THE PATTERN OF MAXILLO-FACIAL FRACTURES IN HOSPITAL UNIVERSITI SAINS MALAYSIA: A RETROSPECTIVE STUDY OF RECENT 5-YEARS

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by

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LIST OF ABBREVIATIONS

MMF	Maxillo-facial fracture
RTA	Road traffic accident
IPV	Interpersonal violence
VAP	Violence Prevention Alliance
USM	Universiti Sains Malysia
WHO	World Health Organization
MVA	Motor vehicle accident
MCA	Motorcycle accident
MIROS	Malaysian Institute of Road Safety Research
OMFS	Oral & Maxillofacial Surgery
ZCF	Zygomatic complex fracture
NOE	Nasal orbito ethmoidal
F	Fracture
ORIF	Open reduction and internal fixation
IMF	Inter maxillary fixation

POLA KEPATAHAN TULANG MAKSILOFASIAL DI HOSPITAL UNIVERSITI SAINS MALAYSIA: KAJIAN RETROSPEKTIF 5-TAHUN KEBELAKANGAN INI

ABSTRAK

Pola kepatahan tulang maksilofasial telah didapati berubah dengan masa bergantung kepada keadaan sosio-ekonomi, kedudukan mukabumi, pelajaran dan status kebudayaan sesebuah masyarakat. Oleh itu analisa data retrospektif terkini berkala adalah mustahak untuk meyediakan maklumat kepada pihak terlibat bagi mengambil tindakan sewajarnya untuk mengurangkan bilangan dan maut akibat daripada kepatahan tulang maksilofasial dan juga menjamin pengurusan yang efektif dan pantas. Objektif kajian ini adalah untuk kenal pasti jenis tulang muka yang paling biasa terdedah kepada patah, faktor etiologi utama, perkaitan diantara patah tulang muka, persatuan diantara umur dan jantina dengan jenis kepatahan tulang dan kaedah-kaedah rawatan yang diberikan olah unit OMFS, hospital USM, Kelantan, Malaysia. Ini merupakan keratan-lintang retrospektif, analisa deskriptif berdasarkan rekod-rekod perubatan pesakit-pesakit patah maksilofasial yang dirawat di unit OMFS, hospital USM, Kelantan sepanjang jangkamasa lima tahun daripada 2012 sehingga 2016. Satu carta lakaran reka bentuk koleksi data digunakan untuk mengumpul data daripada rekod perubatan pesakit. Data yang telah diambil dianalisakan menggunakan statistik deskriptif dan Chi-square Test dalam perisisan SPSS 23.0. Sejumlah 2019 kes kepatahan maksilofasial telah dilibatkan, daripada jumlah itu 167 lelaki dan 42 perempuan; jarak umur adalah daripada 0-70 tahun dan keatas. Faktor penyebab utama yang bertanggungjawab terhadap kepatahan

maksilofasial ialah kemalangan jalanraya, 90.4% dan kumpulan lelaki berumur 21 tahun keatas ialah sebahagian besar terkesan. Tempat kepatahan kompleks zygoma bersama yang utama terkesan (86.1%) diikuti oleh kepatahan kawasan orbital (69.9%). Terdapat korelasi kuat yang signifikan dalam kes zygoma dengan kepatahan orbital dan maxilla dengan kepatahan Le Fort I dan Le Fort II di bahagian muka tengah sedangkan pada muka bawah simfisis mandibula mempunyai kolerasi sederhana yang signifikan dengan condylar. Secara amnya, tiada kesatuan signifikan pada kepatahan maksilofasial dengan umur dan jantina. 45.5% kes-kes dirawat secara pembedahan dan 39.2% kes-kes secara teknik conservetif.

Kata kekunci: Patah maksilofasial, Kolerasi antara kepatahan tulang muka, Kemalangan jalanraya.

THE PATTERN OF MAXILLO-FACIAL FRACTURES IN HOSPITAL UNIVERSITI SAINS MALAYSIA: A RETROSPECTIVE STUDY OF RECENT 5-YEARS

ABSTRACT

Patterns of maxillofacial fracture are found to be changing with the period of time depending upon socio-economic condition, geographical position, education and cultural status of a society. Therefore the periodic recent retrospective data analysis is important to provide the information to the involved parties for taking the necessary actions to reduce number and the fatality of maxillofacial fractures as well as confer effective and fast management. The objectives of this study were to assess the most common type of facial bone that prone to fracture, main etiological factor, correlations between the fractured facial bones, association of age and gender with the types of facial bone fractured and the treatment modalities provided by the OMFS unit, hospital USM, Kelantan, Malaysia. This was a retrospective cross-sectional, descriptive analysis based on the medical records of the maxillo-facial fracture patients that was treated in the OMFS unit, Hospital USM, Kelantan, Malaysia, over a period of five years from 2012 to 2016. A pre-designed data collection chart was used to collect data from patients' medical record. The collected data was analyzed by descriptive statistics and the Chi-square Test in SPSS 23.0 software. Total 209 cases of maxillo-facial fractures were included, out of those 167 males and 42 females; age range was 0-70 years and above. The most responsible etiological factor for maxillofacial fracture was road traffic accident, 90.4% and males of 21-above years age group were predominantly affected. The concomitant

zygomatic complex fracture was mainly affected site (86.1%) followed by fracture in the orbital area (69.9%). There was a strong significant correlation in case of zygoma with orbital fracture and maxilla with Le fort I and le fort II fracture in midface whereas in lower face mandibular symphysis fracture had a significant moderate correlation with condylar fracture. In general, there was no significant association of maxillofacial fracture with the age and sex. 45.5% cases were treated surgically and 39.2% cases by conservative technique.

