilla	58
Mandible	33
Le Fort	13

Table 7 – Pattern of facial fractures

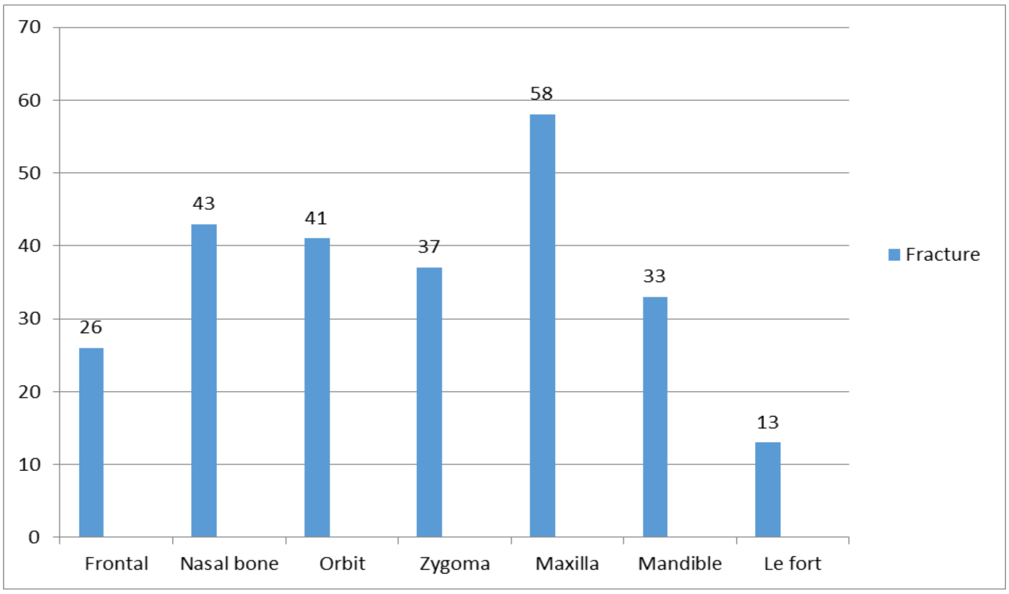


Chart 6/Bar Chart showing pattern of fractures

Frontal bone fractures

26 patients had frontal bone fractures.

Anterior table alone was fractured in 25 patients and both tables were fractured in one patient. None of our study population suffered isolated posterior table fracture. All the patients were managed conservatively for frontal sinus fractures.

Location of frontal fracture	**No of Patients**
Anterior table	26
Posterior table	-
Both Tables	1

Table 8- Pattern of frontal sinus fractures

Nasal bone fractures

43% patients had nasal bone fractures, which were classified into five types (as per table 1)

Type	Type of fracture	n=43
I	Simple straight	21
II	Simple deviated	11
III	Communition of nasal bones	9
IV	Severely deviated nasal and septal fractures	2
V	Complex nasal and septal fractures	0

Table 9- Pattern of nasal bone fractures

Type I nasal bone fracture was the commonest type encountered in our study (21 cases).

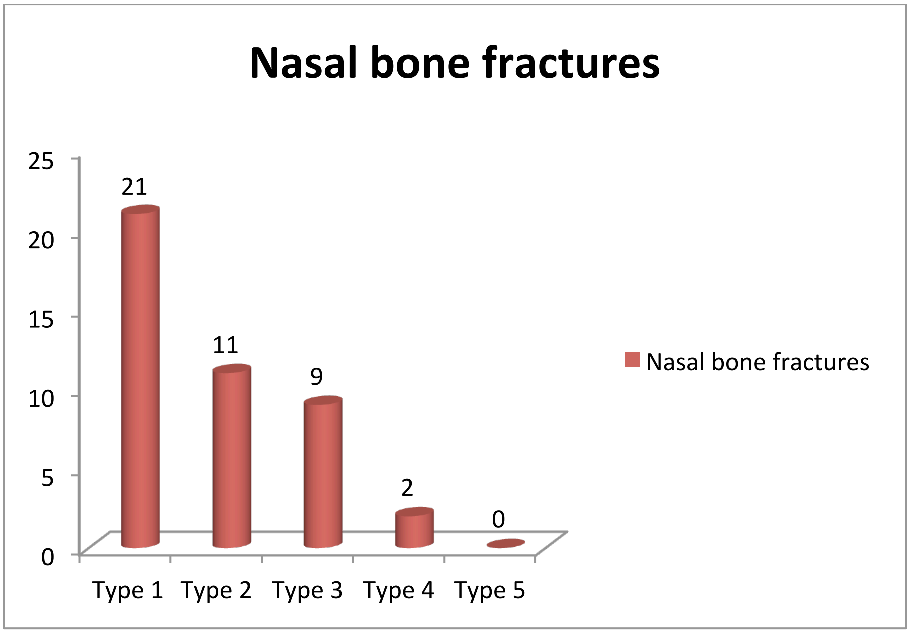


Chart 7/Bar chart showing pattern of nasal bone fractures

Five patients required closed reduction; the rest were managed conservatively. Eight patients with nasal bone fracture had associated head injury.

Orbital fractures

41 patients in our study had orbital wall fractures, a total of 47 fractures were documented. Lateral orbital wall fracture was the commonest encountered fracture. One patient suffered globe rupture and underwent enucleation.

