

**The success rate of osteosynthesis plating without postoperative
maxillomandibular fixation in management of mandibular
fractures: A randomised clinical trial**

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG



Chokoe Nare Hemelton

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Declaration

I Chokoe Nare Hemelton 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.



(Signature of candidate)

08th day of April 2022 in Parktown

Dedication

This piece of work is dedicated to my late grandparents (Wilson and Sara Chokoe), to my lovely children (Lethabo, Lebogang and Lehumo) and my partner Kekana Maletjema.

Abstract

Background

Techniques for repair of mandible fracture have evolved exponentially in the past years. Controversies have erupted with regards to the placement of maxillomandibular fixation (MMF) post open reduction and internal fixation (ORIF).

Aim

To determine whether MMF is indicated post ORIF for fractured mandible.

Methods

A one-year prospective comparative randomised controlled clinical trial of 80 patients treated for mandibular fractures with or without MMF post ORIF. Frequencies and percentages were used to summarize the categorical variables. Fischers exact test was suitable for determining the association between the categorical variables.

Results

Of the 80 treated cases, 5 (6,3%) presented with complications; four cases had infections while one presented with hardware failure. Of the 5 complications, three were only treated with ORIF and two with ORIF and supplementary MMF.

Conclusion

There was no statistical difference between the two groups. There was no significant factor associated with the complications.

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List of Abbreviations

ORIF- Open Reduction and Internal Fixation

MMF- Maxillomandibular Fixation

CMJAH- Charlotte Maxeke Johannesburg Academic Hospital

WHOC- Wits Oral Health Centre

CONSORT- Consolidated Standards of Reporting Trails

HREC- Human Research and Ethics Committee

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CHAPTER 1

1.0 Introduction

The first description of mandibular fractures dates to the 17th century BC in the ‘Edwin Smith papyrus’, bought by Smith in Luxor in 1862 and later translated by Breasted (1944). The mandible is the second most common facial bone to sustain trauma due to its anatomical position, (Busuito *et al*, 1986; VandeGriend *et al*, 2015) although some authors report mandible to be the common facial injury (Abiose, 1986; Azevedo *et al*, 1993; Freidi *et al*, 1996; Lee, 2008; Mogajane and Mabongo, 2018) because of its mobility and proneness to injury (Mohammad *et al*, 2012; Oginni *et al*, 2016).

The aetiology of mandible fracture includes, assaults, traffic accidents, accidental falls, and sports related injuries (Telfer, 1991). The causes of mandibular fractures differ from one country to another because of social, cultural, and environmental factors (Goodday, 2013). The studies from New Zealand (Lee, 2008) and United States of America (Gutta *et al*, 2014) reported assault to be the most common aetiology for mandible fracture. Goodday (2013) noted that assaults are influenced by drugs and alcohol abuse. While some authors from India (Michelet, 2019; Shah, 2019) and Nigeria (Abiose, 1986; Fakuade *et al*, 2020) noted that most mandible fractures are caused by traffic accidents. Reported factors attributing to mandibular fractures secondary to traffic accidents are impatient driving, driving under the influence of alcohol, failure to wear helmets, and poor road maintenance (Al Ahmed *et al*, 2004; Krishnaraj and Chinnasamy, 2007). In South Africa, however, most mandibular fractures are sustained secondary to assault (Mogajane and Mabongo, 2018; Abdoola *et al*, 2021).

The anatomic distribution of mandible fractures include symphysis, parasymphysis, body, angle, condyle and coronoid process (Morris *et al*, 2015). Aleysson *et al* (2008) reported that the mandibular angle was the most affected site for mandibular fractures whilst Gutta *et al* (2014) noted that multiple fractures were more common than isolated fractures.

The goals for mandible repair post fracture include anatomical reduction, bony union, restoration of pre-traumatic occlusion and normal function (Dodson *et al*, 1990). The treatment options range from nonsurgical to surgical methods. These include maxillomandibular fixation (MMF), closed

treatment with external fixation, Kirschner wires, open treatment with reduction and open reduction and internal fixation using various profile plates. Several complications may occur post management of mandible fracture, which may require advanced treatment (Ellis and Walker 1992).

There is still no consensus with regards to the placement of MMF post open reduction and internal fixation (ORIF) (Rodman, 2016). Authors in support of MMF post ORIF, suggested that MMF is needed because it allows soft tissue reattachment, stable occlusion is achieved and low rate of complications is observed (Bolourian *et al*, 2002; Chritah *et al*, 2005, Longwe *et al*, 2010). They also argued that two weeks of MMF does not results in deleterious complications such as trismus (from prolonged immobilisation) and dental caries (from poor oral hygiene). Diaconu *et al* (2016) reported improved follow up rates post ORIF supplemented with MMF.