Key words: Maxillofacial fracture, Correlation between facial bone fractures, Road traffic accident.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Maxillo-facial trauma is one of the leading incidents to create burden of disease and injury which is the biggest challenge for the public health service worldwide (Krug et al. 2000). Challenges comprise in the diagnosis and treatment facilities of facial fractures that usually requires multidisciplinary expertise, equipments and huge financial support (Katzen et al. 2003; Erdmann et al. 2008). Approximately 16000 people die worldwide everyday due to various types of injuries (Krug et al. 2000). Among them facial trauma is one of the most prevalent. As because face is least protected and the most exposed part of body (Alvi et al. 2003). Maxillo-facial fractures may occur isolated or accompanied with other injury results from various types of trauma to the face (Erdmann et al. 2008).

Over the last three-four decades the etiology of maxillo-facial fractures has changed a lot through out the world and that still continuing. Main causes are road traffic accidents, interpersonal violence, assaults, falls, work and sports related injuries, gunshots, etc. (Ellis III et al. 1985; Gassner et al. 2003; Motamedi, 2003; Lee et al. 2010). Epidemiological studies show the incidents of facial fractures varies widely between different countries depending on socio-economic conditions, environmental, political, cultural, attitudes, and racial factors (Al Ahmed et al. 2004; Bakardjiev and Pechalova, 2007; Lee et al. 2010; van Beek and Merkx, 1999). Several studies are carried out in countries like, Japan, Middle East region, New Zealand, Denmark, India, Singapore have shown motor vehicle crashes are the most common causes of maxillo-facial injury. On the other hand countries like, parts of

sub-Saharan Africa and South Africa maxillofacial fractures are more often the results of interpersonal violence in the form of fights, assaults, gunshots (Aksoy et al. 2002; Lee, et al. 2010; Malik, et al. 2017). Some studies describe a decrease in motor vehicle accidents due to strict implementation of road traffic laws like mandatory seat belt application, restriction of mobile phone while driving, speedometer, mandatory yearly fitness checkup of vehicles, etc. and an increase in interpersonal violence due to alcohol abuse and growing aggression in the society (de Matos et al. 2010; Lee, 2009; van Beek and Merkx, 1999).

According to the World Health Organization (WHO), developing countries have highest rates of fatality from road traffic accident compared with developed countries (WHO, 2013). Malaysia being a developing country, the most cases of injuries resulted from road traffic accident (Rahman et al. 2007). According to the statistics provided by Malaysian Institute of Road Safety Research (MIROS) showed in 2016 that there were 7152 deaths recorded in 521466 road crashes, which is increasing in every year due to rapid motorization, reckless driving and not abiding the road traffic laws and safety precaution (MIROS, 2016).

Hospital USM is a tertiary hospital situated in the East Coast of the Peninsular Malaysia in the state of Kelantan. The aim of this study was to find out the demographic data about the most causative factor for maxillofacial fractures, most vulnerable bone to fracture, correlation between fractured facial bones, association of age and sex with the types of fracture and the treatment modalities were required to serve the patients with facial injury in hospital USM, so that, appropriate health education can be provided to the locality and instructions can be

given to the community for manditory implementation of some special protective measures (like- wearing helmet, seat-belt, etc.) to avoid maxillofacial injuries and as well as health care sectors can be equipped with proper instruments, experts and facilities to manage the injured patients thereby get their satisfactions and reduce fatality.

1.2 Statement Problems

Injuries sustained during RTAs or any other factors constitute a major health problem in a population that seeking emergency treatment at all health care facilities nationwide. Due to the anatomical forward position and upper most mobile part of human body, head and face are the most affected integral component of general body trauma. Moreover, as forces on the face usually transmit through the head, patients with maxillofacial fractures invariably suffer from traumatic head injury (Pappachan and Alexander, 2006; Zandi and Hoseini, 2013). Both bone and soft tissue injuries of the oral and maxillofacial area are occasionally fatal while the survivors sustain disabilities and deformities that may compromise their quality of life, if not adequately managed (Krug et al. 2000). The losses caused by these accidents place a heavy burden on the economy and pose a great human tragedy to the families and the nation as a whole. This is one of the major public health concern, which can be largely reduced after knowing and understanding the causative factors, pattern of injuries and their associations as well as age and sex involvement of the affected groups.

1.3 Significance of Study

Study the pattern of the latest five years of maxillo-facial fracture in the patients at the OMFS unit, hospital USM to provide information on demographic

findings such as etiology, interrelation between fractured facial bones, age and sex association with fractured facial bones, treatment modalities required or provided, etc. Hence the safety instructions like, use of helmet while riding motorcycle, use of seat belt while driving motor vehicles, follow proper road-traffic rules, etc. can be made to the population to reduce the number of trauma to the face. On the other hand, Oral & Maxillo-facial surgery unit of hospital USM and other health care facilities can be more equipped with instruments, proper facilities, surgeons and technicians, to give more better and satisfactory management to the patients.

In addition, Government and private instutions can develop their equipments and services to take steps for preventive measures based on the scientific data avilable in study (Gassner et al, 2003).

1.4 Research Questions

a) What was the most vulnerable bone in the facial skeleton?

b) What was the most common etiology for maxillo-facial fracture?

c) Was there any correlation between the types of fractured facial bones?

d) Was there any association of age and gender with the types of fractured facial bones?

e) What were the most common treatment modalities practiced by the OMFS unit, hospital USM for patients with maxillo-facial fracture?