Location of orbital fracture	n=47	%
Roof	6	12.7%
Medial wall	7	14.8%
Lateral wall	29	61.8%
Floor	5	10.7%

Table 10- Pattern of orbital fractures

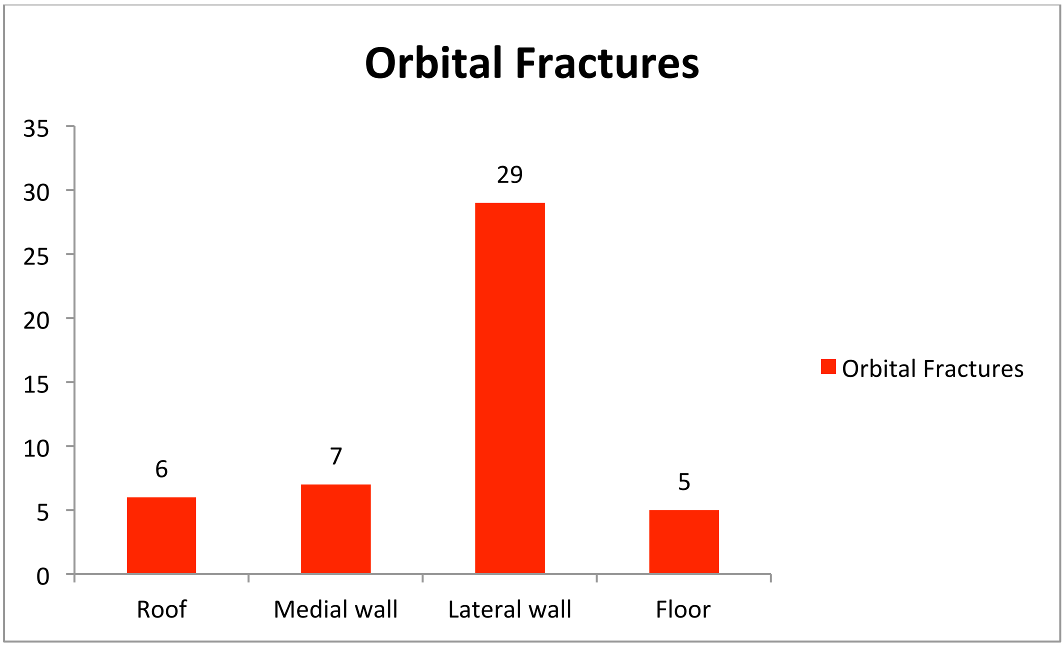


Chart 8/ Bar chart showing pattern of orbital fractures

Zygoma fractures

37 patients had a zygoma fracture. These included 23 fractures of the zygomatic arch and 12 fractures of the body of zygoma and combined fractures in 2 patients. The fractures were simple and undisplaced in 27 patients and displaced in 10 patients.

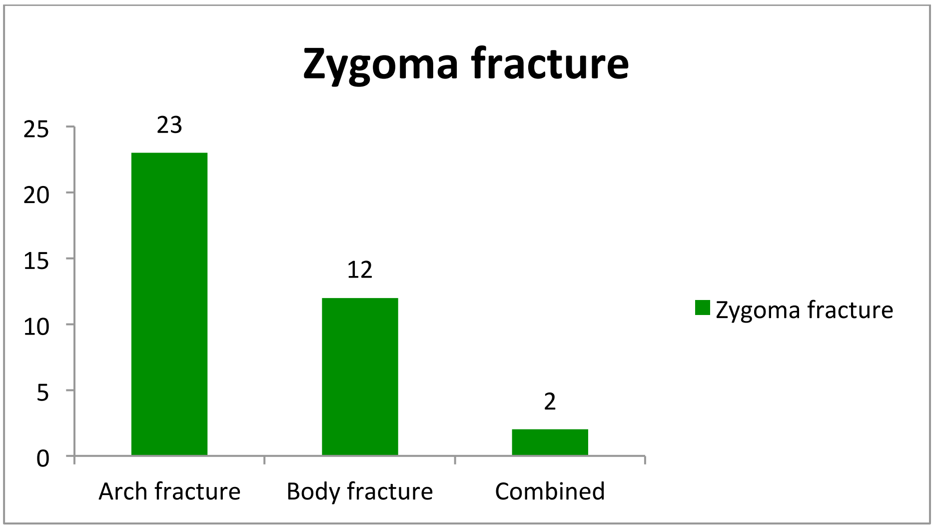


Chart 9/Bar chart showing patterns of zygoma fracture

One patient with zygoma fracture required gillies approach for open reduction and internal fixation.

Maxilla fractures

Maxilla is the most common fractured facial bone in our study (58 patients). Among 58 patients, 45 patients suffered unilateral maxillary fracture and 13 had bilateral fractures. Anterior wall of the maxilla was the commonest site of fracture (57 patients).

Pattern of maxilla fracture	No of cases
Anterior wall	57
Posterior wall	29
Lateral wall	52
Medial wall	32
Floor	2

Table 11- Patterns of maxilla fractures

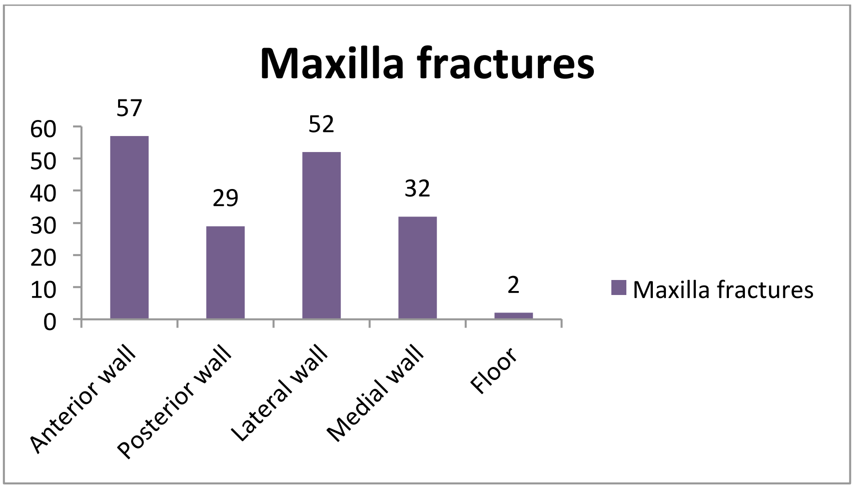


Chart 10/Bar chart showing patterns of maxilla fractures

Le Fort fractures

Only 13 patients had a classical patterned Le fort fracture. Type II Le fort was the commonest fracture type encountered in our study.