The proponents of ORIF without supplementary MMF, noted no significant difference with or without supplemental MMF (Kaplan *et al*, 2001; Kumar *et al*, 2011; Sasman *et al*, 2014; Rout, 2021). They argued that the symptoms such as swelling and pain, acts as physiological MMF as patients are unable to function. Advantages of eliminating supplementary MMF post ORIF include decreased postoperative discomfort, earlier return to normal jaw function, easier maintenance of oral hygiene, elimination of additional surgery (removal of wires) and better nutrition (Dodson *et al*, 1990). However, both groups agreed that the following complications are associated with both protocols (ORIF without supplemental MMF and ORIF with additional MMF) of mandibular repair, wound dehiscence, infection, malocclusion, non-union, and malunion (Kaplan *et al*, 2001; Kumar *et al*, 2011; Sasman *et al*, 2014; Rout, 2021).

CHAPTER 2

2.1 Literature review

2.1.1 Management of mandible fractures

During the pre-Christian era, simple mandible fractures were treated with the use of bandages, obtained from the embalmer and soaked in honey and white of egg (Breasted, 1944). Bandages had undergone different modifications to immobilise the mandible fracture by stabilising it to the maxilla. The bandage passed under the chin and over the head, for prevention of slipping, another one is carried over the occiput (Stimson *et al*, 1893).

Hippocrates introduced intra oral and extra oral immobilisation techniques in the management of mandible fractures. A hand-held, intra-oral approach was used to reduce the fracture ends while immobilised by gold or linen threads tied around the adjacent teeth. He also recommended extra-oral fixation by strips of Carthaginian leather glued to the skin, the ends of which were tied over the skull. Hippocrates reported that healing takes place within 20 days when using this method of fixation, provided that no infection developed (Siegert *et al*, 1990).

During the 19th century, dental splints were favoured to manage the mandibular fractures. So, there was a gradual shift from general surgeons to dental surgeons, because the management of mandible fractures depended on manipulating the dentition (Mukerji *et al*, 2006). Intraoral and extraoral splints have undergone refinements, with the use of either trans-mandibular or circum-mandibular wire fixation to immobilise the mandibular fracture directly or indirectly. High incidence of infections and malocclusion were associated with external fixation splints. (Mukerji *et al*, 2006).

With the usage of dental splints in managing mandible fractures by then, several authors introduced different types of splints. In 1855, Hamilton discovered the gutta-percha while Hayward (1858) developed a metal splint for severely dislocated fractures. Thomas Gunning (1866) designed the 'Gunning splint'. In 1871, Gurnell Hammond developed a wire ligature splint. In 1887, Thomas L. Gilmer reintroduced intermaxillary fixation the use of arch bars for mandibular fractures. Dr. Angle (1890) introduced banding teeth on either side of the fracture,

and then bound in the bands together by wire to immobilise the fracture. Robert H. Ivy (1922) modified the technique of intermaxillary fixation by creating a loop (eyelet) in the wire ligature.

Baudens is credited with being the pioneer of wiring mandibular fractures, and as early as 1840 he used circumferential wires to immobilise an oblique fracture (Siegert and Weerda, 1990). Soon after (1847), Buck applied wire sutures directly to the fractured bone by drilling holes in adjacent segments and wiring them together (Rowe, 1971). Modifications of this technique by using two double wires (Rošse) and the figure-of-eight wire suture (Raas) improved stability (Siegert and Weerda, 1990).

The techniques for mandible fracture repairs have evolved exponentially in the past few decades. These techniques range from, wire osteosynthesis (Theriot *et al*, 1987), lag screw (Niederderdellmann and Shetty, 1987), compression (Ellis and Sinn, 1993) and non-compression plates. Higher infection rate has been reported following intraosseous wiring as compared to rigid internal fixation (Zachariades *et al*, 1993).

Prior to the development of osteosynthesis, the following fixation methods were used to manage mandibular fractures, internal stainless-steel wires, external fixation using rigid metal pins, or custom-made silver cap splints (Mukerji *et al*, 2006). In 1893, Sir William Lane discovered osteosynthesis plate, however, two years later he reported corrosion of the material during the healing process (Lane, 1895). The term osteosynthesis was instituted by Lambotte (1907). He introduced various screws and plates made-up of aluminium, brass, copper and silver. He invented various screw types, first screws were conical with flattened round heads, then later improved to cylindrical with machine cut threads and had self-drilling tips. He also introduced gold or nickel coated steel as a results of encountering metallosis (Lambotte, 1907, 1913, 1927).

