The patterns and distribution of maxillofacial fractures at Pelonomi hospital

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Boyisile Stephen Mvala

A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Dentistry

Johannesburg,2023

DECLARATION

I Boyisile Stephen Mvala declare that this research report is my own, unaided work. It is being submitted for the Masters in Dentistry at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

MVALA STEPHEN BOYISILE

_____

(Signature of candidate) 8th AUGUST 2023 in Parktown

DEDICATION

I dedicate this piece of work to my late father Kekana, my mother Mosele and to my loving wife Foni for the unwavering support and encouragement. To my kids Chwayita and Zolile I hope this serves as proof that no task is impossible to a willing person

ABSTRACT

Background

Despite large volumes of trauma patients treated, no study has analysed the epidemiology of craniofacial trauma at Pelonomi Hospital . Such studies could provide insight into the aetiologies and treatment modalities of maxillofacial injuries; and allow for development of strategies to ensure efficient and optimal utilization of limited health resources.

Aim

To analyse the patterns and distribution of maxillofacial fractures at Pelonomi Hospital (PH).

Methods

We designed and implemented a retrospective, descriptive cross-sectional study whose sample consisted of patients treated for maxillofacial fractures at PH, Frees State, South Africa, between January 1, 2017, and December 31, 2019. Data was collected from the patient's clinical and radiographic records. Variables recorded included demographic data (gender, age), aetiology of the trauma, type of fractures and type of treatment provided. The delay in treatment was determined from date of injury to the day of treatment. The referral letters were assessed to determine district from which the patients were referred. Descriptive statistics of frequency and percentage were used to analyse the data. Fischer's exact test was used to determine the association between the independent and dependent variables. The level of significance was set at a p-value less than 0.05.

.

Results

A total of 307 patients with craniofacial fractures were included in the study. Females constituted 21.8% (n=67) and males were by far the majority of the participants at 78.2% (n=240). Individuals in the 20-29 age group had the most maxillofacial fractures (41.2%) and majority of

patients in the study were Black (81.1%). The major cause of these injuries was interpersonal violence (60.9%). Alcohol contributed in 64.50% of the injuries. The most frequent fracture was a mandible fracture (70.7%). Majority of fractures in the study were treated with closed reduction (52%) and the waiting period prior to treatment was found to be 2 weeks.

Conclusion

Blunt trauma sustained under the influence of alcohol in young individuals is responsible for majority of maxillofacial fractures at Pelonomi Hospital. Future prospective studies with large patient numbers and post treatment follow up are recommended.

ACKNOWLEDGMENTS

To the Head of Dept. (Maxillo-Facial and oral Surgery), and my supervisor Prof RE Rikhotso, thank you for your unwavering support, wisdom and guidance.

From the bottom of my heart, I thank you and no words can express how grateful I am.

To my family, thank you for your support and prayers.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATION

PH- Pelonomi Hospital

CSF- Cerebrospinal fluid

NOE- Naso-Orbito Ethmoidal

CT- Computed Tomography

MCT- Medial Canthal Tendon

OMV- Occipito Mental View

SMV – Submento vertex

IPV- Interpersonal violence

RTA- Road Traffic Accident

LIST OF ANNEXURES

CHAPTER 1

1.0 INTRODUCTION:

Trauma is one of the leading causes of death worldwide, accounting for 8.5% of deaths globally (Zaidi et al., 2019). A significant proportion of trauma patients require urgent life-saving medical treatment. Furthermore, the South African trauma-related mortality rate is six times higher than the global rate (Zaidi et al., 2019). This significant volume of trauma puts a considerable burden on the limited and fragile healthcare facilities available at both provincial and national levels.

The prominence and accessibility of the maxillofacial complex predisposes the region to trauma. Due to the anatomical location and the vital structures present within the area, severe dysfunction can result from injuries sustained to the maxillofacial complex. These injuries are severe and usually associated with significant deformity, morbidity, loss of function, and a high cost for treatment (Keiser et al., 2002; Motamedi et al., 2014; Pillay et al., 2018).

A high incidence of facial fractures was reported in Central Europe, Eastern Europe, and Central Asia, with a regional age-standardized incidence of 254 per 100 000 (Lalloo et al., 2020). Also, countries in the Middle East, Sub-Saharan Africa, and South Asia have experienced a relatively significant increase in incidence between 1990 and 2017 (Lalloo et al., 2020). The reported incidence rate in South Africa was 90 per 100 000. However, this may not be accurate since certain parts of South Africa are deeply rural and sometimes inaccessible, compromising the reporting and recording of cases (Lalloo et al., 2020).

The incidence of facial fractures is influenced by factors such as sex, age, the level of industrialisation, socioeconomic status, geographical location, and seasonal variations (Mogajane & Mabongo, 2018). Pelonomi Hospital, a regional tertiary hospital in the Free State of South Africa, provides specialist care and training to undergraduate and postgraduate students. It is the only maxillofacial unit servicing the province of the Free State. Due to its proximity to Lesotho, it also accepts referrals of patients requiring specialist care from Lesotho (Figure 1).

Figure 1: Map of South Africa indicating the location of PH (Google Maps, 2020).

A study is yet to be conducted analysing the patterns of maxillofacial injuries treated in the unit. A sequential collection of this data will allow public officials and practitioners to assess and address the aetiologies, re-evaluate protocols and design new strategies that can be implemented to ensure efficient and effective utilisation of scarce resources. Its geographic location, multi-disciplinary team approach, and the large population it serves makes Pelonomi an ideal setting for such a study.

CHAPTER 2

2.0 LITERATURE REVIEW

The maxillofacial region is divided into upper, middle, and lower thirds. The upper third is made up of the frontal bone. The middle third consists of the maxilla, nasal and zygomatic bones. Le Fort fractures occur in the middle third of the face and are classified into I, II, and III according to the level of maxillary involvement (Kahnberg et al.,1987). Zygomatic, nasal, orbital, and ethmoidal fractures are also found in the middle third. The mandible and associated dentoalveolar area form the lower third, and fractures in this region are classified based on anatomical location (Dingman et al.,1969).

The maxillofacial region is made of several buttresses, which are divided into horizontal and vertical. They are areas of thickened bone in the maxillofacial area. Horizontal buttresses are the supraorbital rim, infraorbital rim, alveolar ridge with the palate and the mandibular lower border. The vertical buttresses include the nasomaxillary, zygomaticomaxillary, pterygomaxillary, and the ramus of the mandible. Their function is to maintain the face's structure and distribute occlusal forces to the base of the skull.

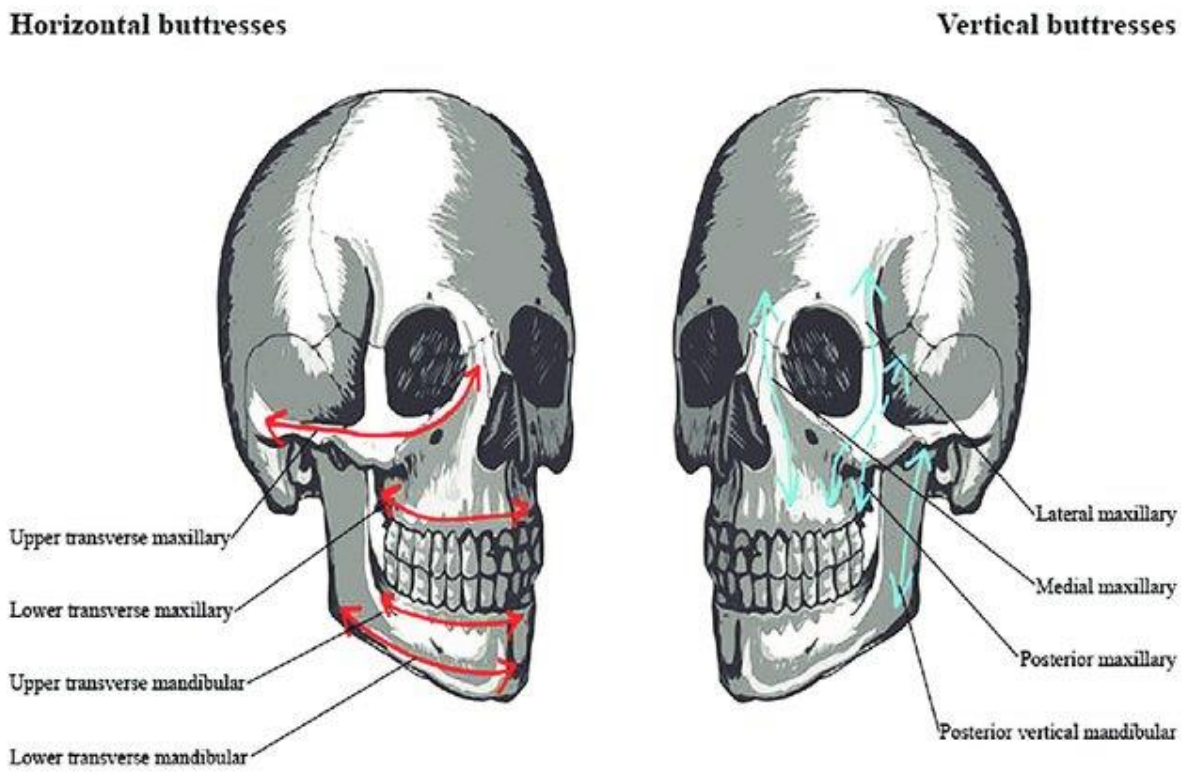

Figure 2. Horizontal and vertical buttresses of the face. (Fonseca et al., 2013)

2.1 Upper third fractures

2.1.1 Frontal bone fractures

Frontal bone fractures, also known as frontal sinus fractures, account for 5-15% of all maxillofacial fractures(Gerbino et al., 2000). This bone has a large surface area and is usually the first site exposed to trauma. However, it's one of the most robust bones in the face, with the ability to withstand force between 800 to 2200 pounds of force before fracturing(Lakhani et al., 2001). It consists of an anterior and posterior table and houses the frontal sinus bilaterally separated by a thin septum. The anterior wall, which is thicker, is stronger than the slightly thinner posterior wall. The nasofrontal duct originates from the posterior medial part of the sinus floor. It then drains into the middle meatus. In 66-88 % of individuals, the drainage is medial to the uncinate process; in 12-34%, the drainage is lateral to the uncinate process. The latter occurs when the uncinate process attaches superiorly to the cribriform or middle turbinate (Kennedy et al., 1997; Landsberg et al., 2001).