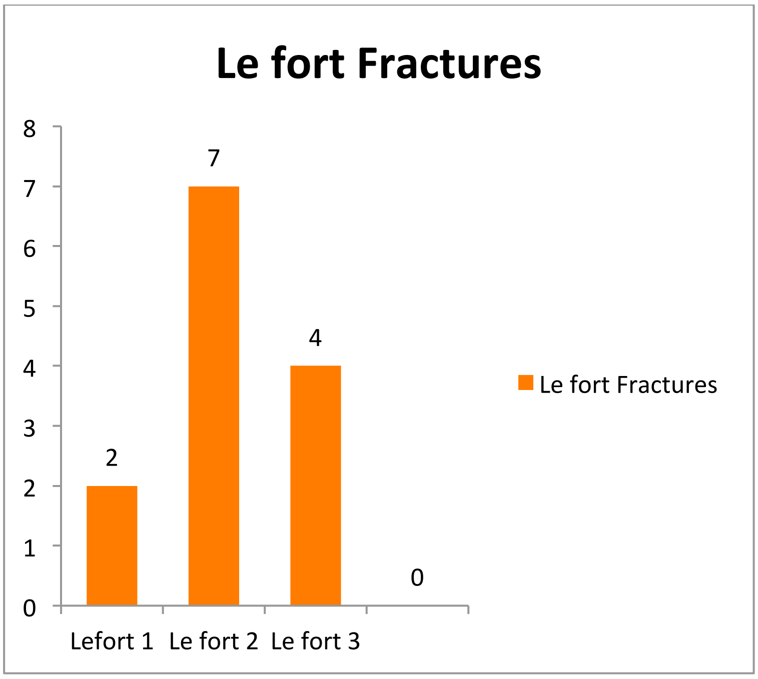


Chart 11/ Bar chart of Le Fort fractures

All 13 patients underwent open reduction and internal fixation with plate and screws.

Mandible Fractures

33 patients suffered mandibular fractures. A total of 43 fractures were documented. Parasymphysis fractures were commonly encountered (22 cases). All fractures of the mandible required open reduction and internal fixation with plate and screws.

Location of fracture	No of cases
Condyle	3
Subcondyle	4
Ramus	2
Angle	3
Body	5
Parasymphysis	22
Symphysis	4

Table 12- Location of mandible fractures

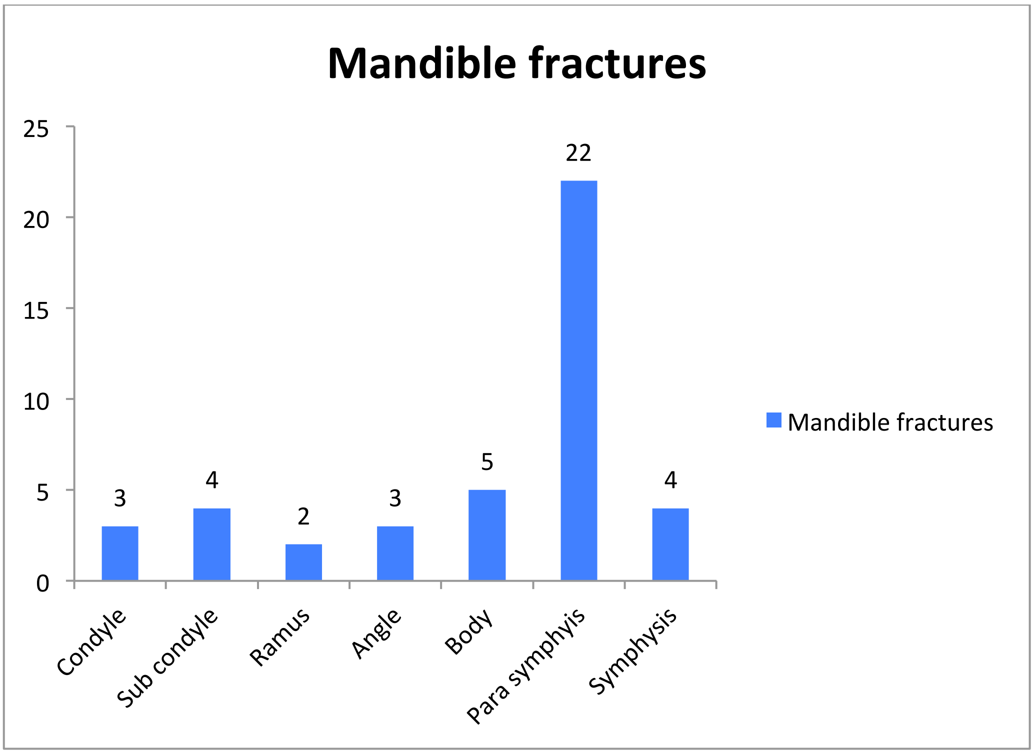


Chart 12/Bar Chart showing Mandibular fractures

Head Injury

21 patients suffered from head injury as documented by CT Brain in the form of Extradural, Subdural, Sub arachnoid or Intra cerebral haemorrhage and contusions.

Type of Head Injury	No of patients
Sub arachnoid hemorrhage	5
Subdural hemorrhage	8
Extradural hemorrhage	7
Intra cerebral bleed	3
Contusion	6