1.5 Research Objectives

1.5.1 General Objective:

To study the pattern and association of maxillo-facial fracture in the patients at OMFS unit, hospital USM**.**

1.5.2 Specific Objectives:

a) To determine the most common type of facial bone fractures.

b) To determine the most common causes of maxillo-facial injuries.

c) To study the correlation between the types of fractured facial bones.

d) To study the association of age and gender with the types of fractured facial bone.

e) To determine the types of treatment modalities of maxillofacial fracture practiced by OMFS unit, hospital USM for patients with maxillo-facial fracture.

1.6 Research Hypothesis

H0- There are no changes of pattern and association of the maxillofacial fractures.

H1- There are changes of pattern and association of maxillofacial fractures.

CHAPTER 2

LITERATURE REVIEW

2.1 Anatomy of Facial Bones

Facial bones are---- (14)

a) Nasal (2)

b) Zygomatic (2)

c) Maxilla (2)

d) Mandible

e) Palatine (2)

f) Lacrimal (2)

g) Inferior nasal concha (2)

h) Vomer

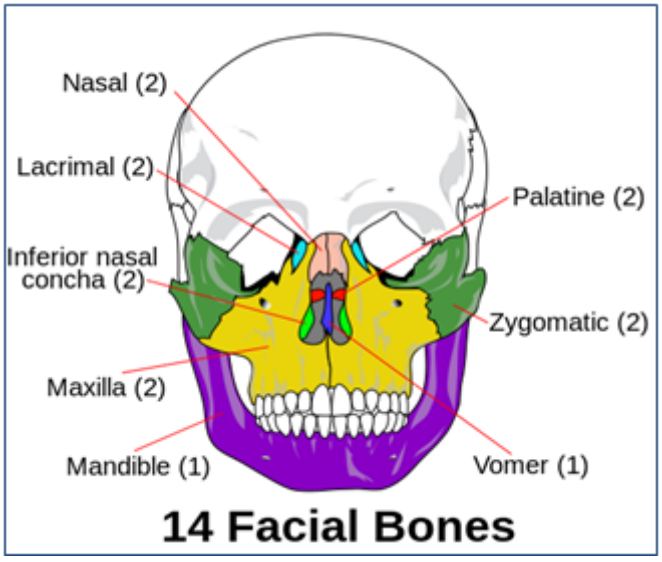

Figure 2.1 Facial skeleton (modified from https://study.com).

2.1.1 The Zygomatic bone

The zygomatic bones also called cheeck bones or malar bones are two facial bones that form the essence of cheeck prominance. This thick, strong, diamond-shaped bone forms the lateral and anterior projections to the midface and is composed of four processes-

a) The frontal process--constitutes the lateral wall of orbit and joints with the frontal bone at the frontozygomatic suture. During isolated zygomatic fracture this suture is splitted and rotated.
b) The temporal process—forms zygomatic arch and articulates with the temporal bone.
c) The orbital process—articulates with maxilla to form the infraorbital rim and part of the floor of the orbit.
d) The maxillary process—articulates with the maxilla on the lateral wall, producing the zygomatic eminence.

Masseter muscle inserts along the crest of the zygoma, on the inferior aspect-- its direction of force is down and backward , therefore during the zygomatic complex fracture contraction of masseter muscle causes the displacement of zygoma (Fonseca 2013).

2.1.2 The Maxilla

Maxilla is the 2nd largest bone in the face. Two maxillary bones form the whole of upper jaw. Each maxilla has a body and four processes (frontal, zygomatic, alveolar and palatine). Each Maxilla contributes in the formation of face, nose, the orbit, roof of the mouth, infratemporal fossa, pterygopalatine fossa.

Body – Contributes the central portion of each maxilla, pyramidal-shaped, base directed mesially at the nasal surface, apex directed laterally at the zygomatic

process. Body has four surfaces- anterior or facial, posterior or infratemporal, medial or nasal, superior or orbital.

a) **Anterior or Facial surface** — directs laterally and gives attachment to th facial muscles. Near upper border infraorbital nerve passes through infraorbital foramen.

b) **Posterior or Infratemporal surface** – concave, directs backward and laterally, forms anterior wall of infratemporal fossa. Posteroinferiorly maxillary tuberosity gives attachment of the superficial head of medial pterygoid muscle.

c) **Superior or Orbital** – triangular and smooth, forms the greater part of floor of orbit. Its posterior border forms most anterior margin of inferior orbital fissure.

d) **Medial or Nasal surface** – forms part of lateral wall of nose. Posterosuperiorly lies maxillary hiatus. Behind the hiatus articulates with the perpendicular plate of palatine bone and encloses greater & lesser palatine canals. In front of the hiatus nasolacrymal groove articulates with descending process of lacrymal bone & lacrymal process of inferior nasal concha to form nasolacrymal canal.

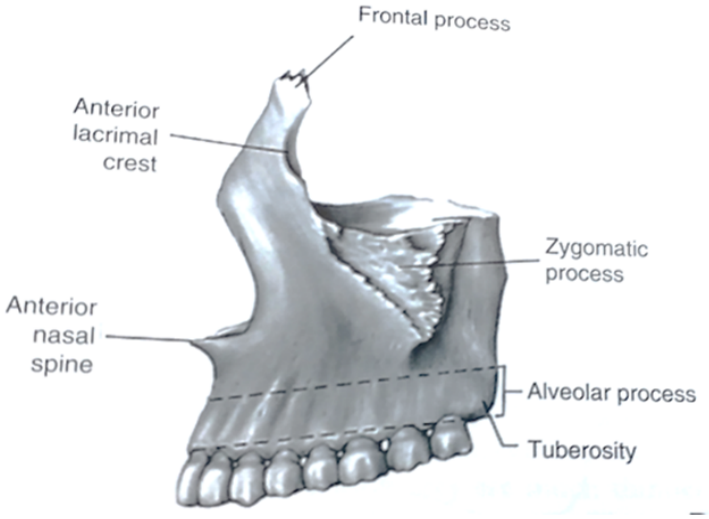

Fig.2.2 The Maxilla (Fonseca, 2013)

Body encloses a large pyramedial cavity called, maxillary sinus, which is lined by mucous membrane and mucous secretions drain into the mid-lateral wall of the nasal cavity through a small opening called ostium (Fonseca 2013).