Sherman (1912, 1922) modified Lambotte's osteosynthesis screws and plates by adding vanadium steel and self-tapping machine cut threads, so that during screw insertion it will cut a bone thread simultaneously resulting in increased screw grip.

Still with all modifications implemented, complications still arose, osteosynthesis systems often showed severe corrosion, metallosis, broken plates and loose screws (Lane, 1914; Sherman, 1922; Zierold, 1924; Kirschner, 1927; Lambotte, 1927).

In 1949, Danis introduced compression plate for osteosynthesis named “coapteur” in French. The bone fragments are pressurised with the aid of a built-in compression screw conducting the force perpendicularly into the inserted lag screws. Fractured mandible treated in this method did not depict any signs of callus formation during healing phase. He then termed it primary bone healing. Luhr (1968) and Perren et al (1969) developed plates with cone-shaped or spherical screw heads and compression holes that were congruent in shape that the way was paved for osteosynthesis to be generally accepted in the treatment of facial fractures. Its use was associated with severe complications such as pseudarthrosis and osteomyelitis (Holtje *et al.*, 1975; Reinert *et al.*, 1996). Schilli and Niederdellmann (1980) reported that compression plate at the inferior border led to separation of the fragments at the alveolar ridge and lingually. To counteract this, these plates were combined with arch bars fixed to the teeth. Another disadvantage was the difficulty of bending these heavy plates in order to adapt them to the bony contour (Schilli and Niederdellmann, 1980).

With the introduction of Dynamic Compression plates by AO/ASIF (Allgower *et al.*, 1969), Spiessl (1969) then applied them in the mandible by modifying these plates to match the dimensions of the mandible. Niederdellmann and Schilli (1972, 1973) further modified the plates by establishing two holes located close to the fracture gap for screws to exert axial pressure with other two holes angled at 45 degrees to build up compression at the alveolar ridge (Niederdellmann and Akuamo-Boateng, 1978): once the screws were inserted, the eccentric position of the holes led to compression at the alveolar ridge. The plate was termed Eccentric Dynamic compression plates.

In 1970, Brons and Boering introduced miniplate osteosynthesis in the mandible, with the placement of the plate at the inferior border of the lower jaw resulting in unfavourable biomechanics. Michelet *et al* (1973) placed the miniplate along the tensile trajectories and placed monocortical screws to prevent injuring the tooth roots. They excluded the addition of intermaxillary fixation. Ellis (2013) recommended open reduction and internal fixation with rigid or semirigid plates for mandibular repair, with adjunctive use of maxillomandibular fixation. He reported a higher rate of complication with semirigid fixation as compared to rigid fixation (15.4% vs 4.9%). Even though Champy (1978) at first did not recommend the usage of miniplates to treat fractures in the presence of infection, Johansson et al (1988) reported success

in managing infected fractures with miniplates and antibiotic course. Sukegawa *et al* (2019) reported that miniplates provides sufficient stability in treating mandible fractures though not recommended in atrophic mandible and heavily comminuted fractures.

In 1993, Hayter and Cawood reported that usage of miniplates osteosynthesis in treating facial skeleton fractures has several advantages, reduced airway risk, patient comfort (immediate mouth opening ease of nutrition). They also mentioned that miniplates osteosynthesis provides bone fixation, which is most effective means of stable bone fixation, whereas MMF provides jaw fixation. Sauerbier (2008), noted following advantages when using miniplates osteosynthesis: simple application via an intra-oral approach, no need to expose much bone and the ease of adapting the plates to the surface of the bone, short hospital stays, early return to work.

2.2 Anatomical placement/positioning of the plate.

2.2.1 Biomechanics mandible

From a biomechanical aspect, the mandible represents Class III lever system with the fulcrum at the condyle, muscle force applied distal to the fulcrum, and occlusal force applied distal to the muscle force as depicted in Fig 2.1. The muscle attachments and forces applied on the mandibular fracture/s are useful in helping the surgeon when planning treatment. The masticatory forces create strains of tension along the alveolar bone above the inferior alveolar canal, while compression is exerted along the inferior border of the mandible. The zone of compression maintains bony contact whereas the zone of tension pulls the fractured segments apart. The torsional force is applied in the anterior fractured mandible, highest in the mandibular symphysis (Goodday, 2013; Braasch and Abubaker, 2013). Torsion is exerted by suprahyoid muscles (digastric, geniohyoid and mylohyoid). With regards to fractured angle of the mandible, masseter, medial pterygoid and temporalis are responsible for vertical displacement of the proximal segment. The horizontal displacement is caused by medial and lateral pterygoid muscles (Fonseca et al, 2017).