These fractures most commonly presenting clinical features include forehead lacerations, frontal bone depression, an altered sensation of the supraorbital nerve, and CSF rhinorrhoea (Manolidis et al., 2004). CSF rhinorrhoea can be confirmed using a halo test clinically. The test is positive when the fluid migrates further than the blood forming a halo effect. A definite confirmation is done by sending the fluid for beta-2 transferrin analysis (Nandapalan et al.,1996). Historically plain x-rays were taken to diagnose these fractures, with the Caldwell and lateral views being the most useful. The gold standard for these fractures is computed tomography. Axial views reveal the location and degree of comminution in the anterior and posterior walls. Coronal views disclose the extent of the floor involvement, and sagittal views assist in examining the frontonasal duct (Finkle at el.,1985).

Fractures of the frontal sinus are classified according to the involvement of either the anterior or posterior walls, involvement of the duct, and CSF leakage from the nose. Gonty classified them into four types, type I, which includes fractures affecting the anterior wall; type II has fractures affecting the anterior and posterior wall, type III, which is for isolated posterior wall fractures and type IV, which is for through and through frontal sinus fractures (Gonty et al.,1999).

Management of these fractures depends on the extent of the fracture, the depression caused, and the duct's status. Anterior wall fractures which are nondisplaced or minimally displaced are treated conservatively (Fattahi et al.,2016). Replaced and marked depression can be treated with open reduction and internal fixation. Posterior wall fractures are more complex to treat due to the risk of CSF leakage, meningitis, and mucocele formation (Rohrich et al.,1995). For minimally displaced fractures and no CSF leak, conservative management is undertaken. Sinus obliteration is indicated if the fracture is greater than 1 table width and there is a CSF leak. In cases where the duct is injured or obstructed, obliteration is suggested. Materials used to obliterate the sinus include fat, bone, or muscle and alloplastic hydroxyapatite (Kalavrzos et al.,1999). Cranialization is indicated when 25-30% of the posterior wall is disrupted (Pollock et al.,2013). Complications of frontal sinus fractures include acute and chronic sinusitis, mucocele and mucopyocele formation, meningitis, osteomyelitis, and brain abscesses (Gerbino et al.,2000).

2.2 Middle third fractures

2.2.1 NOE fractures

Fractures of the nasal region can be divided into those of the nasal orbital ethmoid complex and isolated nasal bone fractures. The NOE complex is a bony union of the nasal, ethmoid, and orbital bones (Nguyen et al., 2010). These fractures make up 15% of paediatric and 5% of adult maxillofacial fractures (Kelley et al.,2005; Chapman et al.,2009). These injuries are caused mainly by high-velocity motor vehicle accidents (Rodenet et al.,2012).

The NOE region is part of the vertical medial buttress of the face. The medial canthal tendon is an essential soft tissue component of the complex. It attaches to the lacrimal fossa after overlying the lacrimal sac anteriorly, posteriorly, and superiorly (Rosenberger et al.,2013). Its status and relation to the central fragment play a considerable role in diagnosing, classifying, and treating NOE fractures.

Injury to the complex results in telecanthus, orbital ecchymosis, epiphora, and CSF rhinorrhoea. Increased intra- canthal distance of greater than 35 mm is suggestive and a distance greater than 40mm is diagnostic of NOE injury. Clinically these injuries are confirmed using a bowstring test and bimanual test. Radiographically these fractures are best diagnosed using a CT scan.

Markowitz et al., (1991) classified these fractures into three types, emphasising the medial canthal tendon attachment and its relation to the central fragment. Type I fracture with a large significant fragment with the MCT attached. Type II fractures are comminuted with the MCT attached.
Type III fractures are comminuted, and there is a loss of attachment of the MCT.

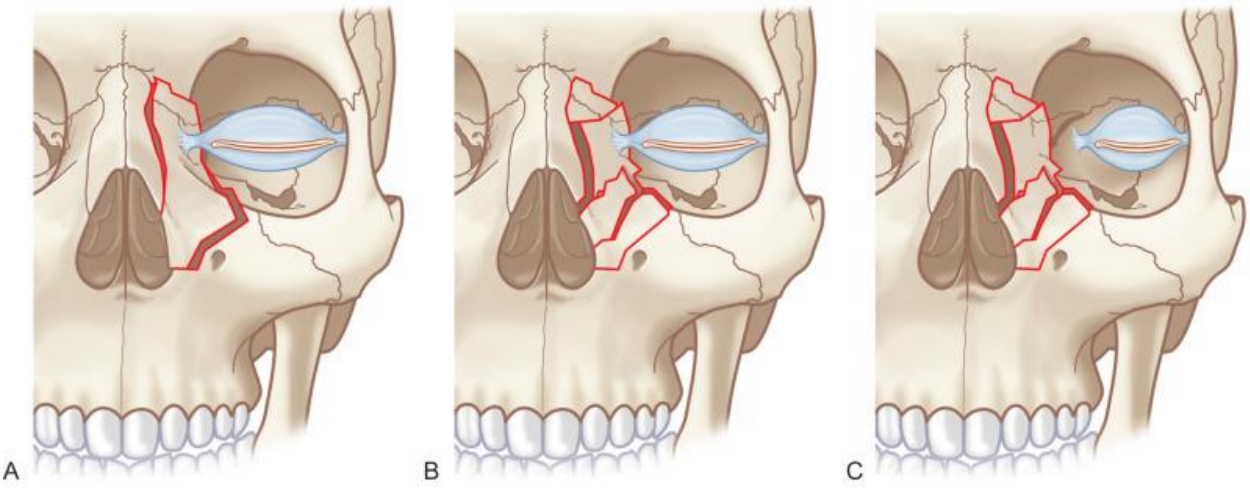

Figure 3. NOE classification A-type I, B-type II, and C- type III (Markowitz et al., 1991)

Management of NOE depends on the displacement, level of comminution, and status of the MCT. Type I fractures that are not displaced can be treated conservatively, and those that are displaced are treated with open reduction and internal fixation. Type II fractures can be treated with ORIF or intraosseous wiring. If the bone containing the MCT is rigidly fixated, no canthopexy is required. Type III fractures are treated through transnasal wiring and canthopexy, with the medial canthal tendon reattaches superior and more posteriorly. The most common complications of these fractures are telecanthus and epiphora.

2.2.2 Nasal bone fractures

Isolated nasal bone fractures frequently occur as a result of the nose prominence and weaker nasal bones owing to their thinness. They are the most common facial fractures but often are not reported as they occur with other facial fractures. The nose is pyramidal in shape and consists of bone and cartilage covered by muscles, mucosa, and skin.

These fractures present with swelling, tenderness, deformity, and haemorrhage of the nasal area. Epistaxis occurs if there is an injury to the blood vessels supplying the area. Plain radiographs may be taken for these fractures. However, if they occur in conjunction with other fractured, it is essential to take a CT scan.

Rohdrich and Adams (2000) classified these fractures into five types. Type I consist of simple unilateral fractures. Type II is simple fractures occurring bilaterally and type III is for comminuted fractures. Type III fractures are subdivided into three subgroups. The first subtype, A, is for unilateral comminution, B – biliteral comminution and C- fractures, including frontal process. Type IV fractures are complex with septal disruption, and they have subtypes. The first is those occurring with hematomas, and the second is those with nasal lacerations. Type V fractures are those associated with NOE and midface fractures.

Type I-III fractures are commonly managed with closed reduction, and types IV and V are primarily managed with open reduction.

2.2.3 Orbital fractures

Orbital fractures make up 10% of all maxilla-facial fractures (Nolasco et al.,1995). They can occur in less frequent isolation or in conjunction with other fractures like the zygomatic complex fractures. Those that involve the orbital bones are termed pure fractures. Fractures that involve surrounding bones are known as impure fractures. These fractures can be further classified as a blowout or blow-in. Blow-in fractures are where the orbital volume is reduced. Blowout fractures result in an increased orbital volume due to the floor being displaced inferiorly.

The most common mechanisms of injury are interpersonal violence and motor vehicle accidents and in children, being hit with a ball or falling is common. Three theories were suggested on the mechanism of blowout fractures. The first theory was by King in 1944, which is called the hydraulic theory. This theory suggests that there is an increased orbital pressure due to the globe being pushed posteriorly. The globe to wall theory was suggested by Pfeiffer in 1943 indicated that these fractures are caused by force delivered to the globe, and thus the globe hitting the walls and resulting in fractures. The third theory was by Le fort in 1901, and it is known as the bone conduction theory. It states that the force is delivered to the orbital rim, which then buckles resulting in a fracture on the floor or medial wall.

Clinical findings associated with these fractures include subconjunctival haemorrhage, periorbital, oedema, muscle entrapment, enophthalmos, and exophthalmos. Computed tomography is the gold standard for diagnoses of these fractures in 1-2 mm cuts.
Jaquiery et al., (2007) classified orbital defects according to the size of the defect, which zones of the orbital wall were affected, and indicated how complex it is to reconstruct the fracture.

Management of orbital fractures is indicated when there is diplopia, enophthalmos, restriction of eye movement, and orbital emergencies. Orbital floor fractures greater than 50% are repaired using titanium mesh, polyethene, or bone grafts. Forced duction is utilised during surgery to check the mobility of the eye during surgery. Complications of orbital fractures include persistent diplopia, enophthalmos, infection, and blindness.

Table 1. Classification of orbital defects by Jaquiery et al (2007).

Category	Description	Note
I	Isolated defect of the orbital floor or the medial wall, 1-2 cm^2, within the anterior two-thirds	
II	Defect of the orbital floor and/or the medial wall, >2 cm^2, within the anterior two-thirds	Bony ledge preserved at the medial margin of the infraorbital fissure
III	Defect of the orbital floor and/or the medial wall, >2 cm^2, within the anterior two-thirds	Missing bony ledge medial to the infraorbital fissure
IV	Defect of the entire orbital floor and the medial wall, extending into the posterior third	Missing bony ledge medial to the infraorbital fissure
V	Same as category IV, extending into the orbital roof	

2.2.4 Le fort fractures

Maxillary fractures are among the commonly described fractures of the facial skeleton. They are more primarily associated with motor vehicle and motorbike accidents than any other facial fracture (Iida et al., 2001). Men in their 2nd to 4th decade are affected mainly by these fractures (Grasner et al., 2003).