Processes – 4 processes--

a) **Frontal process** -- projects upward & backwards from body and articulates above with nasal margin of frontal bone in between nasal & lacrimal bone.

b) **Zygomatic prosses** – pyramidal, extends from the lateral surface of the body to articulate with zygomatic bone.

c) **Alveolar process** – inferior extention of body from both maxillae marges together to form alveolar prosses that contains socket (alveoli) for teeth. Buccinator arises from posterior part of its outer surface upto 1st molar tooth.

d) **Palatine process** -- from the lower border of maxillae two sleeve like extentions meet each other medialy to from the palatine process that froms the anterior 3/4th of bony hard palate and floor of the nasal cavity. Posterior border articulates with horizontal plate of palatine bone (Fonseca 2013).

Articulation of maxilla –

- **Superiorly –** 3 bones
  a) Frontal
  b) Nasal
  c) Lacrymal
- **Laterally –** 1 bone
  Zygomatic bone
- **Medially –** 5 bones
  a) Ethmoid

b) Inferior nasal concha

c) Vomer

d) Palatine

e) Opposite maxilla (Fonseca 2013).

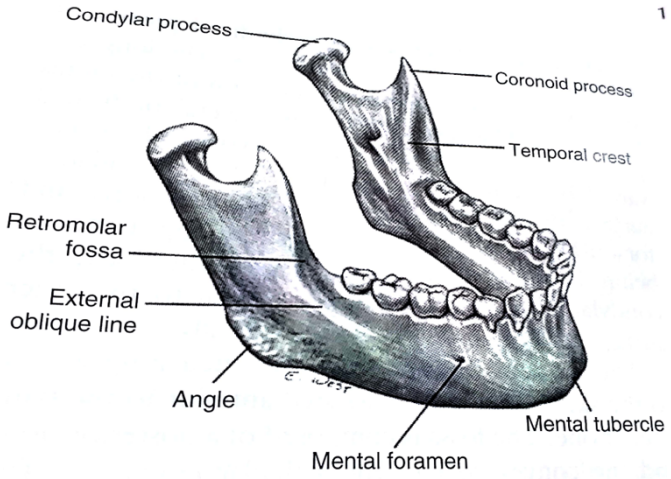

Fig.2.3 The bony Mandible (Fonseca, 2013)

2.1.3 The Mandible

It is the largest and strongest facial bone, even though, due to its position and prominance, it is fractured twice as often as midface. However, experimentally proved that almost four times as much force is required to fracture the mandible than maxilla. Its osteology, different direction muscles attachment and there influence, and the presence of dentition play a considerable role in producing inherent weaknes. Weakned areas are included- the area lateral to the mental protuberance, mental foramen, mandibular angle and condylar neck. If teeth are present in the sockets are weak zone, specially if teeth are impacted or unerupted, therefore child in the mixed dentition stages may be highly susceptible to fracture (Fonseca 2013).

The mandible is composed of body, two rami and their junction or angle forming the prominent gonion—

Body, is U-shaped and has an external and internal cortical surface, the external cortical plate is thickest at the mental protuberance contains mental foramen between the root apices of 1st and 2nd premolars. The internal cortical surface is elevated in the midline, contain two pairs of discrete bone prominences called genial tubercles which give origin of geniohyoid muscle inferiorly and genioglossus muscle superiorly. Mylohyoid line, an oblique ridge runs horizontally and slightly superior from front to back, gives attachment to the mylohyoid muscle. The body of the mandible supports the alveolus and dental structures.

Ramus, is a quadrilateral structure, the lateral surface is rough and thickened in the region of the angle by the insertion of massetar muscle. On the medial surface, the mandibular foramen, which leads downward and forward into the mandibular canal and transmits the inferior alveolar nerve and vessels. The lingula is a medial bony projection to which the sphenomandibular ligament is attached. The mylohyiod groove extends from the lingula and runs anteriorly and inferiorly to the submandibular fossa, below this medial pterygoid muscle inserted. Superior edge of ramus devided into two processes called coronoid and condylar process, which seperated by mandibular notch. Coronoid process gives attachment to the temporalis muscle. Lateral pterygoid muscle inserted to the neck of the condyle (Fonseca 2013).

2.1.4 Nasal, Inferior concha & Vomer

The prominence of the nose makes it a frequent target in interpersonal conflict and often traumatized structure in other forms of facial injury. The external nose is composed of the cartilaginous lower half and the nasal bone superiorly. The

bony opening of the nose is composed of two paired bones—the maxilla inferiorly and the nasal bones superiorly. Cartilaginous structure derives from alveolar process of the maxilla in the piriform apertures. The nasal cavity, devided by nasal septum, is roughly teardrop-shaped in the frontal section, with the narrow area above. The walls of the internal nose are formed medially by the nasal septum; laterally by the maxilla, ethmoid bone, and nasal cartilage; inferiorly by the maxilla and palatine bones; and superiorly by the cribriform plate of ethmoid bone.