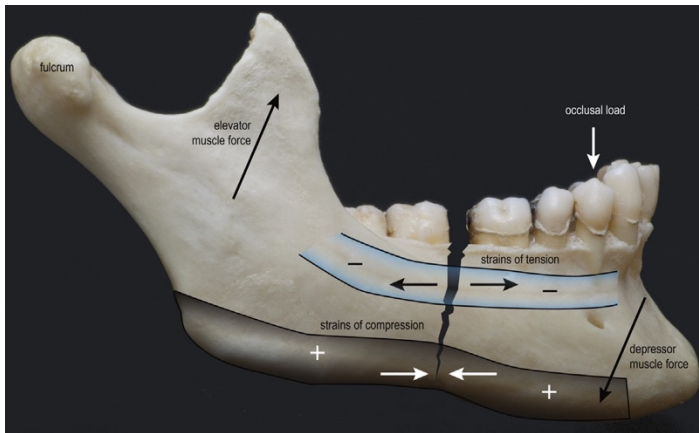


Figure 2.1 - Biomechanics of mandible

Champy and Lodde (1978) discovered the ideal lines of osteosynthesis in the mandible or locations where osteosynthesis plating should provide the most stable means of fixation using the biomechanical approach (Fig 2.2).



Figure 2.2 - Champy's ideal lines of osteosynthesis.

2.2.2 Management of mandibular angle fracture

Levy *et al* (1991) suggested the use of two miniplates at the fractured angle mandible, one placed at the superior and a second one at the inferior border to counter tensional and compression forces. In 2019 Wusiman *et al* reported that the one miniplate is superior to two miniplates, as the one miniplate system resulted in fewer complications. Al-Moraissi and colleagues (2014), they

also concur with one miniplate in treatment of mandibular angle fracture, however they noted the placement of one lateral miniplate via transbuccal approach superior to the one placed on the external oblique ridge using a transoral approach. The laterally placed miniplate resulted in low incidence of postoperative complications. According to Champy and Lodde's ideal line of osteosynthesis, at the mandibular angle, they recommended placement of the plate at the superior border of the mandible as it is the most effective location (Champy and Lodde, 1978). Most authors recommend the single miniplate at the upper border because of least morbidity with the lowest number of complications (Ellis and Krans, 1992; Ellis and Walker, 1994; Ellis, 1999; Siddiqui, 2007; Sabhlok and Waknis, 2010; Wusiman et al, 2019).

2.2.3 Management of symphyseal and/or body fracture of mandible

Champy *et al* (1978) advocate the use of two miniplates in the symphyseal and parasymphyseal region in order to counteract the torsional forces. The two plates should be a minimum of 5mm apart (Champy *et al*, 1978). Even though the application of two miniplates at the anterior fractured mandible has gained popularity, Ellis (2011) reported more postoperative complications as compared to only one stronger plate. He favoured application of one stronger plate as it serves same purpose as two miniplates by preventing interfragmentary motion even with active use of the mandible.

2.3 ORIF without supplemental MMF

Schmelzeisen *et al* (1992) and Kaplan *et al* (2001) advocate the immediate mobilisation following fixation with 2.0 miniplates without supplemental MMF. In 2011, Kumar *et al* reported 14% complications associated with no additional MMF in patients treated with miniplates osteosynthesis for fractured mandibles. Seventeen percent complication rate was reported in patients with supplemental MMF. The two groups did not reveal any statistical difference in relation to trismus, pain occlusal disturbance, wound dehiscence, infection, nonunion and malocclusion.

Sasman *et al* (2014), in their retrospective study, also did not find any advantage of additional MMF post open reduction and internal fixation for fractured mandible. Outcomes were based on rates of wound dehiscence, infections, plate removal, non-union, malunion and malocclusion,

with no significant statistical difference. Rodman and Kellman (2016), suggested that no need for postoperative MMF if good reduction is achieved while fractures are stabilized with plates.