Clinically, Le fort fractures present with oedema of the soft tissues and lacerations. Bilateral periorbital ecchymosis and enophthalmos are associated with Le fort II and III. Mobility of the maxilla is noted, and it is usually associated with malocclusion. Often they presents with ecchymosis on the buccal sulcus. If the maxilla is impacted posteriorly, an anterior open bite will occur. Fractures with a mid-palatal split present with ecchymosis and a step between the central incisors.

Maxillary fractures were classified by Rene Le fort into three types according to which level of the maxilla is fractured. Le fort I fracture runs the pyriform rim and lateral nasal wall to the pterygomaxillary fissure. Le fort II fracture is a typical pyramidal fracture where the pterygoid plates are fractured, and the fracture includes the nasofrontal suture. Le fort III fractures are described as craniofacial disjunction with fractures of the pterygoid plates, frontozygomatic sutures, zygomatic arches, and nasofrontal sutures.

Plain films utilised to diagnose these fractures include occipitomental and waters views. When using the OM views, it is essential to follow McGregor-Campbell and Trapnell's lines (figure 4) to identify fractures. Computed tomography is still the gold standard for imaging in these fractures.

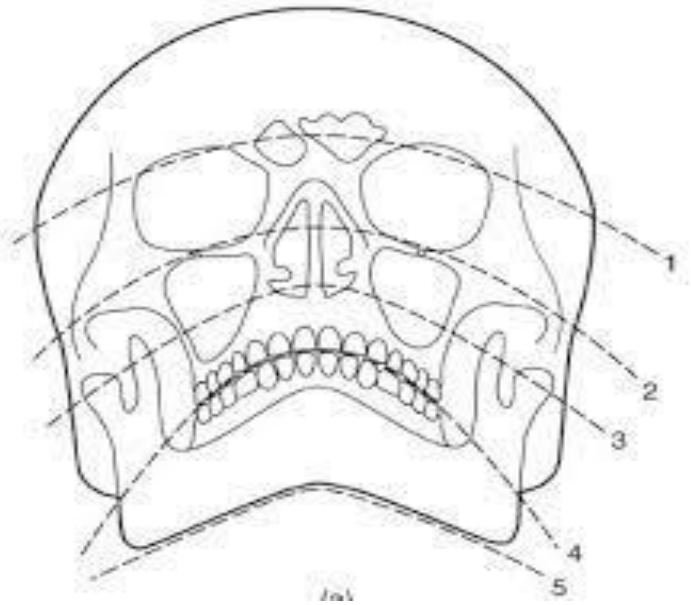

Figure 4. McGregor -Campbell and Trapnell's lines. (Bowley et al .,2007)

The management of these fractures aims to establish good occlusion and to improve aesthetics (Gruss et al., 1986). For minimally displaced fractures and where occlusion is not grossly affected, intermaxillary fixation can be placed against a stable mandible. However, most of these fractures are treated with open reduction and internal fixation as they are displaced and present with an impacted maxilla, which requires mobilisation and disimpaction.

Common complications of these fractures include malocclusion, infraorbital nerve paraesthesia and infection(Hang et al., 1997).

2.2.5 Zygomatic complex fractures and zygomatic arch fractures

The zygoma complex is very prominent in the face and is often injured. Fractures involving the zygoma account for about 25% of all facial fractures(Ellis et al., 1996). Interpersonal violence, sports injuries, and motor vehicle accidents cause these fractures. Males in their 3rd decade of life are affected mostly by these fractures.

Patients affected by these fractures present with a flattened malar area, periorbital oedema and infraorbital nerve paraesthesia. Other symptoms of these fractures include diplopia, malocclusion, and restricted mouth opening when the arch is fractured and impinging on the coronoid process of the mandible. Computed tomography is still the standard gold imaging for these fractures, as all the involved sutures can be analysed. Traditionally, plain films utilised for these fractures include Waters, Caldwell, and SMV views.

North and Knight classified these fractures utilising Waters view in 1961 (Table 2). They divided the fractures into six types. Manson, in 1990 employed CT scans to classify these fractures into low, middle, and high energy according to displacement.

Table 2. North and Knight classification.

Type I	Undisplaced fractures
Type II	Isolated arch fractures

Type III	Unrotated body fractures
Type IV	Medially rotated fractures
Type V	Laterally rotated fractures
Type VI	Complex fractures

The goals of treatment for these fractures are to improve aesthetics and function. The treatment then depends on the degree of displacement, effect on the function, and aesthetics. Low-energy fractures are minimally displaced and thus can be treated conservatively. Middle-energy and high-energy fractures can be treated with open reduction and internal fixation. Depressed zygomatic arch fractures are treated by lifting the arch via the Gillies or Quinn approach. Complications of these fractures include infra-orbital paraesthesia, enophthalmos, diplopia, facial asymmetry, and trismus.

2.3 Lower third fractures

2.3.1 Mandibular fracture

The mandible is reported to be the most affected bone by facial fractures. This is due to its prominence and the fact that it is the only mobile bone of the facial skeleton. Mandibular fractures are caused mostly by interpersonal violence and motor vehicle accidents. Males in the 2nd and 3rd decades of life are affected mainly by mandibular fractures. These fractures present with the following symptoms malocclusion, steps in the lower border and occlusion, mobility of the fractured segments, lacerations in the oral mucosa, localised swelling which is tender to palpation, limited mouth opening, and nerve injury.

Fractures of the mandible were anatomically classified by Dingman and Natvig (1969) divided into the following areas: symphyseal, para-symphyseal, body, angle, ramus, coronoid and condyle fractures. Kazanjian and Converse, in 1974, classified them into three classes based on the presence of teeth and the serviceability of those teeth. Class I fractures are those with teeth present on both sides. Class II fractures have teeth on one side of the fracture, and class III fractures occur in edentulous patients. They were further classified in relation to the environment and type by Kruger and Schii (1982). Simple fractures are those with no communication to the oral cavity or the skin, and compound fractures have communication with the skin or the oral mucosa. The types of fractures were divided into greenstick, complete, incomplete and community. Shetty described these fractures in the body and angle into favourable and unfavourable according to the direction of the fracture and muscle action on the fractured segments.

Management of these fractures depends on factors such as fracture displacement, infection, and availability of resources. These fractures can be treated conservatively or through closed reduction and open reduction. Conservative management is reserved for incomplete fractures or hairline. Closed reduction is for minimally displaced fractures where intermaxillary fixation would be sufficient to reduce the fractures. Open reduction is when the fractures are opened, physically reduced, and fixated into the previous position before fracturing. It is more for severely displaced fractures and insufficient teeth for intermaxillary fixation.

Common complications of these fractures include post-operative infection, malunion and non-union, and malocclusion.

2.3.2 Condylar fracture

Condylar fractures are defined as any fracture which occurs above the sigmoid notch and the fracture line running posteriorly to involve the base, neck, or condylar head (Loukota et al.,2003). These fractures are considered a preventative mechanism for intracranial intrusion of the condyles into the middle cranial fossa (Matsumulo et al.,2005). Ellis's study showed that these fractures compromised 29.3% of all mandibular fractures. Mostly males are affected by condylar fractures, they are caused by interpersonal violence and falls (Silvennoinen et al.,1992).

Patients with condylar fractures present with pain, pre-auricular swelling, limited mouth opening, malocclusion, anterior open bite with bilateral condylar fractures, and deviation to the affected side with unilateral fractures due to the action of the lateral pterygoid muscle. Imaging utilised for these fractures include panoramic, reverse Townes x -rays, and computed tomography. MRI are best for assessing intracapsular fractures.

The Wits Classification system describes 4 types of condylar fractures. Type I is for undisplaced fractures, type II is for displaced fractures, and is divided into two subgroups. The first IIA is for displaced fractures with no loss of ramal height and IIb with ramal height loss. Type III fractures are dislocated from the glenoid fossa, and type IV fractures are comminuted (Figure 5).