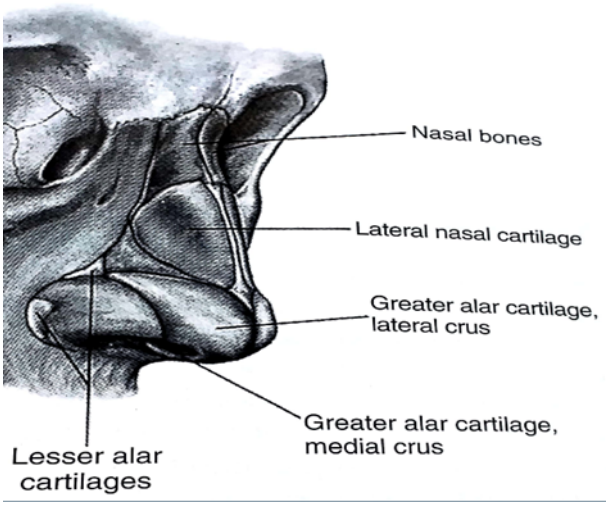

Fig.2.4 The substructure of external nose

The nasal septum is the common medial wall of the two nasal cavities, formed by the perpendicular plate of the ethmoid bone and by the vomer posteriorly, by the septal cartilage and the medial crus of the alar cartilages anteriorly. Below, the nasal crests of the maxilla and palatine bones complete the septum. The septum rests in the groove formed by these bones and if displaced by trauma requires replacement in the groove to prevent functional and aesthetc problems. The lateral wall of the nose is formed inferiorly by the lateral wall of the maxilla and the inferior nasal concha. Superiorly, the lateral wall is formed by the segments of the ethmoid bone, which form the middle and superior conchae.

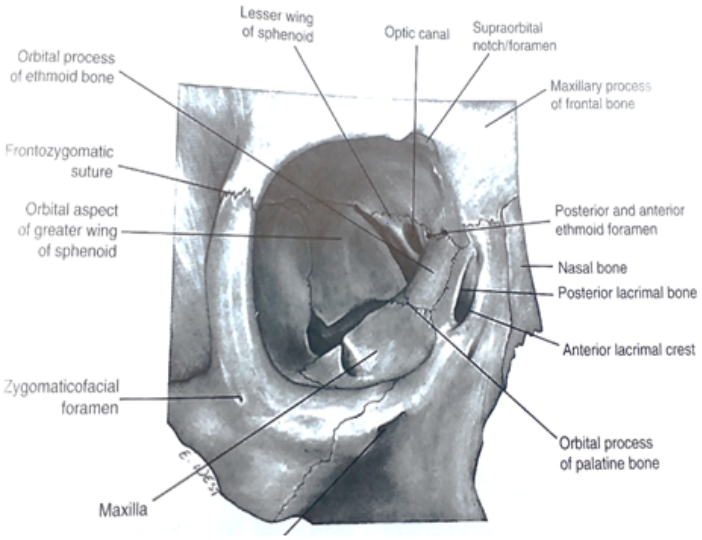

Fig. 2.5 The bony Orbit (Fonseca, 2013)

2.1.5 The Orbit

Bony orbit is pyramidal shape, base facing anteriorly. Each bony orbit is composed of seven bones, as follows:

a) Frontal bone

b) Zygoma

c) Maxilla

d) Lacrimal bone

e) Ethmoid bone

f) Sphnoid bone

g) Palatine bone

The medial walls (formed by lamina papyracea of the ethmoid,lacrimal, and palatine bones) are parallel to the sagittal plane. It is the thinnest wall of the orbit.The lateral walls are constituted by zygoma, sphenoid, and frontal bones. Lateral orbital rim is formed by zygoma. Floor of the orbit is formed by maxilla,

which is the roof of maxillary sinus and is relatively thin and anatomically weakened by the passage of the infraorbital nerve. Roof of the orbit is formed mainly by the frontal bone and partly by the sphenoid bone.

The trochlea, which transmits the tendone of the superior oblique muscle, is a special periosteal attachment in the area of the junction of the medial wall and the roof of the orbit – approximately 4 mm posterior to the orbital rim. Its intrigity must be maintained during medial orbital wall exploration (Fonseca 2013).

2.2 Growth and Development of Facial bones

Facial skeleton consists of upper fixed part, which is attached to the under surface of the front part of the cranial base and lower movable part, which is movable at the temperomandibular joints. Face develops from membraneous bones which are formed arround the cartilage of the nasal capsule and Meckel's cartilage. As they grow, initially remain separate, later the bony elements approaches one another to form union by suture (Scott, 1954). Ossification centres of some bones are initiated with the relation of important nerve trunks (e.g. mandible, maxilla, palatine bones); few develop by replacing part of cartilage (e.g. ethmoid, inferior concha).

Bone grows by three methods:

a) By replacement of cartilage, is active at three important sites- the synchondrosis between the basi-occipital and basi- sphenoid bones, mandibular condyles and the nasal septum. The replacement is very active in late fetal life and continues after birth.

b) At the sutures, specially in the cranial vault and upper face, which is continues about the end of first decades.