2.4 ORIF with additional MMF

Advocates of ORIF with supplemental MMF argued that the additional MMF allow soft tissue reattachment and stabilize the occlusion and thus decrease the incidence of complications (Bolourian *et al*, 2002; Chritah *et al*, 2005, Longwe *et al*, 2010). The duration of supplemental MMF varied from one week to four weeks. Bolourian *et al* (2002) suggested two weeks of additional MMF post ORIF. Chritah *et al* (2005) reported 98% success rate of primary bone healing when miniplate is supplemented with one week of MMF. Of the non-compliance factors including poor oral hygiene, poor oral intake, smoking, drugs, alcohol use and early self-removal of the MMF, Longwe *et al* (2010), reported early release of MMF resulting in infection due to patient poor compliance. Rout *et al* (2021) recommended additional MMF if occlusion is achieved with difficulty, otherwise no reported statistical difference between two weeks of supplemental MMF and without MMF.

2.5 Rationale for the study

MMF post ORIF of mandibular fractures is a very controversial treatment option in the management of mandible fractures both locally and internationally. In the Wits Oral Health Centre (WOHC), supplemental MMF has been a favoured technique for a long time, however some consultants at the facility do not believe in supplemental MMF post ORIF. These opposing views provided the basis for this randomised controlled clinical study that sought to compare ORIF without additional MMF and ORIF with supplementary MMF for the outcome of mandibular fracture. The Consolidated Standards of Reporting Trails (CONSORT) guidelines of 2017 were followed in terms of writing up the findings of this trial.

2.6 Null Hypothesis

There is no difference in outcomes between patients who were managed with MMF and those without MMF post ORIF for fractured mandible.

2.7 Aim

To evaluate outcome of mandibular fractures treated by ORIF without supplemental MMF.

2.8 Objectives

1. To determine complications associated with and without supplemental MMF post ORIF in patients who were treated for mandibular fractures.
2. To compare complications of the two protocols.
3. To determine factors associated with complications.

CHAPTER 3

3.1 MATERIALS AND METHODS

3.1.1 Study design

This was a prospective randomised controlled clinical trial that compared ORIF versus ORIF with additional MMF for the management of mandibular fractures.

3.1.2 Study setting and population

The study only included patients treated at Charlotte Maxeke Johannesburg Academic hospital (CMJAH) within the Department of Maxillo-Facial and Oral Surgery from March 2020 to February 2021. All subjects were treated for mandibular fractures using ORIF. Some had supplemental MMF, while others did not have MMF after ORIF. All patients who presented with clinical and radiological evidence of mandibular fracture/s were invited to participate in this study voluntarily.

Using the Fishbowl technique, participants were randomly allocated into two groups (Group A, patients with intraorally placed plates without MMF and group B, patients with intraoral plate placement and MMF for 4 weeks) respectively.

3.1.3 Inclusion criteria

- Mandibular fractures involving symphysis, parasymphysis, body and angle
- Open reduction and internal fixation for fractured mandible with or without supplemental maxillomandibular fixation performed in dentate patients
- Mandibular fracture/s less than 14 days post injury
- Epileptic patients were only be included in group A
- Patients ≥ 18 -years old

3.1.4 Exclusion criteria

- Patients were excluded if they presented with any one or more of the following features:
Condylar/ subcondylar fracture/s
- Comminuted mandibular fractures
- Mandibular fracture older than 14 days post injury
- Infected mandibular fractures
- Immunocompromised patients
- Edentulousness
- Soft/ bony tissue defects

3.1.5 Sample size

Power analysis was utilized to determine the sample size and according to this calculation a sample size of 100 was suitable for measuring and comparing meaningful outcomes for this study. Unfortunately, the sample size was reduced to 80 due to the Covid-19 pandemic and the restrictions put in place such as alcohol bans, limited access to public transport and healthcare services. As a result of pandemic, the facility was intermittently closed, and patient intake was reduced to emergencies that required immediate surgical intervention during certain levels of the lockdown. Most common mandible fractures are as a result of assaults (Gutta *et al*, 2014). Goodday (2013) noted that assaults are influenced by drugs and alcohol abuse.

3.1.6 Randomisation

The fishbowl technique was applied for randomisation purposes due to the low cost and the ease of application (Saran *et al.*, 2018; Kurdi and Muthukalai, 2016). Numbers (1-80) were placed in a box and drawing them out per patient. Patients who picked an odd number belonged to group A, and those who picked an even number belonged to group B. The draw was performed by a dental officer who was not part of this study.