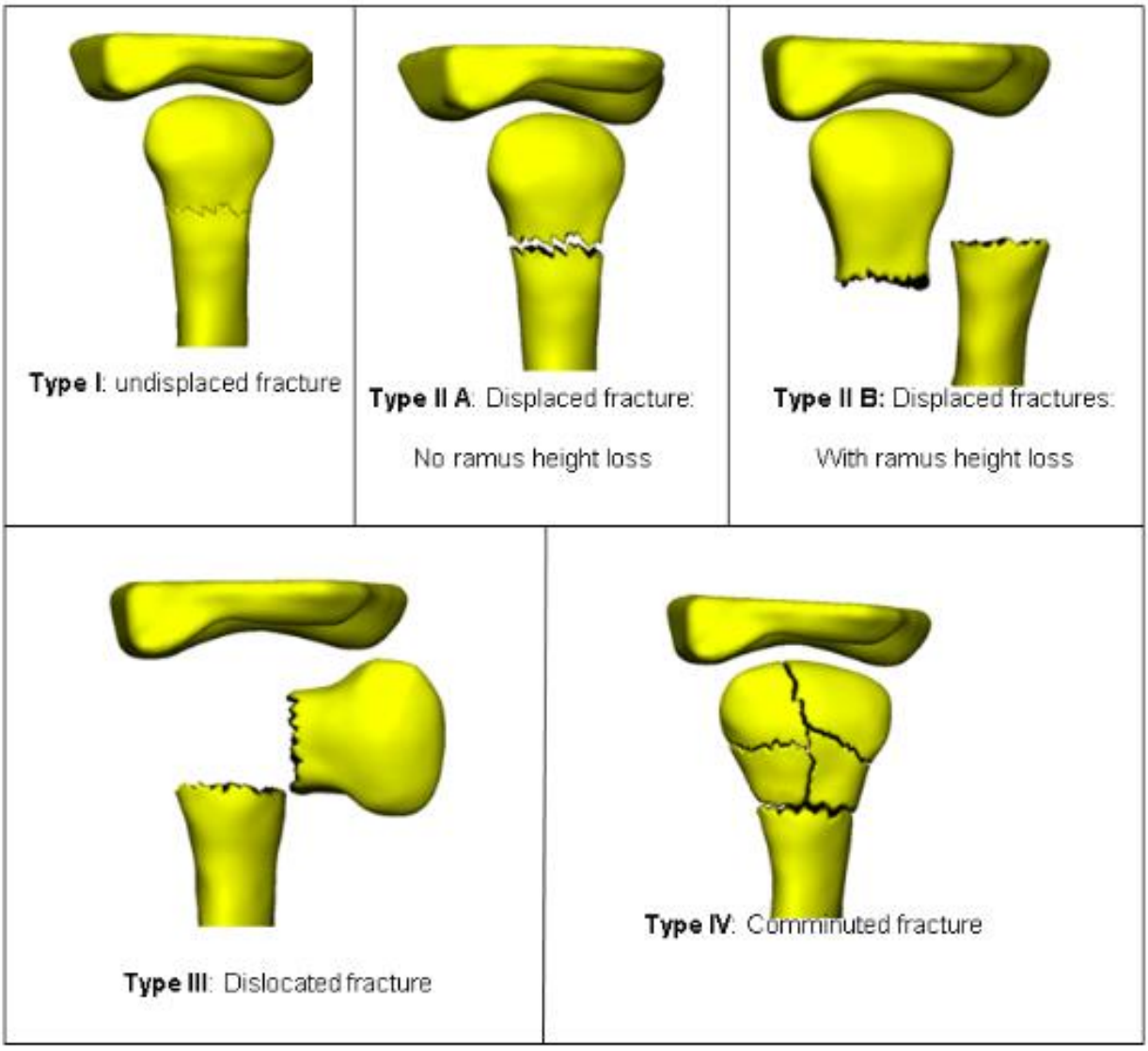

Figure 5. The Wits classification of condylar fractures.

Management of these fractures is based on the condylar head position with the glenoid fossa and either loss or maintenance of the ramal height (Kleinhuiz et al.,1988). Fractures classified as type I and IIA are mostly treated with closed reduction or conservatively. Open reduction is indicated in fractures with displacement into the middle cranial fossa, the presence of a foreign body, extracapsular displacement of the condyle laterally, and the inability to obtain acceptable occlusion (Zide and Kent., 1983).

The complications of these fractures include malocclusion, ankylosis, facial asymmetry in children, and infection. With an extra oral approach to these fractures, the common complications are facial nerve injury and keloid formation.

2.3.3 Dentoalveolar fractures

Dentoalveolar fractures are injuries involving the alveolar part of the maxilla or the mandible and surrounding soft tissues (Dale., 2000). These fractures are common among children and adolescents. They occur primarily in males compared to females and are often caused by falls, sports injuries, and motor vehicle accidents.

Presenting symptoms include soft tissue swelling, mobility of the teeth and bone, laceration of the oral mucosa, displaced teeth, avulsed teeth, and crown fractures. Radiographic examinations for these fractures include intra-oral periapical and panoramic x-rays, and if there are other facial fractures, computed tomographs are indicated (Kullman et al., 2002).
The most common classification for these fractures is by Andreasen, which is based on the involvement of hard tissues, periodontal injuries, supporting bone, and oral mucosa (Glender et al., 2007)

- Comminution of the alveolar socket.
- Fracture of the alveolar socket wall.
- Fracture of the alveolar process.
- Fracture of the mandible or maxilla.

Management of these fractures depends on which tissue is involved. Crown fractures are treated with fillings, and root canals are done if the pulp is involved. Teeth with periodontal injuries are treated with implantation and stabilising with arch bars. Soft tissue injuries are debrided, and those involving the alveolar bone are treated with arch bars for six weeks. Complications of these fractures include infection, ankylosis of teeth, and malocclusion.

Several aetiological factors result in craniofacial trauma, and although there are global variations, interpersonal violence and road traffic accidents feature prominently (Rikhotso & Ferretti, 2008; Mogajane & Mabongo, 2018; Pillay et al., 2018; Zaidi et al., 2019). Other causes are self-inflicted injuries, falls, burns, and occupational and sports-related injuries (Leles et al., 2010; Zaidi et al., 2019). In Brazil and India, road traffic accidents were reported to be the leading causes of trauma (Alves et al., 2012; Gorg et al., 2012). In Sweden, falls were the leading cause of trauma, while in Germany and Australia, interpersonal violence accounted for most of the reported trauma (Kai, 2012; Boffano et al., 2015). This suggests that the aetiology of maxillofacial injuries differs based on socioeconomic status, geographic location, and level of industrialisation. The patterns of maxillofacial trauma in rural areas will thus differ from those reported in urban areas (Pillay et al., 2018; Mogajane & Mabongo, 2018).

Even though the mandible is the largest and strongest facial bone, it is the most fractured bone in maxillofacial trauma due to its position on the face and prominence (Upton, 1991). Studies globally have also shown that the mandible is the most commonly affected maxillofacial area (Kai, 2012; Boffano et al., 2015; Alves et al., 2018; Pillay et al., 2018). In contrast, a German study reported zygomatic bone fractures as the most common (Schneider et al., 2015). Mogajane and Mabongo found that orbital fractures were the second most common, accounting for about 9% of all fractures. However, Pillay et al. (2018) reported in their study that zygomatic fractures were the second most common fractures. Similarly, zygomatic bone fractures were also reported as the second-highest fractures in Australia, Ukraine, and Norway (Kai, 2012; Boffano et al., 2015). Patterns of maxillofacial fractures, therefore, differ based on geographic location.

Maxillofacial trauma is more prevalent in males than females in various parts of the world (Boffano et al., 2015; Alves, 2018; Pillay et al., 2018). Males are more predisposed to trauma based on behavioural patterns, alcohol consumption, and exposure to occupational hazards (Boffano et al., 2015; Alves, 2018). The age distribution of those individuals diagnosed with fractures differs from region to region: in the Eastern Cape, individuals aged 18-24 years were more frequently involved, while in Gauteng, the range was from 21-30 years (Pillay et al., 2018; Mogajane & Mabongo, 2018). This finding concurs with the 19-32 years age distribution reported

by Boffano e al., (2015). In Germany, it was found that males aged 20-29 years and females aged 50-59 years were most affected (Schneider et al., 2015). In Australia, the most affected age group in males and females was 16 -30 years (Kai et al., 2012). Although there are global and geographic variations, facial fractures appear more prevalent in the 2nd and 3rd decades.

Treatment of these fractures depends on the country's socioeconomic status and the affected individuals, as well as the availability of facilities with trained personnel. In first-world countries such as the United States of America and the United Kingdom, these fractures are routinely treated with open reduction and a concise waiting period (Schneider et al., 2015). In contrast, in second-world countries like Uganda and Columbia, most fractures are not treated immediately, and closed reduction is used more frequently (Teshome et al., 2017). Limited access to healthcare facilities, lack of resources (financial and human resources), and trained personnel often lead to inordinate delays and compromised treatment of facial fractures in developing countries. All these factors often result in poor treatment outcomes.

Pelonomi Hospital is a regional tertiary hospital in the Free State, providing specialist care and training to both undergraduate and postgraduate students. Pelonomi Hospital has the only maxillofacial unit in the Free State province offering services to the entire province. Due to its close proximity to the country of Lesotho, it also accepts referrals of patients requiring specialist oral and maxillofacial surgery care from Lesotho.

A study analysing the patterns of maxillofacial injuries treated in the unit has not been conducted. A sequential collection of this data will allow public officials and practitioners to assess and address the aetiologies, re-evaluate protocols and design new strategies that can be implemented to ensure efficient and effective utilization of scarce resources. Due to Pelonomi Hospital’s

geographic location, its multi-disciplinary team approach and the large population it serves, it is an ideal setting for such a study.

2.4 Aim

To analyse the patterns and distribution of maxillofacial fractures at Pelonomi Hospital.

2.5 Objectives

1. To determine the demographics of patients presenting with maxillofacial fractures.
2. To determine the aetiology and type of facial fractures.
3. To determine the patterns and appropriateness of referrals to the maxillofacial unit at Pelonomi Hospital (PH).
4. To describe the type of treatment and any delay in treatment.

2.6 Rationale for the study

It is envisaged that data derived from this study will be instrumental in developing a more effective and efficient referral system in the Free State. The study will also provide insight into the aetiologies and patterns of maxillofacial trauma within the Free State, which could be used to develop preventative measures to reduce the occurrence of maxillofacial trauma within the region. Understanding the patterns and appropriateness of referrals can reduce waiting times and ensure the proper utilization of limited resources at the facility. The information obtained from the study can also be disseminated to local clinics to create awareness and improve the referral system to the

specialized unit. The study will provide data regarding the patterns of maxillofacial trauma in a typical South African setting, thereby contributing to literature with local relevance

CHAPTER 3

3.1 MATERIALS AND METHODS

3.1.1 Study design

This was a retrospective, cross-sectional, descriptive study designed to analyse the patterns and distribution of maxillofacial fractures at Pelonomi Hospital over three years (January 2017 – December 2019).

3.1.2 Study population

Convenience sampling was used to determine the study population. All the patients seen within the specified period (January 2017- December 2019) who met the inclusion criteria made up the study population.

3.2 Data collection

Data was collected from the administrative registers, radiological archives, and inpatient and outpatient records available at Pelonomi Hospital from January 2017 - December 2019. A data collection sheet was used to record all the patient's clinical and radiographic records (Annexure A). Variables recorded included demographic data (gender, age), aetiology of the trauma, type of fractures, type of treatment provided which were conservative for patients that were given analgesics, closed for the use intermaxillary fixation and open reduction were plates and screws were utilised. The delay in treatment was determined from date of injury to the day of treatment (Annexure A). The referral letters were assessed to determine the appropriateness of the referral and the district from which the patient was referred. Radiographic records were retrieved from archives and evaluated for the type of fractures. These radiographs were sent to a maxillofacial and oral surgeon skilled in radiographic interpretation for a second opinion on the kinds of

fractures diagnosed. The fractures were classified based on location into upper, middle and lower third facial fractures.