Table 13- Type of head injury

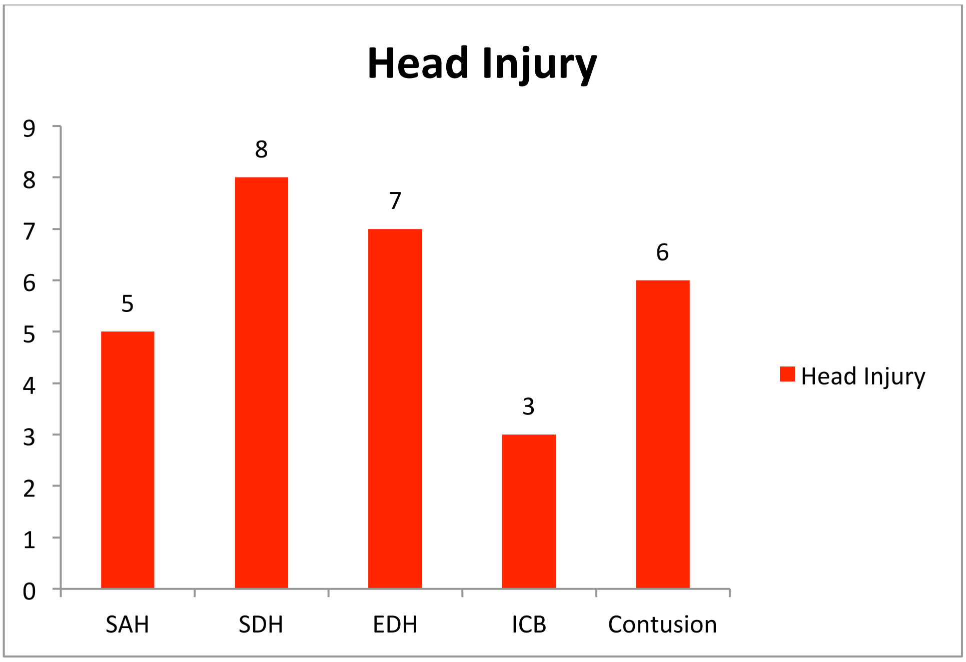


Chart 13/ Bar Chart showing type of head injury

The commonest type of head injury was subdural hemorrhage followed by extradural hemorrhage and Contusions. 19 patients with head injury had multiple facial bone fractures.

Facial nerve Palsy

One patient in our study developed delayed facial palsy of lower motor neuron type and was managed conservatively by oral steroids. There was no obvious compression of the facial nerve on high resolution CT scan. Patient recovered 3 months later with conservative treatment.

Intervention

In the emergency room, Interventions were done to control bleeding and secure the airway. Seven patients underwent nasal packing, both conventional and merocel packing. 19 patients underwent tracheostomy, of which 10 were for upper airway obstruction and 9 were for prolonged intubation.

18 patients underwent inter maxillary fixation for temporary stabilization of fractures. Five patients with nasal bone fractures underwent closed reduction. 40 patients underwent Open reduction and internal fixation the indications of which were fracture mandible in 33 cases and midface fractures in the rest. All 13 patients with Le Fort fractures and one patient with zygoma fracture and one with unilateral maxilla fracture underwent Open reduction and fixation with plate and screws.

Majority of the facial fractures documented by CT scan were managed conservatively (48 patients).

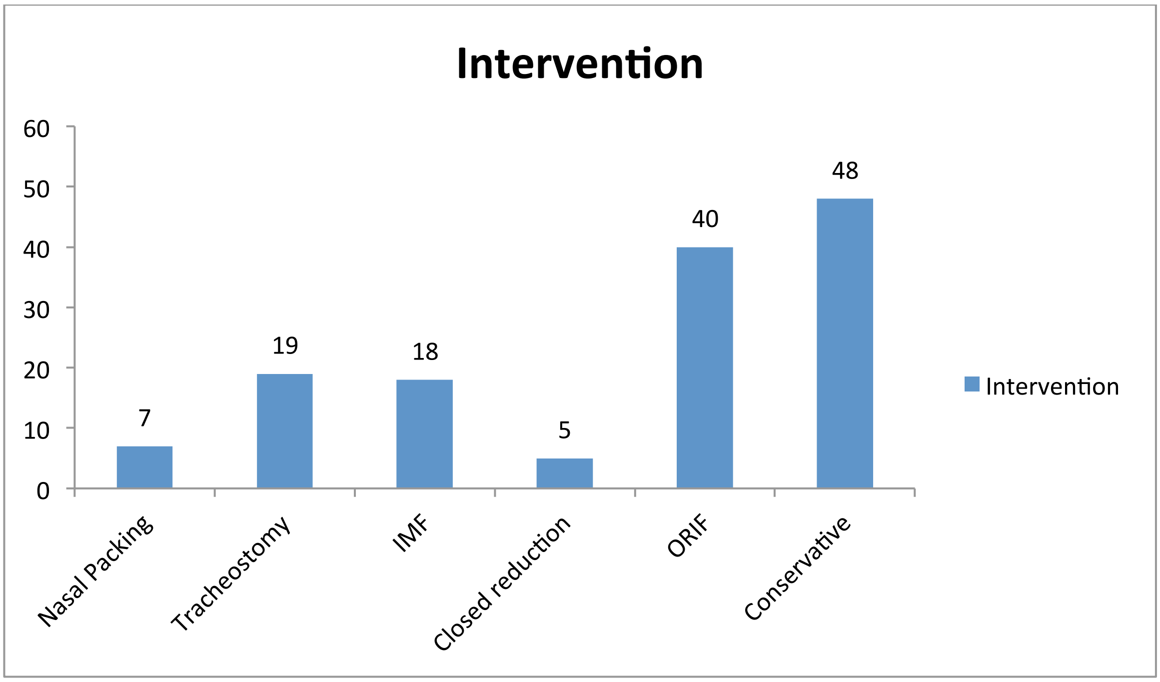


Chart 14/ Bar chart showing intervention done

Complications

11 patients in our study developed complications following maxillofacial injury during the three month follow up period (11%).

Malocclusion was the commonest complication in our study (8 patients). This complication was documented in patients with Le Fort and Mandibular fractures.

3 patients underwent correction by open reduction and internal fixation and five patients were lost to follow up. Wound infection was documented in 4 cases. Wound swab was taken in all cases and analysed by culture and sensitivity. Appropriate antibiotic therapy was started and all wound infections responded to treatment and were resolved within a week.

Four patients had CSF rhinorrhoea, among them one was secondary to fracture of both tables of frontal sinus, and three secondary to naso ethmoid fractures. Among them, two required endoscopic repair.