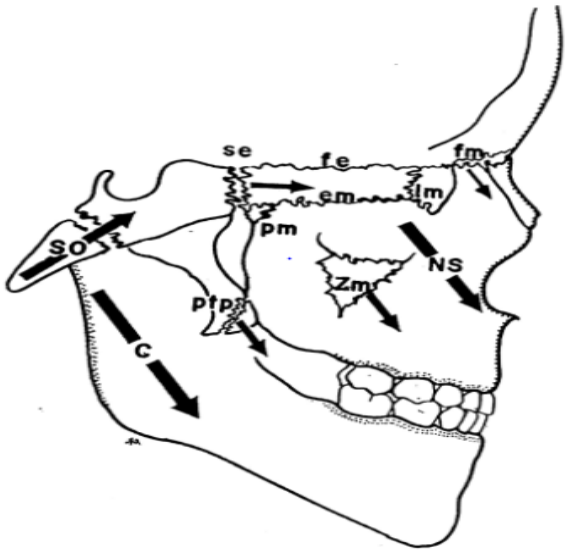

Fig. 2.6 Growth directions of cranial base and facial sutures—cranial portion moves upward and forward and facial portion moves downward and forward. SO- Spheno-occipital synchondrosis. C-Reflection of the condyle. NS- Nasal septum, Se- Spheno-ethmoidal suture, ptp- pterygopalatine suture, pm-palatomaxillary suture, fe- frontoethmoidal suture, fm-frontomaxillary suture, em-ethmoidal-maxillary suture, fm-frontomaxillary suture, zm-zygomaticomaxillary suture (Graber, 1966).

c) Surface deposition, this occurs over the external surfaces of the facial bones beneath periostium. In some areas surface bone deposition is associated with bone resorption like, the floor of the nasal cavity, the nasal air sinuses and anterior border of the mandibular ramus. It is the most important method of growing of facial skeleton during late childhood and adolescence and may continues in some areas into the adult life (Scott et al. 1982).

Scott considers that before the age of seven, growth is largely at the sutures after that growth is mainly due to surface deposition. In addition, growth of

cartilaginous nasal septum causes the downward and forward displacement of maxilla.

Position of the midface and mandible is directly influenced by the growth of cranial base. Elongation of cranial fossae and sphen-occipital complex displace the entire midface anteriorly and cause enlargement in nasomaxillary complex, pharynx

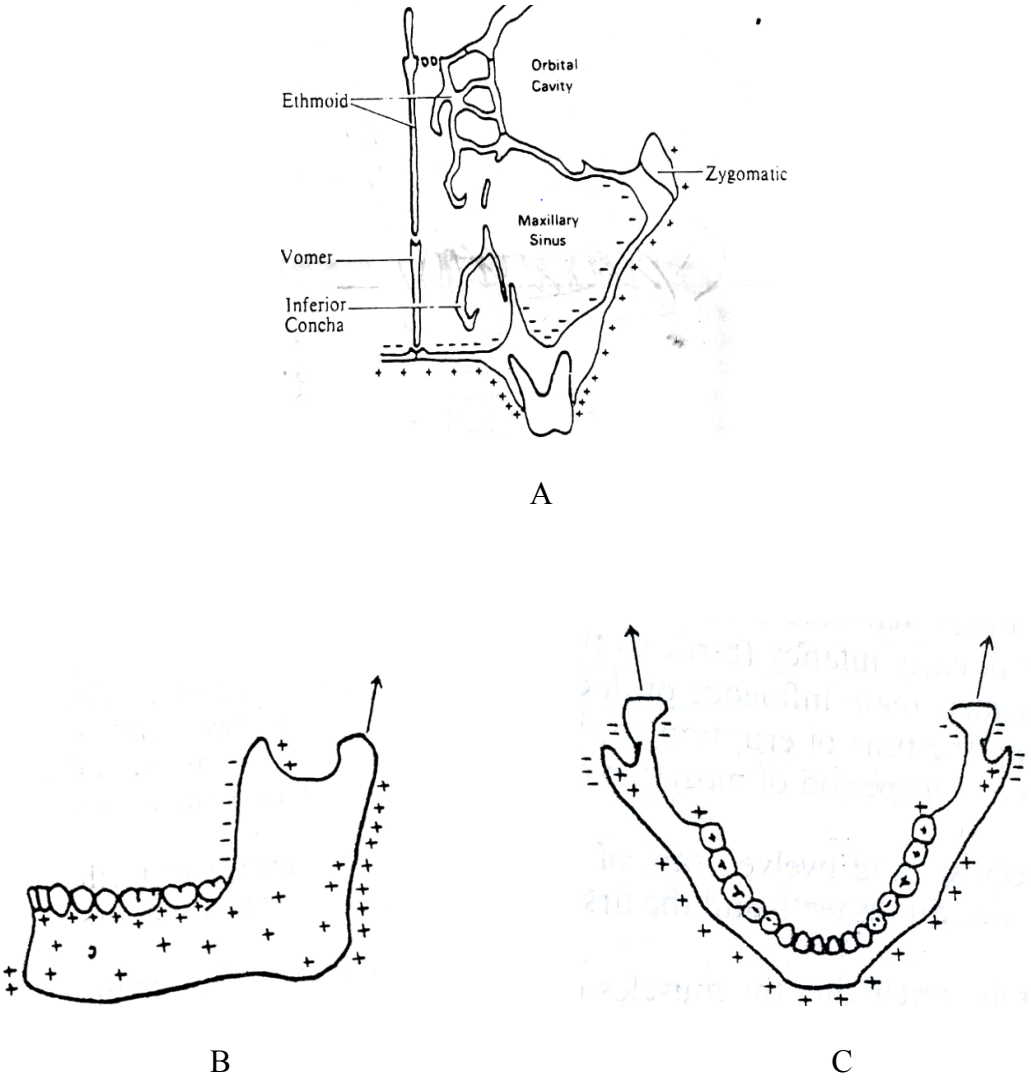

Fig. 2.7 Diagrammatic representation of surface deposition and resorption.
A. Diagrammatic representation of a coronal section through the upper facial skeleton at the level of the first permanent molar showing the major sites of surface deposition (+) and resorption (-). B & C. Diagrammatic representation of the mandible showing the major sites of surface deposition (+) and resorption (-), arrows showing the direction of condylar growth (Scott et al. 1982).

and ramus corespondingly, resulting the forward displacement of mandible in conjunction with the forward displacement of maxillae (Moyers, 1973).