3.3 Data analysis

Descriptive statistics of frequency and percentage were used to summarise the data. Fischer's exact test was used to determine the association between the independent and dependent variables. The significance was determined by Monte Carlo significance (2-sided) with a 99% confidence interval (Silva and Assunção, 2018). The Monte Carlo significance was used because the data 2 x 2 does not meet the requirement to perform a Chi-Squared test; all the difficulty of associations has cells with 0 frequencies in at least one cell (Swinscow and Campbell, 2002). The level of significance was set at a p-value less than 0.05.

3.4 Inclusion criteria

All patients who presented with maxillofacial fractures during the specified period were included in the study.

3.5 Exclusion criteria

Patients with isolated soft tissue injuries and maxillofacial fractures secondary to pathology. Incomplete records and missing records.

3.6 Ethics

Ethical approval was obtained from the Human Research Ethics Committee (Medical) at the University of the Witwatersrand (Ethics number M210207). A request for permission to use hospital records was introduced to the Clinical Manager and Chief Executive Officer of Pelonomi Hospital.

3.7 Confidentiality

The principal investigator maintained the participants' anonymity and the captured data's confidentiality. Personal identifiers were removed from the data and were only accessible to the principal investigator (Annexure ?).

3.8 Funding

The primary investigator funded the study.

CHAPTER 4

4.1. Results

4.1.1 Demographic characteristics of the participants

The majority of the participants were males (78.2%), and 41.2% were aged between 20 – 29 years old. The most affected ethnic group were Blacks making up 81.1% of the study population (Table 3).

Table 3: Demographics characteristics of the participants

AGE category in years	Frequency	Percent
20-29	127	41.4
30-39	108	35.2
40-49	29	9.4
13-19	22	7.2
>50	16	5.2
<12	5	1.6
GENDER		
Male	240	78.2
Female	67	21.8
RACE		
Black	249	81.1
White	53	17.3
Other	5	1,6
DISTRICT		
Mangaung	122	39.7

Thabo Mofutsanyane	61	19.9
Lejweleputwa	43	14.0
Xhariep	33	10.7
Fezile Dabi	31	10.1
Lesotho	17	5.5

4.2 Aetiology of trauma

A total of 307 patients with maxillofacial fractures were included in the study. The most common cause of fracture was blunt trauma due to interpersonal violence (IPV) (60.91%), followed by road traffic accidents (RTA) (23.13%), falls (8.14%), and sports (7.82%). Most of those who sustained fractures due to interpersonal violence were assaulted without a weapon, 54.44% (Table 3). Motor vehicle accidents were the leading cause of injuries within road traffic accidents category, with 73.4%, followed by pedestrian-vehicle accidents(Table 2). Within the sports-related injuries, rugby and soccer were responsible for the same number of injuries, with 41.67% (Table 3).

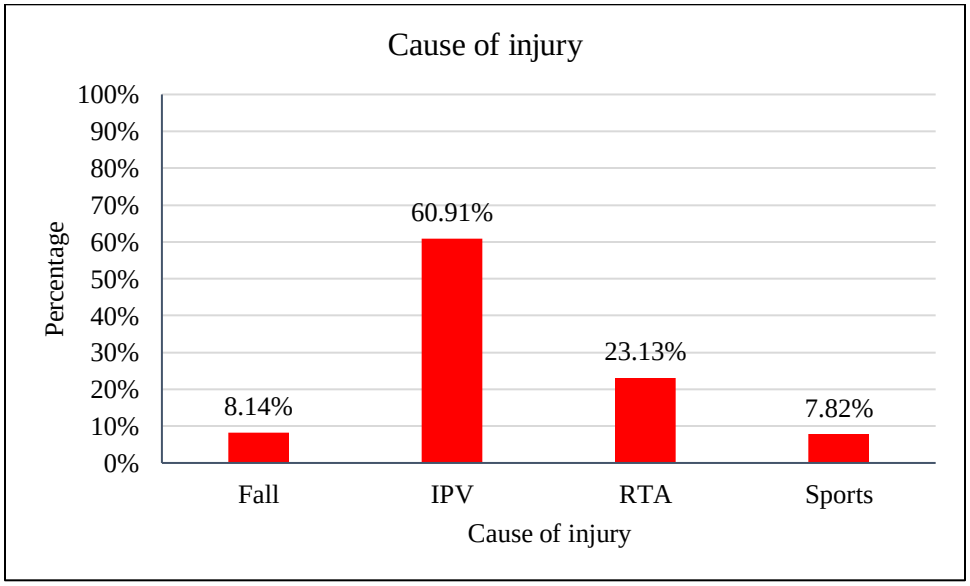

Figure 6: Cause of trauma (N=307)

Table 4: Aetiology of fractures (N=307)

Cause of trauma	Frequency	Per cent
FALL	25	8.14%
Epileptic	8	32%
Walking	6	24%
Collapsed	5	20%
Running	3	12%
From height	3	12%
INTERPERSONAL VIOLENCE	187	60.91%
Without a weapon	102	54.55%
With a weapon	85	45,45%
ROAD TRAFFIC ACCIDENT	71	23.13%
Motor vehicle	52	73.24%
Pedestrian	11	15.49%
Motorcycle	7	9.86%
Bicycle	1	1.41%
SPORTS	24	7.82%
Soccer	10	41.67%
Rugby	10	41.67%
Other	3	12.50%
Cricket	1	4.17%
Alcohol involvement		
Yes	198	64.50%
No	109	35.50%

4.3 Alcohol involvement

Of the 307 patients, 198 reported to have been under the influence of alcohol at the time of injury (Figure 2).

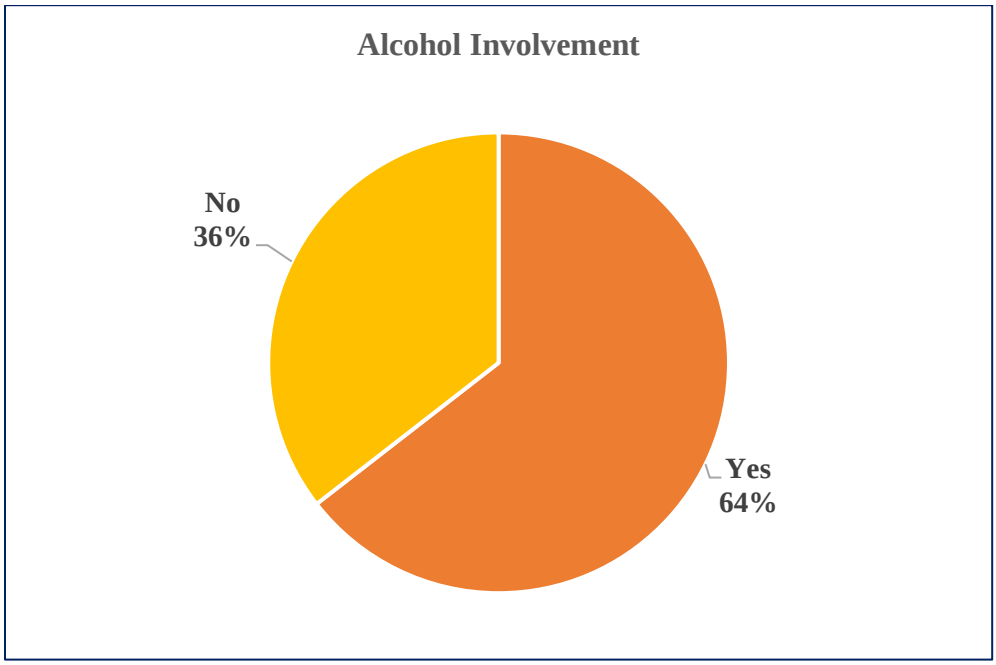

Figure 7: Alcohol involvement (N=307)

4.4 Type of maxillofacial trauma

70.7% of the participants had mandibular fractures, followed by zygoma fractures (9.1%), nasal bone fractures (6.8%) and dentoalveolar fractures (Table 5).

Table 5: Type of maxillofacial trauma (N=307)

Type of maxillofacial trauma	Frequency	Percent
Mandible fractures	217	70.7
Zygomatic fractures	28	9.1
Nasal Bone fractures	21	6.8
Dentoalveolar fractures	16	5.2
Le fort fractures	14	4.6
Orbital fractures	7	2.3
Frontal bone fractures	4	1.3

4.5 Treatment

More than half of the fractures were managed using closed reduction (52%) and the rest were managed using open reduction (36%) and conservatively (12%) (Figure 8).

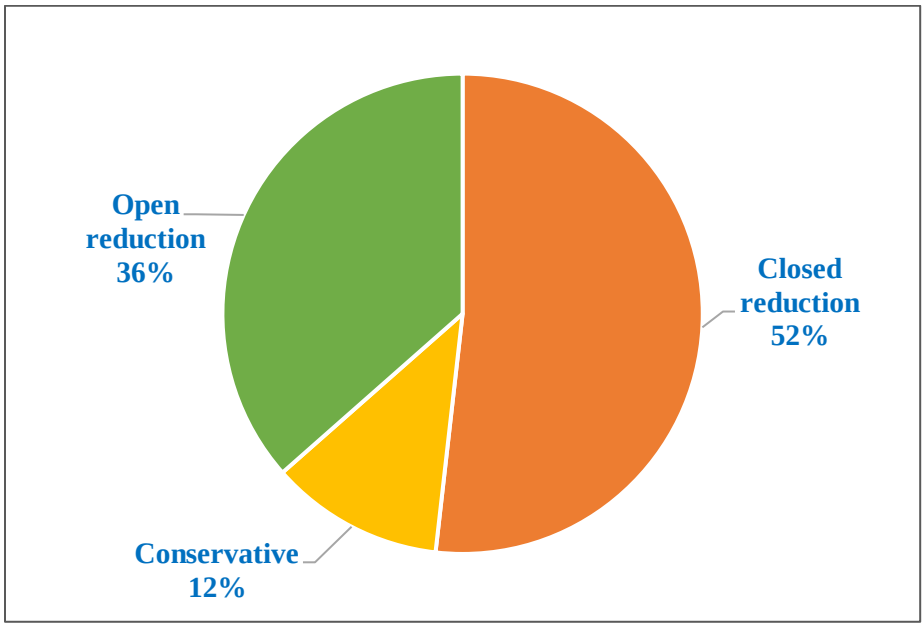

Figure 8: Treatment (N=307)

4.6 Waiting period for treatment.

Majority of the study population (58.6%) waited 2 weeks for treatment (Table 6).