	No of cases
Secondary wound Infection	4
Malocclusion	8
Chronic sinusitis	0
Non union	0
Anosmia	0
CSF Leak	4

Table 14- Incidence of complications

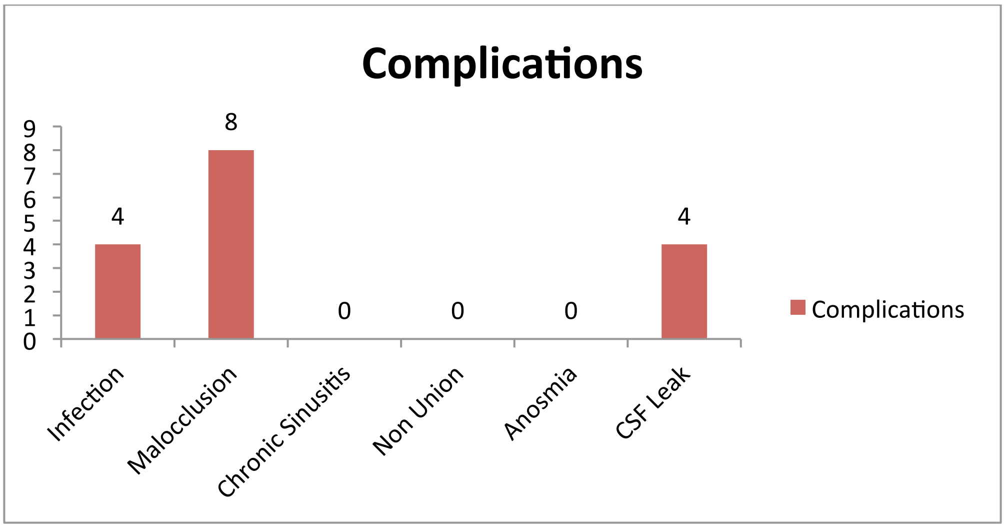


Chart 15/ Bar chart showing incidence of complications

DISCUSSION

The pattern of maxillofacial injuries varies from one geographical area to another depending on the prevailing socioeconomic, cultural, geographic and environmental factors.[6] Road traffic accidents are the major cause of maxillofacial trauma in our country and around the world. This has been proved by various studies in developing and developed countries.[6]

There is a paucity of studies which deal with maxillofacial injuries due to road traffic accidents alone. Most of the existing studies include maxillofacial injuries due to other causes - assaults, sports injuries, industrial accidents, fall from height, as well. The male predominance in our study agrees with what is reported in the literature.[1,6,8,9,21] Males are at a greater risk of accidents and maxillofacial injuries because of the increased use of vehicles and travel compared to females.

91 % of our patients were males and the male to female ratio in our study was 9:1. This was comparable to other studies by Kapoor et al[12] and Singh et al.[13]Both the retrospective studies included more than 1000 maxillofacial trauma cases.

The mean age in our study was 32.08 years which was comparable to the studies by Ozkaya[8], Chalya [6] and Kapoor et al[12].

The peak incidence of maxillofacial injuries was in the age group 21-30 years which was in concordance with all the other studies.[1,6,8,9,12,13,17,18,21] This is because of the increased use of vehicles and travel in the third decade of life.

The most common etiological factor for maxillofacial injuries is road traffic accidents in our country. This has been proved by several studies.[6,8,9,13]

A large majority of the cases (81%) were two wheeler riders or pillions. Second largest group were 3 wheeler travellers (5%). In the study by Subhashraj et al[9], 62% cases were two wheeler riders and 23% were four wheeler passengers. It was alarming that only one out of the 81 two wheeler passengers in our study used helmet. This is due to a lack of awareness and the leniency of traffic rules in the rural areas of the state.

Soft tissue injuries were the commonest type of maxillofacial injury throughout the literature. We primarily aimed at studying the patterns of maxillofacial fractures as documented by radiological investigations. However in our study, soft tissue injuries were documented as abrasions in 64%, lacerations in 63% and contusions/swelling in 71% cases. The incidence of soft tissue injuries in our study was 97% higher than in other studies[5,6]. The overall incidences of soft tissue injuries were higher in our study as compared to other studies.

Bleeding from oral (45%) and nasal (75%) cavities were the commonest presenting symptom in our study. Most of the bleeding was managed conservatively as they stopped spontaneously. 9.33% patients required a nasal pack to control the bleeding. Conventional nasal packs and merocil nasal packs were used for anterior nasal bleeding and foley`s catheter for posterior bleeds. 10% of our patients had upper airway obstruction due to mandibular fractures or gross soft tissue oedema which warranted a tracheostomy.

In our study, 76 patients underwent CT scan of the head and face to evaluate fractures of the facial skeleton and also for evaluation of associated head injury.

Xray lateral oblique view of the mandible was taken in 34 patients, most of whom had isolated mandibular fractures clinically and those planned for surgical intervention. Water`s view radiograph of the paranasal sinuses was taken in 22 patients, most of whom were planned for intervention or in whom isolated injury of the midface was clinically suspected. Lateral Xray of the nasal bones were taken in 7 patients to confirm the clinical suspicion of fracture.

Plain radiograph may be indicated in isolated maxillofacial fractures and for follow up as was in our study where plain radiographs were most often used to evaluate isolated fractures. But plain radiographs suffer from inherent limitation of anatomical superimposition and soft tissue edema obscuring the fracture.[35] Hwang et al[36] evaluated 503 nasal bone fractures using lateral and water`s view and only 82% of nasal bone fractures were identified.

CT scan is the preffered imaging modality for multiple and complex maxillofacial injuries, it offers excellent bone details especially in case of mid face fractures which have a complex anatomy and also to evaluate associated head injury.[35] Most of our patients were evaluated by axial sections of CT scan. Coronal sections were used in patients who are stable and with no cervical spine injury.

Maxilla fracture was the commonest (58%) of which majority were unilateral maxillary fractures (45%), requiring no surgical intervention and anterior wall being commonly fractured (57%). The incidence complex fracture, Le fort`s was 13% of which Le fort 2 was the commonest. All the 13 Le Fort fractures were managed by Open reduction and internal fixation.