2.2.1 The maxilla

Growth of nasomaxillary complex takes place at the sutures, the nasal septum, the periosteal and endosteal surfaces, and the alveolar processes (Moyers, 1973). Growth continues upto the first few years after birth at the sutures (e.g. sutures between frontal, zygomatic, ethmoid, and palatine bones). The enlargement of cartilaginous nasal septum, orbit and its contents , eyeball, muscles and the intervening fibro-fatty tissue thrust the maxilla downward and forward and causes the seperation of facial bones permits growth to take place at the sutures (Scott et al. 1982).

Size of maxillary bone increases maximum between 6 months and 5 years of age in both sex. Over the first 5 years both anteroposterior and vertical growth is almost similar. After 5 years vertical growth aheads significantly than anteroposterior growth and yearly growth velocities decelerated regularly thereafter until 16 years. Maturation in female is earlier than male (Laowansiri et al. 2012).

Maxillary Height – Maxillary height increases by the sutural growth at the suture with frontal and zygomatic bones and appositional growth in the alveolar process (Moyers, 1973). By the seventh year growth of the orbital cavity closes to the end causes thrusting of maxilla downwards to increase the height of each orbital cavity. Surface deposition occurs on the floor of the orbital cavity with the resorptive modeling of the lower surfaces, there by increases the height of the maxillary entrum above the level of its opening into the middle meatus (Scott, 1954). Simultaneously

the nasal floor is lowered by resoption while deposition of new bone on the oral surface of the hard palate (Scott, 1954).

During the second decade of life, facial skeleton grows predominately vertically due to more active surface deposition-resorption mechanism. Hight of the mouth cavity increases as a result of continuous surface deposition of both upper and lower alveolar processes (Scott, 1954). Increase the height of alveolar processes are closely corelated with eruption of teeth. This coincides with the downward growth of mandible by the active growth of the mandibular condyle upwards and backwards and elongation of the ramus usually up to the late adolescence period. Growth of alveolar process contributes nearly 40% of the total maxillary height (Moyers, 1973).

Maxillary width—During fetal life and at birth, growth at the mid sagittal suture is mainly responsible for the increase in width of cranio-facial skeleton, but with the attainment of adult dimensions of the orbital cavity at about seven years of age, median suture growth becomes considerably reduced. Afterwards width is increased by mainly surface deposition of bone associated with internal resorption. Outward deposition of the alveolar process also contributes maxillary width (Scott et al. 1982).

Maxillary length—Surface deposition on the maxillary tuberosity and by sutural growth towards the palatine bone are responsible for the increase in length usually occurs after the second year of life (Moyers,1973).

2.2.2 The Mandible

Mandible is basically a slender, U-shaped bone with endochondral growth mechanism at each end and intramembranous growth in between. Growth and shape remodeling is predominantly regulated by the activity of muscles inserted on it and the eruption of teeth rather than intrinsic cartelaginous or osteogenic factors (Moyers, 1973).

The condylar cartilage, a secondary cartilage, is responsible for overall increase in length of mandible from condyle to symphysis and at the same time increase in height of ramus (Moyers, 1973). The condylar cartilage replaces gradually by bone cxcept its growing articular surface, which continues up to the end of the second decade or beganing of third decade. Direction of condylar growth takes place backward, upward, and outward. By that it maintains the articulation with the increasing width of the base of the skull (Scott et al. 1982). As the condyles are fixed with the glenoid fossae, progressive growth diplaces the mandible downward and forward. In addition, the activity of muscles of mastication also responsible for the forward and downward dislacement of mandible to maintain the occlusal relation with the upper teeth in the growing face (Scott et al. 1982).

Accompanying with the growth of the condyle, bone deposition occurs along the posterior border of the ramus to built backward for maintaining the relationship with the condyle, while bone resorption occurs along the anterior border, thereby, increasinng the length of body of mandible. At the same time bone deposition occurs along the upper edge of ramus and the coronoid process to increase the height of ramus. In general, the dimentions of mandibular body increase throughout the growth period by surface deposition of bone. Though deposition along the lower border

contributes little in increase in height of the body, the greatest increase is produced by alveolar growth, which is closely related with the eruption of the teeth and their attainment of the occlusal plane (Scott et al. 1982). Alveolar process grows during the dental eruption and it acts as a buffer zone to maintain the occlusal relationships during differential mandibular and midface growth (Moyers, 1973). Vertical alveolar growth persists even in adulthood to maintain the occlusal height as the occlusal surfaces wear and resorbs when teeth are exfoliated or extracted (Moyers, 1973).

2.3 Aetiology of Maxillo-facial fracture

Depending upon the cultural, social and economical background aetiology of maxillofacial fracture (MFF) varies from country to country or different places in the same country (Maladiere et al. 2001; Motamedi, 2003; Gassner et al. 2003; Brasilerio and Passeri, 2006; Allareddy et al. 2011; Rajandram et al. 2014; Scheyerer et al. 2015). Based on several studies in different countries worldwide aetiological factors of MFF can be summarized as,

a) Road traffic accidents (RTA)
b) Assault or interpersonal violence
c) Sports
d) Falls and
e) Others