Table 6: Waiting period for treatment.

Waiting period	Number	%
2 weeks	180	58.6
<1week	87	28.3
3 weeks	38	12.4
>3 weeks	2	0.7

4.2 Associations between variables

4.2.1Association between age and type of maxillofacial fracture

Fischer's exact test showed that type of maxillofacial fracture was significantly associated with age (p-value=0.00) (Table 7).

Table 7: Association between the type of fracture and age (in years)

Type of maxillofacial fracture	< 19	20-29	30-39	40-49	>50	Fischer's exact test	Sig.
Dento-alveolar fractures	5(18.5)	7(5.5)	-	2(6.9)	2(12.5)	44.50	0.00*
Frontal fractures			3(2.8)	1(3.4)			
Le fort fractures	1(3.7)	4(3.1)	5(4.6)	3(10.3)	1(6.3)		
Mandible fractures	14(51.9)	95(74.8)	80(74.1)	19(85.5)	9(56.3)		
Nasal bone fractures	5(18.5)	7(5.5)	9(8.3)	-	-		
Orbital fractures	-	1(0.8)	5(4.6)	1(3.4)	-		
Zygomatic fractures	2(7.4)	13(10.2)	6(5.6)	3(10.3)	4(25)		

4.2.2 Association between the type of maxillofacial fracture and gender

There was no significant association between gender and type of maxillofacial fracture, p=0.20 (Table 8).

Table 8: Association between the type of fracture and gender

Type of maxillofacial fracture	Male	Female	Fischer's exact test	Sig.
Dento-alveolar fractures	9(3.8)	7(10.4)	8.15	0.20
Frontal fractures	3(1.3)	1(1.5)		
Le fort fractures	13(5.4)	1(1.5)		
Mandible fractures	168(70)	49(73.1)		
Nasal bone fractures	16(6.7)	5(7.5)		
Orbital fractures	6(2.5)	1(1.5)		
Zygomatic fractures	25(10.4)	3(4.5)		

4.2.3 Association between the type of maxillofacial fracture and race

There was no significant association between the type of maxillofacial fracture and race, p=0.58 (Table 9).

Table 9: Association between the type of maxillofacial fracture and race

Type of maxillofacial fracture	Black	White	Others	Fischer's exact test	Sig.
Dento-alveolar fractures	11(4.4)	5(9.4)	-	9.89	0.58
Frontal fractures	3(1.2)	1(1.9)	-		
Le fort fractures	14(5.6)	-	-		
Mandible fractures	174(69.9)	39(73.6)	4(80)		
Nasal bone fractures	17(6.8)	3(5.7)	1(20)		
Orbital fractures	6(2.4)	1(1.9)	-		
Zygomatic fractures	24(9.6)	4(7.5)	-		

4.2.4 Association between the type of maxillofacial fracture and district

There was no significant association between type of maxillofacial fracture and district, p=0.14 (Table 10).

Table 10: Association between the type of maxillofacial injury and district

Type of maxillofacial fracture	fezile dabi	Lejweleputsa	Lesotho	Mangaung	matshabeng	t.mofitsanyane	Xhariep	Fischer's exact test	Sig.
Dento-alveolar fractures	-	1(2.4)	-	10(8.2)	-	3(4.9)	2(6.1)	43.47	0.14
Frontal fractures	1(3.2)	1(2.4)	-	1(0.8)	-	-	1(3)		
Le fort fractures	2(6.5)	2(4.8)	4(23.5)	4(3.3)	-	1(1.6)	1(3)		
Mandible fractures	18(58.1)	31(73.8)	11(64.7)	84(68.9)	1(100)	46(75.4)	26(78.8)		
Nasal bone fractures	5(16.1)	1(2.4)	-	8(6.6)	-	6(9.8)	1(3)		
Orbital fractures	2(6.5)	3(7.1)	-	1(0.8)	-	1(1.6)	-		
Zygomatic fractures	3(9.7)	3(7.1)	2(11.8)	14(11.5)	-	4(6.6)	2(6.1)		

4.2.5 Association between aetiology and type of maxillofacial fractures

There was a significant association between the cause of injury and type of maxillofacial fracture (p=0.00) (Table 11).

Table 11: Association between the type of maxillofacial fracture and cause of injury

Type of maxillofacial fracture	Fall	IPV	RTA	Sports	Fischer's exact test	Sig.
Dento-alveolar fractures	5(20)	7(3.7)	-	4(16.7)	46.81	0.00*
Frontal fractures	-	1(0.5)	3(4.2)	-		
Le fort fractures	2(8)	9(4.8)	3(4.2)	-		
Mandible fractures	16(64)	139(74.3)	50(70.4)	12(50)		
Nasal bone fractures	1(4)	12(6.4)	1(1.4)	7(29.2)		
Orbital fractures	-	4(2.1)	2(2.8)	1(4.2)		
Zygomatic fractures	1(4)	15(8)	12(16.9)	-		

IPV – Interpersonal Violence

RTA – Road Traffic Accident

4.2.6 Association between the type of maxillofacial fracture and alcohol involvement

There was no significant association between alcohol involvement and type of maxillofacial fracture (p=0.11) (Table 12).

Table 12: Association between the type of maxillofacial fracture and alcohol involvement

Type of maxillofacial fracture	Yes	No	Fischer's exact test	Sig.
Dento-alveolar fractures	6(3)	10(9.2)	10.55	0.11
Frontal fractures	3(1.5)	1(0.9)		
Le fort fractures	11(5.6)	3(2.8)		
Mandible fractures	145(73.2)	72(66.1)		
Nasal bone fractures	10(5.1)	11(10.1)		
Orbital fractures	6(3)	1(0.9)		
Zygomatic fractures	17(8.6)	11(10.1)		

4.2.7 Association between treatment and type of maxillofacial fracture

Fischer exact test showed that there was a significant association between treatment type and type of maxillofacial fracture (p=0.00) as shown in Table 13.

Table 13: Association between treatment and type of maxillofacial fracture

Type of maxillofacial fracture	Closed reduction	Conservative	Open reduction	Fischer's exact test	Sig.
Dento-alveolar fractures	16(10.1)	-	-	193.73	0.00*
Frontal fractures	-	4(11.1)	-		
Le fort fractures	-	-ss	14(12.5)		
Mandible fractures	139(87.4)	1(2.8)	77(68.8)		
Nasal bone fractures	4(2.5)	15(41.7)	2(1.8)		
Orbital fractures	-	3(8.3)	4(3.6)		
Zygomatic fractures	-	13(36.1)	15(13.4)		

4.2.8 Association between waiting period and type of maxillofacial fracture

There was no significant association between the waiting period and type of maxillofacial fracture (p=0.38) (Table 14).

Table 14: Association between waiting period and type of maxillofacial fracture

Type of maxillofacial fracture	<1week	2 weeks	3 weeks	>3weeks	Fisher's exact test	Sig.
Dento-alveolar fractures	3(3.4)	11(6.1)	2(5.3)	-	20.56	0.38
Frontal fractures	1(1.1)	3(1.7)	-	-		
Le fort fractures	5(5.7)	9(5)	-	-		
Mandible fractures	58(66.7)	126(70)	32(84.2)	1(50)		
Nasal bone fractures	10(11.5)	10(5.6)	1(2.6)	-		
Orbital fractures	4(4.6)	2(1.1)	1(2.6)	-		
Zygomatic fractures	6(6.9)	19(10.6)	2(5.3)	1(50)		

CHAPTER 5

5. DISCUSSION

5.1. Demographics

5.1.1. Gender

We found in this study that the trend with regard to gender of patients with facial fractures was similar to those reported in previous studies (Pillay et al., 2018; Verma et al., 2015; Mogajane et al., 2018).· 78,2% of the study population were males, and 21,8% were females. This resulted in a male-to-female ratio of 4,5:1. This is in agreement with other studies done locally and internationally (Pillay et al.,.2018, Verma et al.,.2015; Schneider et al.,2015). Males are usually injured because of involvement in contact sport, driving and interpersonal violence more than females. 82 % of the males sustained their injuries while under the influence of alcohol and only 18% females were injured having consumed alcohol.

5.1.1.2 Age

Individuals in the 2nd decade of life were affected mainly by facial fractures (41.4%), followed by those in the third decade (35,2%). Daliverska et al., (2012) and Schneider et al.,(2015) reported results which are in consonance with our study. This is due to the active lifestyle individuals in this group have.

5.1.1.3 Ethnicity

The majority of the individuals in the study were blacks (81%), followed by whites (17.3%). This is in alignment with the study done by Mogajane et al ., (2018). This was expected and is a result of blacks being the majority of the population in the province (88,7%). There was no association between race and type of fracture sustained.

5.2 Aetiology of facial fractures and effects of alcohol on maxillofacial trauma

In the present study, interpersonal violence (50,91%), followed by road traffic accidents were the leading causes of maxillofacial fractures. This concurs with previous local studies (Pillay et al., 2018, Mogajane et al., 2018) . In contrast, Motamedi et al., (2014) and Shah et al., (2016) found that road traffic accidents followed by falls were the leading causes. This was found to be related to the level of urbanisation of the area in which the study was conducted.

Excessive alcohol consumption is a co-factor in interpersonal violence and motor vehicle accidents-related facial injuries (Lee at el., 2010). Alcohol contributed to 65% of the maxillofacial fractures within our study population. This is in agreement with other studies that found that 65% of facial trauma was related to alcohol (Desai et al ,.2010). Schneider et al.,(2015) also reported that 75% of their study population had sustained facial fractures while under the influence of alcohol. In contrast most Middle East countries report a low association between alcohol and facial fractures. The reasons stipulated for this was banning alcohol and religious beliefs.

5.3 Type of facial fractures

Mandibular fractures were the most common type of fractures (70.7%), followed by nasal bone fractures. Shankar et al ,. (2011) and Shah et al., (2016) also found the mandible to be the most affected bone. Reasons for this include the fact that the mandible is very prominent and mobile compared to other facial bones. Despite the fact that the mandible is the largest and strongest facial bone, it is the most commonly fractured bone in maxillofacial trauma due to its position on the face and its prominence (Upton, 1991). The mandible also has less bony support than the maxilla. In their study, Pillay et al., (2018) found zygomatic complex fractures to be the second most common fractures after mandibles.