The commonest and the second most commonly fractured bones in comparison with other studies –

Table 15- Comparison of commonest fractured bone between studies

	Commonest bone fractured	Second commonest fracture
Kapoor et al[12]	Mandible (63%)	Midface (22%)
Chalya et al[6]	Mandible (70.4%)	Nasal bone (11.1%)
Obuekwe et al[39]	Mandible (29.2%)	Zygoma (18%)
Subhashraj et al[9]	Mid third (37%)	Mandible (16%)
Singh et al[13]	Mandible (47.88%)	Maxilla (26.49%)
Our study	Maxilla (58%)	Nasal bone (43%)

Mandible is the commonest fractured bone in most of the other studies. This is because of the fact that most of these studies were retrospective studies on patients who had undergone intervention in the hospital and most of the studies included maxillofacial injuries due to various causes.

The second commonest bone fractured were the Nasal bones(43%). The incidence of nasal bone fractures was 11.1% in a prospective study of maxillofacial injuries due to various causes, the predominant cause of injury being road traffic accidents.[3]Nasal bone fractures were classified into five types and their patterns studied. These were compared to the studies by Yilmaz[16] and Ondik[17].

	Type 1	Type 2	Type 3	Type 4	Type 5
Yimaz et al[16]	25%	50%	25%	-	-
Ondik et al[17]	9.3%	37.2%	13.9%	31.4%	8.1%
Our study	48.8%	25.5%	20.9%	4.6%	-

Table 16- Comparison of types of nasal bone fratures

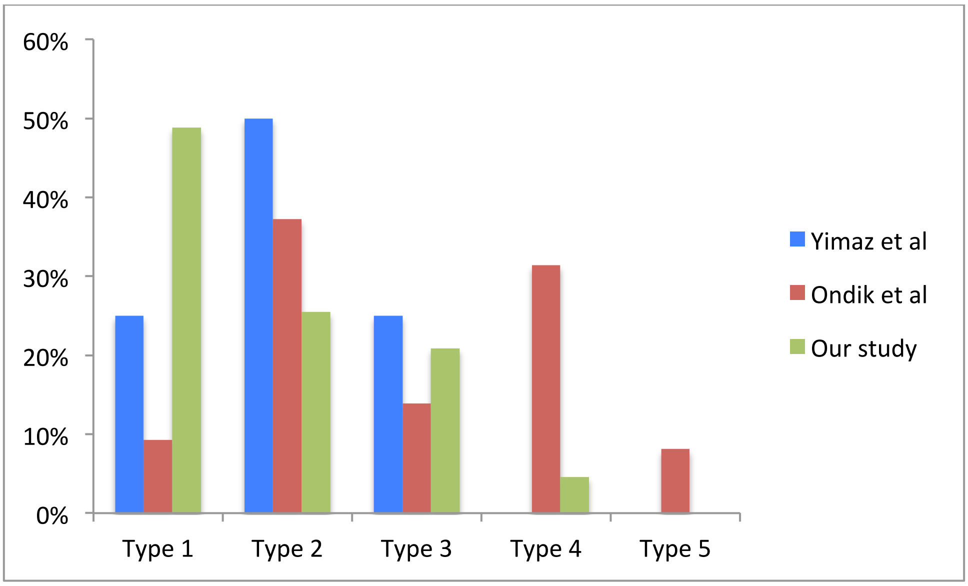


Chart 16/ Bar chart comparing patterns of nasal bone fractures with other studies

Type 1 nasal bone fractures were the commonest in our study as against Type 2 fractures in the above mentioned studies. The disparity may be due to the fact that our study was a descriptive one, whereas the above said studies were retrospective and the study population were patients who required hospitalization and intervention. Type 4 and type 5 fractures were not that common in our study.

Twenty six patients suffered from fontal bone fractures in our study with anterior table (96%) fractures being the commonest. Only 1 patient in our study had bitable fracture. Study of 33 patients who suffered from frontal sinus fractures, 63% were anterior table fractures, 33% were bitable fractures and 3% were isolated posterior table fractures.[37]Retrospective study of 875 frontal sinus fractures ,the incidence of posterior table fracture was 7.7%.Anterior table fractures being the most commonest type encountered.[15] Isolated posterior table fractures although rare, are usually associated with intracranial complications.

Orbital fractures were the third commonest fracture in our series (41%).Lateral orbital wall fracture was the commonest type of orbital fractures (61.8%). Various studies quote the medial orbital wall to be commonly involved.[38]This variation may be due to the mode of injury sustained.The floor of the orbit was the least injured structure in our study.

Zygoma was fractured in 37% cases, which included undisplaced (27%) and displaced fractures (10%).In studies by Obuekwe et al[39] and Menon et al[18] the incidence of zygoma fractures were 18% and 31.7%. Of the 37 fractures of the zygoma, arch fractures were the commonest(62.1%).In the study by Adam[19], body of zygoma were commonly fractured (57.7%) followed by combined fractures and isolated arch fractures.

Le fort fractures were present in 13 % cases, with Le fort 2 being the commonest (7%) which was in concordance with other studies, dealing with maxillofacial injuries predominantly caused by road traffic accidents.[9,13]

	Le fort 1	Le fort 2	Le fort 3
Subhashraj et al[9]	12.4%	17.7%	5.6%
Singh et al[13]	2.2%	22.2%	1.63%
Our study	2%	7%	4%