2.3.1 Road traffic accidents (RTA)

According to WHO, over 3400 people die on world's road every day and 10 millions of people are injured or disabled every year. Children, pedistrians, cyclists and older people are among the most vulnerable of road users. It is the leading cause

of death among young people aged between 15 to 29 years and government expences approximately 3% of GDP (WHO, 2015) . Low and middle-income countries are the hardest hit, with double fatality rates and 90% of global road traffic deaths (WHO, 2015) . Vulnerable groups are pedestrians, cyclists, and motorcyclists-- they make up half of these fatalities (WHO, 2015). Study at Kajang hospital in Malaysia showed, out of 313 patients with maxillofacial injuries 79% were males and the majority (34%) were between 21 and 30 years old (Hussaini et al. 2007). According to the annual report of MIROS (Malaysian Institute of Road Safety Research), major causes of RTA are pedestrian's behaviour that is not to wait for pedestrian green signal for road crossing, over speed, using wrong tract for driving by commercial heavy vehicles and taxies, not using high visibility wind breaker by motorcyclists, not wearing seat-belt and helmets, lack of road safety awareness, inadequate perception on traffic volume, not following the child restraint system, etc. (MIROS, 2016). To curb the road traffic crash and casualties MIROS runs extensive traffic enforcement activity, called **OPS Selamat**, especially during festival time.

Globally, high rate of RTA seen in low and middle income countries, like in Asia, Middle-Eastern region, Africa, South America, due to rapid motorization, poor road structures, heavy traffic load and their behavioral attitude i.e. not abiding the road-traffic rules, negligence in wearing seat-belt and helmet, poor vehicle safety. On the other hand, developed countries, like- European, despite their gradual increasing number vehicles RTA casualties is declining as the day progresses. This is due to excellent road structure, maximum vehicle safety profile, proper

implementation of road traffic rules, effective traffic monitoring system as well as improved behavioral change of road users (WHO, 2015).

2.3.2 Assault or interpersonal violence (IPV)

According to Violence Prevention Alliance (VAP), a network of WHO, interpersonal violence means—the intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment, or deprivation. Interpersonal violence refers to violence between individuals, and is subdivided into family and intimate partner violence and community violence.

Developed countries, where MFF due to RTA is a declining trend, IPV become a major etiological factor for Oro-facial injuries due to high drug and alcohol abuse (Magennis et al. 1998). Several studies show, such as—in Sweden MFF due to assault was 30% (Wladis et al. 1999); in New Zealand 44% cases of MFF due to IVP (Lee 2009); Gerber et al. in 2009 showed in Queen Elizabeth Medical centre, UK 55% cases of assault that lead to facial injuries in women; Laverick et al. in 2009 also showed that the highest cause of referrals for OMF injuries to three Medical centers in the United Kingdom between 2003-2004 was IPV and the age-group most involved was 20 and 29 years (57%) for both females and males and male alone 89%; Another study showed, out of 236 emergency admission 81% present presented with maxillofacial injuries and 67% cases due assault (Lee et al. 2001). Drug and alcohol abuse gradually spreaded to developing countries, so this scenario also unfolded in some developing world due to changes in people's life style. One study

showed in Kenya 74.9% of mandibular fracture due to IPV, whereas 13.8% fracture recorded due to RTA (Mwaniki et al. 1990). Another report in Zimbabwe, 89.8% mandibular fractures caused by IPV managed at Harare central Hospital (Chidzonga, 1988).

2.3.3 Sports

Sports injury ether by exercise, competition or the simple enjoyment of recreational activity, accounts 10-39% of all maxillofacial injuries and children between 7-11 years old were most prone to sports-related oral and maxillofacial injury (Newsome, 2003; Tesini et al. 2000; Rodd et al 1997). According to the Journal of the American Dental Association (JADA), 2-18% of all maxillofacial injuries are sports-related; males were traumatized twice as often as females (Kumamoto et al. 2005; Kumamoto et al. 2004). In a study showed basketball had the highest injury rate with both male and female students due to hand or elbow contact or by collision with other players. The close contact of basketball players, as well as the speed of the game increases the potential for possible orofacial trauma (Cohenca et al. 2007). In addition, football, baseball, rugby, hokey, like all others contact sports contribute sports-related injury. The most frequent site of bony injury is the zygoma (cheekbone) and mandible, which comprises approximately 10% of the maxillofacial fractures in sports injuries, occurring as a result of direct blunt trauma from a fall, elbow or fist, strikes a hard surface, another player, or equipment (Padilla et al. 1993). In a study by Linn and others, of the 319 patients treated for sports-related injuries, males proved to be more prone to zygomatic fractures than females because of the powerful physical contacts during sports (Linn et al. 1986).

Demographic characteristics regardless the types of sport and country are highly related with MFF and majority injuries involve with young adult of 20-30 years of age due to high level of physical activities (Maladiere et al. 2001; Delilbasi et al. 2004; Antoun et al. 2008).

2.3.4 Falls

A fall is defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level. Adults older than 65 years of age suffer the greatest number of fatal falls. Each year an estimated 646 000 individuals die from falls globally, the second leading cause of unintentional injury that causes death, after road traffic injuries worldwide (WHO, 2018). According to World Health Organization, over 80% of fall-related fatalities occur in low- and middle-income countries, with regions of the Western Pacific and South East Asia accounting for 60% of these deaths. In all regions of the world, death rates are highest among adults over the age of 60 years. The largest morbidity occurs in people aged 65 years or older, young adults aged 15–29 years and children aged 15 years or younger (WHO, 2018).

In a study of 505 patients with facial fractures from January 1997 to May 2001 showed fall is the higher risk factor of fractures in older females (Iida et al. 2003).

2.3.5 Others

Other causes of maxillofacial trauma are industrial or work related injuries, pathological fractures, gun-shot injuries, animal attacks, etc. Incidence of MFF is negligible in these categories.