5.4 Referral patterns

Motheo district (Mangaung metro) accounted for the majority of patients in the study (39,7%). This is due to the high population density of the community, urbanisation, and industrialisation compared to other districts. Batista et al,.(2012) showed a high prevalence of maxillofacial trauma in urban areas of Brazil compared to rural areas. The reasons stipulated for this were high number of people found in urban areas due to availability of jobs, presence of more motor vehicles which increases the risk for road accidents and industrial jobs which may predispose individuals to injury. Mogajane et al.,(2018) also reported similar findings between urban and rural hospitals in South Africa. In contrast Al- Dajani et al,.(2015) found a high prevalence of facial trauma in the rural areas of Ontario. Their explanation was that most families from rural areas do not have medical insurance and hence they present more than the urban population who have an option to present to the private sector. Thabo Mofutsanyane district followed with (19,9%) as the most prominent district. However, this district is the furthest from the maxillofacial unit. Lesotho accounted for 5.5% of the patients in the study due to the unavailability of maxillofacial surgeons in that country.

5.5 Treatment

Most fractures were treated with closed reduction (52%). It appears like lack resources is a significant contributor to this finding. These include lack of human resources, funding for plates and screws, and lack of available theatre time. This finding is similar to Shah et al.,.(2016), in which closed reduction was used as a treatment modality for most fractures. However, Manodh et al., (2016) found that most of the patients in their study were treated with open reduction and internal fixation (73,5 %). The benefits for this were increased success rates postoperatively, early active mobilisation of the jaws, and less patient morbidity (Shetty et al., 2008). In our study, only 36% of the patients were treated with open reduction.

5.6 Waiting period for treatment.

Early treatment of fractures is advocated as it reduces the chances of infection, pain, and post-operative complications . Ideally, mandibular fractures should be treated in the first week and other facial fractures within two weeks. Hermund et al., (2008) advocated for early treatment of fractures within the first 72 hours post injury. The main reason for this was that the outcome of the fracture depends on the cellular activity around the fracture area, and it was high with 3-

4 days post injury. Derdyn et al.,(1990) argued that delay in treatment is associated with fibrous tissue deposition and callus formation in the fracture site. This then increase the difficulty in reducing the fractures, directly affecting treatment outcomes. However, many factors inhibit patients from presenting early such as getting treatment for more life-threatening injuries, lack of compliance and financial constraints. In addition, hospital related factors such delayed transfers, lack of theatre time and shortage of resources can contribute to delay in treatment. In our study, most patients waited for two weeks (58%), followed by less than one week (28%). Possible factors responsible for delay in treatment include delay in transportation of patients to the unit and lack of readily available theatres.

There are a number of limitations associated with our study. Our sample size may not have been large enough to detect the association between alcohol, gender and type of fractures. Additionally, long term follow-up and complications associated with the different fractures and treatment types were not investigated.

Other factors such as available workforce at PH, delay in presentation and seniority of the surgeon were also not investigated. Notwithstanding its limitations, this study has added valuable information to the patterns and distribution of maxillofacial fractures at PH and the Free State province at large.

In conclusion, this study has shown that blunt trauma due to inter-personal violence is responsible for most maxillofacial fractures at PH, with mandibular fractures being the most common fracture type. Majority of the patients with facial fractures were males in the 20-29 age group category and were treated by closed reduction. Most patients sustained their fractures whilst under the influence of alcohol.

Future prospective studies, involving a larger number of patients, as well as post-treatment follow-up period that will include data on treatment complications, delay in presentation and fracture types are recommended.

REFERENCES:

Alves, L., Arago, I.,2014. Patterns of maxillofacial fractures in severe multiple trauma patients: A 7years prospective study. Brazilian Dental Journal,25(6), pp1-4.

Boffano, P., Roccia, F.2015. Assault related maxillofacial injuries. The results from European Maxillofacial Trauma multicenter prosespective calloboration. Oral surg,119, pp385-391.

Bowley NB, Brown J. Radiology for maxillofacial trauma. In Booth PW, Schendel SA, Hausamen J-E, editors. Maxillofacial surgery. Churchill Livingstone Elsevier; 2007. p. 278–9.

Chapman VM, Fenton LZ, Gao D, et al. Facial fractures in children: unique patterns of injury observed by computed tomography. J Comput Assist Tomogr 2009;33: 70–72 .

Dingman RO, Natvig P. Surgery of facial fractures. Philadelphia, PA: Saunders; 1964. p. 193.

Dingman, R., Natvig, P.,1967. Surgery of facial fractures. W. Saunders company, 142-144.

Ellis E 3rd, Kittidumkerng W. Analysis of treatment for isolated zygomaticomaxillary complex fractures. J Oral Maxillofac Surg1996;54(4):386-400.

Fattahi T, Salman S. An aesthetic approach in the repair of anterior frontal sinus fractures. Int J Oral Maxillofac Surg. 2016;45(9):1104–7.

Finkle DR, Ringler SL, Luttenton CR, et al. Comparison of the diagnostic methods used in maxillo- facial trauma. Plast Reconstr Surg. 1985;75(1):32–41.

Gassner R, Tuli T, Hèchl O, et al.: Cranio-maxillofacial trauma: a 10 year review of 9543 cases with 21067 injuries, *J Craniomaxillofac Surg 31:51–61, 2003.*

Gerbino, G., Roccia, F., Benech, A., et al. Anal- ysis of 158 frontal sinus fractures: Current surgical manage- ment and complications. J Craniomaxillofac Surg. 28: 133.

Gonty AA, Marciani RD, Adornato DC. Management of fron- tal sinus fractures: a review of 33 cases. J Oral Maxillofac Surg. 1999;57:372–9.

Grag, V., Singh, H.,2012. Trends of maxillofacial trauma at a tertiary care hospital in rural area of Southern Punjab. Journal of Indian Academic Forensic Medicine,34(1), pp 49-51.

Gruss JS, Mackinnon SE. Complex maxillary fractures: role of buttress reconstruction and immediate bone grafts. Plast Reconstr Surg. 1986;78(1):9–22.

Hogg, N.J.V., Stewart, T.C.,2000. Epidemiology of maxillofacial injuries at trauma hospitals in Ontario,Canada between 1992 to 1997. Journal of trauma, 49(3),pp 425-432.

https://www.google.com/maps/place/Pelonomi+Academic+Hospital./@-28.7130548,24.0783608,5.87z/data=!4m5!3m4!1s0x1e8fcf8161155cd1:0x7d1c399986e7717a!8m2!3d-29.1395525!4d26.2447241?hl=en

Iida S, Kogo M, Sugiura T, et al.: Retrospective analysis of 1502 patients with facial fractures, Intl J Oral Maxillofac Surg 30: 286–290, 2001.

Jaquiéry C, Aeppli C, Cornelius P, et al. Reconstruction of orbital wall defects: critical review of 72 patients. Int J Oral Maxillofac Surg. 2007;36(3):193–9.

Kahnberg, K., Gothberg, K.,1987. Le fort fractures. A study of frequency, etiology and treatment. International Journal of Oral and Maxillofacial Surgery,16(2), pp154-159.

Kai, L.,2012. Global trends in maxillofacial fractures. Craniomaxillofac trauma recon ,5, pp 213-236.

Kalavrezos ND, Gratz KW, Warnke T, et al. Frontal sinus fractures: computed tomography evaluation of sinus oblit- eration with lyophilized cartilage. J Craniomaxillofac Surg 1999;27:20—4.

Kazanjian VH, Converse JM. Surgical Treatment of Facial Injuries, 3rd ed. The Williams and Wilkins Company: Baltimore. 1974; 1: 161-163.

Keiser, J., Stephenson, S.,2002. Seriousfacial fractures in New Zealand from 1979-1998.

Inter J Oral Maxillofac Surg,31, pp206-209.

Kelley P, Crawford M, Higuera S, et al. Two hundred ninety-four consecutive facial fractures in an urban trauma center: lessons learned. PlastReconstr Surg 2005;116: 42e–49e

Kennedy, D.W and Senior ,B.A. Edoscopic sinus surgey:A review. Otolaryng Clin North Am: 30:313, 1997.

Kullman L, Al Sane M: Guidelines for dental radiography immediately after a dento-alveolar trauma, a systematic literature review, Dent Traumat 28:193–199, 2012

Lakhani, R. S., Shibuya, T. Y., Mathog, et al. Titanium mesh repair of the severely comminuted frontal sinus fracture. Arch Otolaryng. Head Neck Surg. 127: 665, 2001.

Lalloo, R., Lucchesi, L.R., Bisignano, C., et al, 2020. Epidemiology of facial fractures: incidence, prevalence and years lived with disability estimates from the Global Burden of Disease 2017 study. Injury prevention.

Landsberg, R and Freidman, M.A. A computerised assisted anatomical study of the nasofrontal region. Larryngoscope 111:2125,2001.

Leles, J.L.R., Santos, Ê.J.D., Jorge, F.D., et al, 2010. Risk factors for maxillofacial injuries in a Brazilian emergency hospital sample. J Appl Oral Sci, 18(1), pp.23-29.

Loukota RA, Eckelt U, De Bont L, et al. Subclassification of fractures of the condylar process of the mandible. Br J Oral Maxillofac Surg 2005; 43: 72-73.

Manolidis, S. Frontalsinus injuries; Associated injuries and surgical management of 93 patients. J.Oral Maxillofac.Surg. 62:882,2002.

Markowitz BL, Manson PN, Sargent L, et al.: Management of the medial canthal tendon in nasoethmoid orbital fractures: the importance of the central fragment in classification and treatment, Plast Reconstr Surg 87(5):843–53, 1991.

Matsumoto T, Baba M, Ohtsuki O, et al. Three-dimensional finite element analysis of the human temporomandibular joint with anterior disc displacement due to occlusal forces. Int J Oral Maxillofac Surg 2005; 34, Supplement 1, p 118.