Table 17- Comparison of Le fort fractures

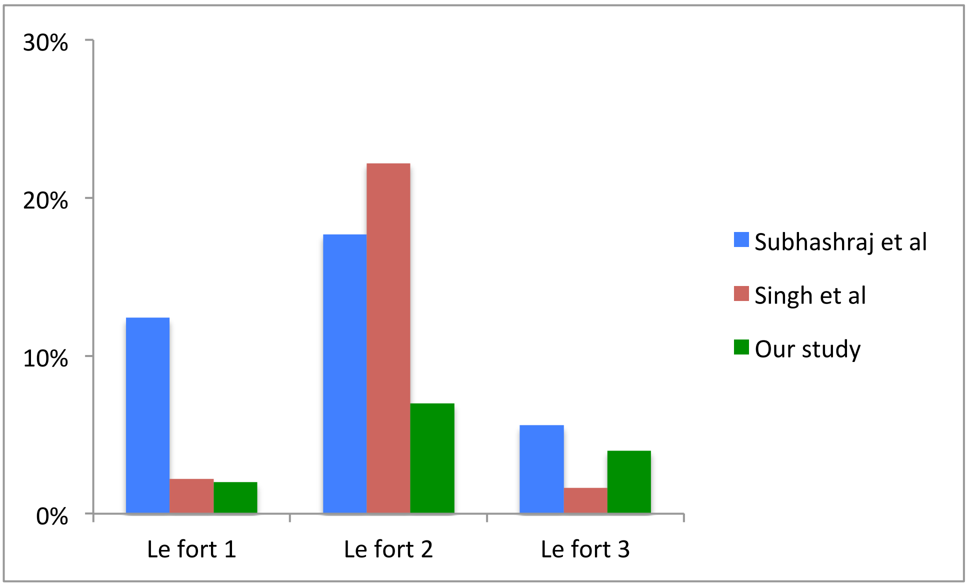


Chart 17/ Bar chart comparing Le fort fractures with other studies

Mandible fractures showed a 33% incidence which was comparable to the studies by Obuekwe et al[39] and Subhashraj et al.[9]

	Incidence of mandibular fractures
Kapoor et al[12]	63%
Obuekwe et al[39]	29.2%
Subhashraj et al[9]	16%
Singh et al[12]	47.8%
Our study	33%

Table 18- Comparison of the incidence of mandible fractures

Among mandibular fractures, parasymphysis was the commonest site fractured (66% of mandible fractures). These were compared to the fractures described in studies by Andreas et al[40] and Natu et al[41] from which only RTA cases were isolated and compared and study by Singh et al and Subhashraj et al in which the major aetiology of fracture was RTAs (97.1% cases and 85% cases respectively).

	Andreas et al[40]	Subhashraj et al[9]	Singh et al[13]	Natu et al[41]	Our study
Parasymphysis		31%	45.2%	31.8%	66.6%
Symphysis	36.6%	11%	4.2%	4.5%	12.1%
Body	5%	8%	51.5%	22.7%	15.1%
Angle	6.5%	12%	26.9%	15.2%	9.09%
Ramus	0.5%	5%	1.6%	1.5%	6.06%
Condyle/ Subcondyle	50.2%	19%	27.1%	21.2%	21.2%

Table 19- Comparison of the location of mandible fractures

Parasymphysis as the commonest location of mandible fracture in our study was in concordance with the studies by Natu et al[41] and Subhashraj et al[9]. Symphysis and body of mandible were the commonest in other studies.

There is a close relationship between the presence of accompanying head injury in patients with maxillofacial fractures. Head injury, documented by CT scan as contusion or intra cranial bleed was reported in 21% cases. 13 of these patients (61.9%) required a neurosurgical intervention. A higher incidence of head injuries were noted in the studies by Subhashraj et al[9] (39%), Chalya et al[6] (52.9%) ,Obuekwe et al[39] (55.8%).

An analysis of various studies dealing with maxillofacial trauma due to various aetiologies has revealed an average incidence of associated head injury to be around 40.8%.

Head injury is the commonest associated injury in maxillofacial fractures. Multiple fractures were seen to be commonly associated with head injury. Of the 21 patients with head injury in our study, 19 (90.4%) had multiple facial bone fractures. Hence, screening for head injury by CT scan becomes important in patients with multiple facial fractures.

Subdural haemorrhage was the commonest documented head injury in our study (8%) followed by Extradural haemorrhage. In the study by Isik et al[21], skull fractures were more commonly documented (6.09%) than intracerebral haemorrhage (3.65%).

There are many treatment regimes in maxillofacial fractures, but the choice and timing of the definitive treatment varies according to the type and location of the fracture, the patient factors, associated injuries and surgeon`s choice. Each patient and each fracture differ in certain properties and so standardization is not possible.

Nasal packing and tracheostomy are the primary interventions that are done in the Emergency room. Temporary IMF (Intermaxillary fixation) is done to stabilize the fractures. Closed reduction is also advocated especially for nasal bone fractures. However, open reduction and internal fixation is the gold standard of treatment for maxillofacial fractures. It can be done using miniplate with screws, elevation and reduction procedures for zygoma fractures. 40% of our patients were managed by open reduction and internal fixation, 5% by closed reduction and intermaxillary fixation in 18% cases.

Nasal packing was done in the emergency room in 7% cases and tracheostomy was done either for upper airway obstruction or prolonged intubation as for head injury in 19% cases.

In contradiction to the studies by Ozkaya et al and Singh et al, majority of our cases (48%) were managed conservatively. 40% of our cases underwent Open reduction and internal fixation as against 70% and 80% in the above mentioned studies.

The overall complication rate in our study was 11% whereas it varies between 7-29% in various other studies.[6] In concordance with other studies[8], malocclusion was the commonest complication encountered in our series. The differences in complication rates between several studies can be explained by differences in the severity of fractures and their management.

Infection and malocclusion are the two most common complications in maxillofacial fractures. The overall infection rate was around 4% in our study in comparison to 5.6% in the study by Ahmed et al.[42] This low rate of infection was because of the usage of prophylactic antibiotics. In our study, all cases with wound infection resolved with antibiotics and did not require surgical debridement. There was no evidence of osteomyelitis. In a study of 64 patients with compound mandibular fractures, Zallen and Curry found a complication rate of 50.3% in patients who did not receive prophylactic antibiotics compared with a complication rate of 6.25% in those who did.[23]

Malocclusion was the commonest complication in our study, 8% of the total cases. 7 patients with malocclusion had combined mandibular and maxillary fractures and one from isolated mandibular fracture. All these patients had undergone open reduction and internal fixation. Thus, 20% of the patients who underwent open reduction and internal fixation developed malocclusion. In a study of 1024 patients with maxillofacial trauma by Brasileiro et al, 19% developed malocclusion.[24]

Four of our patients developed post traumatic CSF rhinorrhoea. Three of these were secondary to midface (nasoethmoid fracture) and one was secondary to fracture of both tables of frontal sinus. These patients underwent high resolution CT scan to identify the defect. Two patients with nasoethmoid fracture who had CSF rhinorrhoea required endoscopic repair and the rest resolved spontaneously with bed rest, head end elevation and oral glycerol. In the study by Bell et al, 85% of the post traumatic CSF rhinorrhoea closed spontaneously.[43]

Oral hygiene of the patient and nutritional status are also factors leading to complications like infection and malocclusion thereafter.[3, 8]

CONCLUSION

- Multiple facial bone fractures involving the midface region are common in road traffic accidents. These are usually associated with soft tissue injuries. The maxilla, is most commonly involved in midfacial fractures. Among the complex fractures Le Fort type II was the most common.
- Type 1 nasal bone fracture was the most common isolated facial bone fracture
- Clinical and radiological evaluation is required for early detection and adequate treatment in maxillofacial injuries.
- Complications were more common in fracture of the midface region. Malocclusion, the commonest complication, was more profound in combined fracture of maxilla and mandible.
- There is paucity of studies dealing with maxillofacial trauma secondary to road traffic accidents and further studies are required in this regard

SUMMARY

Our study was conducted on hundred road traffic accident cases with maxillofacial injuries and the patterns of maxillofacial injuries were studied by clinical and radiological methods. Road traffic accident is reported to be the leading cause of maxillofacial fractures.

It was noted that males are at a higher risk of maxillofacial injuries in road traffic accidents than females and the incidence of maxillofacial injuries is higher in the third decade of life. Two wheeler riders were found to be at a higher risk of maxillofacial injuries.

Soft tissue injury is the commonest type of injury in maxillofacial trauma due to road traffic accidents. Head injury is the commonest associated injury in maxillofacial fractures and is commoner in patients with multiple facial bone fractures.

The commonest facial bone fractured as a result of road traffic accidents was found to be the maxilla, in 58% cases, followed by the nasal bone and the orbital bone. Fracture of anterior table of frontal bone was the commonest among the three types of frontal bone fractures. In our study, Le fort II was the commonest type of midface fractures. Type 1 (simple undisplaced) fractures were the commonest type of nasal bone fractures in our study. Parasymphysis was the commonest part of mandible fractured in road traffic accidents.

The gold standard of treatment of maxillofacial fractures is open reduction and internal fixation but the timing of the definitive treatment depends on the associated injuries, surgeon`s choice and location of the fracture. 48% of the fractures in our study were managed conservatively and 40% by open reduction methods. 11% of our patients developed complications in a three month follow up period and malocclusion was the commonest of them.

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Annexure -1

PROFORMA OF CASE SHEET

A clinical study of MAXILLOFACIAL injuries in RTA

DEPT OF ENT

Case No.

1.Name **2.Age/Sex**

3.D.O.A **4.Hospital No**

5.History

a.Mode of the accident

Pedestrian

Two wheeler – Rider /Pillion Helmet

Three/Four wheeler

Others

b.History

LOC- Present/Absent

Seizures- Present/Absent

Vomiting- Present/Absent

Nasal bleed- Present/Absent R / L /Both

Oral bleed- Present/Absent

Diplopia - Present/Absent

Numbness on face- Present/Absent

Pain on opening mouth- Present/Absent

Difficulty in opening the mouth- Present/Absent

Breathing difficulty- Present/Absent

Swallowing difficulty- Present/Absent

Watery nasal discharge- Present/Absent R/ L/ Both

6. Examination

INSPECTION

Abrasion

Laceration

Swelling

PALPATION

Tenderness

Orbital margins- Normal / Deranged

Nasal bones – Crepitus Tenderness

Zygoma- Displaced/ Undisplaced

Infraorbital area- Normal/ Anaesthesia/ Parasthesia R / L / Both

Zygomaticomaxillary complex – Normal / Deranged

Condylar movement- Normal/ Deranged

Mandible- Normal / Deranged

Mental nerve- Normal/ Anaesthesia/ Parasthesia R / L / Both

Maxilla- Normal / Deranged

Nasoethmoid complex- Normal / Deranged

INTRA ORAL

Mouth opening- Adequate/ Reduced

Laceration in mucosa-

Swelling-

Teeth

Occlusion- Normal / Deranged

Movement of mandible- Normal / Deranged

HEAD INJURY STATUS

GCS-

7.INVESTIGATIONS

X ray

CT Scan

8.MANAGEMENT

Conservative – Antibiotic

Analgesic

Nasal packing

Tracheostomy

IMF

Fracture reduction

Closed reduction

ORIF

Annexure-2

Key to Master Chart

MOI	Mechanism of injury
2WR	2 wheeler rider
2WP	2 wheeler pillion
3WD	3 wheeler driver
3WP	3 wheeler passenger
4WD	4 wheeler driver
4WP	4 wheeer passenger
PT	Public transport
P	Pedestrian
HI	Head injury
SAH	Sub arachnoid hemorrhage
SDH	Subdural hemorrhage
EDH	Extradural hemorrhage
ICH	Intracerebral hemorrhage
Ct	Contusion
FP	Facial palsy
O.bl	Oral bleed
N.bl	Nasal bleed
UAO	Upper airway obstruction
Abr	Abrasion
Lac	Laceration

Swell	Swelling
NB	Nasal bone
B	Bilateral
AT	Anterior table
PT	Posterior table
R	Roof
M	Medial wall
L	Lateral wall
P	Posterior wall
F	Floor
A	Anterior wall
S	Simple fracture
D	Displaced fracture
Zyg	Zygoma
LF 1	Le fort 1 fracture
LF 2	Le fort 2 fracture
LF 3	Le fort 3 fracture
PS	Parasymphysis
Bo	Body
SC	Subcondyle
C	Condyle
Sy	Symphysis
Ra	Ramus
An	Angle

NP	Nasal packing
Trach	Tracheostomy
IMF	Intermaxillary fixation
CR	Closed reduction
ORIF	Open reduction & internal fixation
Cons	Conservative treatment
Maloccl	Malocclusion
Chr.S	Chronic sinusitis
0	No fracture
1	Fracture present