Mogajane, B.M. and Mabongo, M., 2018. Epidemiology of maxillofacial fractures at two maxillofacial units in South Africa. South African Dental Journal, 73(3), pp.132-136.

Motamedi, M.H.K., Dadgar, E.,2014. Pattern of maxillofacial fractures: A 5 year analysis of 8818 patients. J trauma vol 77(4),pp.630-634.

Nandapalan,V., Watson, I.D., and Swift, A. C. Beta-2-transferrin and cerebrospinal fluid rhinorrhoea. Clin. Otolaryngol.21: 259, 1996.

Nguyen M, Koshy JC, Hollier LH Jr. Pearls of nasoorbitoethmoid trauma management. Semin Plast Surg. 2010;24:383–8.

Nolasco FP, Mathog RH. Medial orbital wall fractures: classification and clinical profile. Otolaryngol Head Neck Surg. 1995 Apr;112(4):549-56.

O'Connor, R.C., Shakib, K. and Brennan, P.A., 2015. Recent advances in the management of oral and maxillofacial trauma. Br J Oral and Maxillofac Surg, 53(10), pp.913-921.

Pillay, L., Mabongo, M. and Buch, B., 2018. Prevalence and aetiological factors of maxillofacial trauma in a rural district hospital in the eastern cape. South African Dental J, 73(5), pp.348-353.

Pollock R, Hill J, Davenport D, et al. Cranialization in a cohort of 154 consecutive patients with frontal sinus fractures (1987–2007): review and update of a compel- ling procedure in the selected patient. Ann Plast Surg. 2013;71(1):54–9.

Rikhotso RE, Reyneke JP, Nel M. Does Open Reduction and Internal Fixation Yield Better Outcomes Over Closed Reduction of Mandibular Condylar Fractures? J Oral Maxillofac Surg. 2022 Oct;80(10):1641-1654. doi: 10.1016/j.joms.2022.06.023. Epub 2022 Jun 30. PMID: 35922010.

Rohrich RJ, Adams Jr WP: Nasal fracture management: minimizing secondary nasal deformities, Plast Reconstr Surg 106(2):266–273, 2000.

Rohrich, R.J., and Hollier, L.H. Management of facial fractures: Changing concepts. Clin.Plastic.Surg.19:219,1992.

Rosenberger E, Kriet JD, Humphrey C. Management of naso- ethmoid fractures. Curr Opin Otolaryngol Head Neck Surg. 2013;21:410–6. (Anatomy of MCL, physical examination of the complex and displacement) .

Schneider, D., Kammerer, P.2015. Etiology and injury patterns of maxillofacial fractures from the year 2010-2013 in Micklenberg West Pomerania, Germany: A retrospective study of 409 patients. J Cranio-maxillofac surg,43, pp1948-1951.

Silvennoinen U, Tateyuki I, Oikarinen K, et al. Analysis of possible factors leading to problems after non-surgical treatment of condylar fractures. J Oral Maxillofac Surg 1994; 52: 793-799.

Teshome, A., Andualem, G.2017. Two years retrospective study of maxillofacial trauma at a tertiary centre in North West Ethopia. BMC Research Notes 10:373.

Zaidi, A.A., Dixon, J., Lupez, K., et al 2019. The burden of trauma at a district hospital in the Western Cape Province of South Africa. African J Emerg Medicine, 9, pp.S14-S20.

Zide MF, Kent JN. Indications for open reduc- tion of mandibular condyle fractures. J Oral Maxillofac Surg 1983;41:89–98.

ANNEXURE A.

PROFORMA

IDENTIFICATION CODE OF PATIENT **……**					
DATE:					
AGE:					
GENDER:	MALE:			FEMALE:	
REFERED:	Yes	No	**REFERRAL DISTRICT:**		
TYPE OF MAXILLOFACIAL FRACTURES					
Upper Third	Frontal bone				
Middle Third	Dentoalveolar	Maxilla	Nasal	NOE	Zygoma
Lower Third	Dentoalveolar Fractures:			Mandible:	
DESCRIPTION:					
CAUSE OF TRAUMA: **ROAD TRAFFIC ACCIDENTS:**					
Motor Vehicle:	Motorcycle:	Pedestrian:	Bicycle:		
INTERPERSONAL VIOLENCE:					
With a weapon:		Without a weapon:			

SPORTS:					
Soccer:	Cricket:	Rugby:	Other:		
FALL:					
Epileptic:	Collapsed:	From a Height:	Running/walking:		
OTHER:					
ALCOHOLINVOLVEMENT:	Yes	No			
WAITING PERIOD TILL TREATMENT:	≤ 1 week	1-2 weeks	2-3 weeks	≥ 3 weeks	
TYPE OF TREATMENT PROVIDED:					
Open Reduction	Closed reduction	Conservative			

ANNEXURE B.

PATIENT IDENTIFIER

Patient Name…….

Identification code…….

Hospital / File number……

ANNEXURE C

pelonomi hospital
Department of Health
Pelonomi Tertiary Hospital
FREE STATE PROVINCE

DATE:	05 May 2021		ENQUIRIES
TO:	Dr BS Mvala Department of Health WITS	FROM:	Dr GP Matshediso Acting: Head of Clinical Services MatshediGP@fshealth.gov.za 051 405 1936/1711 Bloemfontein 9301

SUBJECT: The patterns and distribution of maxillofacial fractures at Pelonomi Hospital in the Free State province.

Pelonomi Tertiary Hospital **grants you permission** to conduct researches/studies and the following criteria must be met.

- [x] That you obtain ethical clearance from the human research ethics committee of the relevant university and approval by the Head of Health of the Free State.
- [x] That the Hospital incurs no cost in the course of your research.
- [x] That access to the staff and patients at the Pelonomi Hospital will not interrupt the daily provision of services.
- [x] That prior to conducting the research you will liaise with the supervisors of the relevant sections and introduce yourself with permission letter and to make arrangements with them in a manner that is convenient to the sections.

Yours Sincerely

.....

Dr GP Matshediso
Acting: Head of Clinical Services
Pelonomi Tertiary Hospital

PELONOMI TERTIARY HOSPITAL
05 -05- 2021
PRIVATE BAG X20581
BLOEMFONTEIN 9300

ANNEXURE D

health
Department of Health
FREE STATE PROVINCE

06 April 2021

Dr BS Mvala
Department of Health
WITS

Dear Dr BS Mavala

Subject: The patterns and distribution of maxillofacial fractures at Pelonomi Hospital in the Free State province

- Please ensure that you read the whole document, Permission is hereby granted for the above – mentioned research on the following conditions:
- Serious Adverse events to be reported to the Free State department of health and/ or termination of the study
- Ascertain that your data collection exercise neither interferes with the day to day running of **Pelonomi Hospital** nor the performance of duties by the respondents or health care workers.
- Confidentiality of information will be ensured and please do not obtain information regarding the identity of the participants.
- **Research results and a complete report should be made available to the Free State Department of Health on completion of the study (a hard copy plus a soft copy).**
- Progress report must be presented not later than one year after approval of the project to the Ethics Committee of the University of Pretoria and to Free State Department of Health.
- Any amendments, extension or other modifications to the protocol or investigators must be submitted to the Ethics Committee of the University of Pretoria and to Free State Department of Health.
- **Conditions stated in your Ethical Approval letter should be adhered to and a final copy of the Ethics Clearance Certificate should be submitted to** [illegible] **before you commence with the study**
- No financial liability will be placed on the Free State Department of Health
- **Please discuss your study with Institution Manager on commencement for logistical arrangements see 2nd page for contact details.**
- Department of Health to be fully indemnified from any harm that participants and staff experiences in the study
- Researchers will be required to enter in to a formal agreement with the Free State department of health regulating and formalizing the research relationship (document will follow)
- **As part of feedback you will be required to present your study findings/results at the Free State Provincial health research day**

Trust you find the above in order.

Kind Regards

Dr D Motau
HEAD: HEALTH
Date: 7/04/2021

Head : Health
PO Box 227, Bloemfontein, 9300
4th Floor, Executive Suite, Bophelo House, cnr Maitland and, Harvey Road, Bloemfontein
Tel: (051) 408 1646 Fax: (051) 408 1598 e-mail: [illegible]/chikobvup@fshealth.gov.za
www.fs.gov.za

ANNEXURE E

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr Boyisile Stephen Mvala

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M210207

NAME: (Principal Investigator)	Dr Boyisile Stephen Mvala
DEPARTMENT:	Health Pelonomi Tertiary Hospital, Free State Province
PROJECT TITLE:	The patterns and distribution of maxillofacial fractures at Pelonomi Hospital in the Free State province
DATE CONSIDERED:	26/02/2021
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Prof Risimati Rikhotso and Dr Lingeswara Pillay
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	26/02/2021

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions.Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.** The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **February** and will therefore be due in the month of **February** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature _____ Date _____

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

ANNEXURE F

Dr

by Stephen Mvala

Submission date: 19-Jul-2023 03:31PM (UTC+0200)
Submission ID: 2133560292
File name: MVALA-_draft_3_RECENT-19-07-23.docx (697.24K)
Word count: 8717
Character count: 49588

Dr

ORIGINALITY REPORT

7%	6%	5%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	wiredspace.wits.ac.za Internet Source	1%
2	hdl.handle.net Internet Source	1%
3	drj.mui.ac.ir Internet Source	1%
4	zh.scribd.com Internet Source	1%
5	Paramesh, Roshan Cherian. "A Prospective CT Study of Faciomaxillary Injuries in Patients with Head Injury of 500 Consecutive Cases", Rajiv Gandhi University of Health Sciences (India), 2023 Publication	1%
6	"42 Annual Congress of AOMSI Nagpur 16–18 Nov 2017", Journal of Maxillofacial and Oral Surgery, 2017 Publication	1%
7	"Maxillofacial Trauma", Springer Science and Business Media LLC, 2021	1%

	Publication	
8	Risimati Ephraim Rikhotso, Johan P. Reyneke, Marietha Nel. "Does open reduction and internal fixation yield better outcomes over closed treatment of mandibular condylar fractures?", Journal of Oral and Maxillofacial Surgery, 2022 Publication	1 %
9	Emergency Radiology, 2013. Publication	1 %
10	Submitted to Higher Education Commission Pakistan Student Paper	1 %

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		