3.1.7 Operative management

The surgical procedure was carried out by the Maxillo-Facial and Oral Surgery registrars (at least two-years' experience) and/or consultants under general anaesthesia. All patients were treated under general anaesthesia for ORIF for fractured mandible in tooth bearing areas. Group A subjects did not have additional MMF post ORIF. Group B subjects had supplemental MMF. KLS Martin plating set was utilised. Postoperative review was conducted at 1st, 4th, and 6th week. For group B patients, MMF was released at 4th week. Six weeks of follow-up was chosen because most fractures are healed by this time and most major complications present before then (Adeyemi *et al*, 2012; Dimitroulis, 2002).

3.1.8 Surgical procedures

Surgical procedures were carried out as per standard practise and protocols of the Department of Maxillofacial and Oral Surgery, University of the Witwatersrand. Intraoperatively, one dose of prophylactic antibiotic, Augmentin 1.2g or Clindamycin 600mg (for penicillin allergy) was administered and the remaining two doses were administered every eight hours post-operatively. Following nasal intubation and general anaesthesia, a throat pack was inserted, and local anaesthesia (Xylotox E80) administered. Stainless steel wire (0.18-gauge) eyelets were placed interdentally in both groups as per standard practice to guide maintain the occlusion during reduction.

An intra-oral flap was raised to expose the fracture and debridement performed. Compromised teeth in the fracture line were extracted. The fracture/s was then reduced with maxillomandibular fixation in place. Before internal fixation, the occlusion was assessed for a normal anatomic relationship between both jaws with maximum intercuspation and whether there was adequate fracture reduction between the segments. For plating, 2.0mm miniplates were used to fixate the fracture. Anterior to the mental foramen, two 2.0mm miniplates were used, while posterior to mental foramen only one 2.0mm miniplate following Champy's line of osteosynthesis (Fig 1.1).



Fig 2.2- Champy's ideal lines of osteosynthesis.

At the angle one 2.0mm miniplate applying Champy superior border technique as depicted in Fig 3.1 (Champy, 1978). Following plating MMF was released, passive occlusion was confirmed. The intra-oral flap was then approximated and sutured in position with 3/0 chromic catgut (*SCIMITAR Chromic catgut sutures®*). The throat pack was removed, oropharynx area suctioned with a Yankauer suction tip before securing MMF for group B patients.



Figure 3.1- Champy's superior border plate

3.1.9 Blinding

At the 6th week follow-up appointment, the eyelets were removed from both groups and a proforma based assessment completed. The proforma based assessment was completed by an experienced and skilled maxillo-facial surgeon who was not familiar with the patients and the group allocations. The surgeon was calibrated to the assessment to maintain standards. The group allocation of the patients was concealed from the maxillo-facial surgeon to ensure complete objectivity in the assessment.

3.1.10 Assessment of treatment outcome

A successful outcome was determined by uneventful bone healing at sixth-week review. Subjects were also assessed for the following at the three visits:

Complications	Indications
Infections	Presence of erythema of the adjacent gingiva, swelling, and pus discharge ¹⁸
Malocclusion	Molar and canine relationship
Hardware failure	Loose hardware on exposure. Radiolucent lesion around the hardware (screws) as depicted on the x-ray
Malunion	Healed fracture site with step at fracture line
Nonunion	Mobile fracture site after 6 weeks of fixation
Wound dehiscence	Hardware and surrounding bone exposure.

3.1.11 Data collection

The principal investigator retrieved and collected data from the administrative registers, radiological and patient records. Using a proforma (data collection tool) the variables collected included, age, gender (male/female), medical history (clear/present), medication (none/name),

aetiology (assault / motor vehicle accident/ fall/ sport related injury/ other), injury period in days, site of fracture/s (symphysis / parasymphysis/body/angle), treatment (ORIF/ORIF and MMF), tooth in fracture line (extracted/not extracted), intraoperative MMF (yes/no), fixation type (rigid/semi rigid), complications (infection/malocclusion/hardware failure/malunion or non-union/wound dehiscence/other), review period in weeks (1st/4th/6th). See annexure A.

3.1.12 Data analysis

Data were analyzed using IBM SPSS version 27. Frequencies and percentages were used to summarize the categorical variables. Fischers exact test was most suitable for determining association between the categorical variables because the 2*2 table consists of cell where the expected number of frequencies is fewer than 5

Median and interquartile range was used to summarize the continuous variables. A Shapiro–Wilk’s test was conducted to assess the nature (distribution) of the data. For skewed data a non-parametric test, Fischer’s exact test, was used to determine the association between categorical variables and Mann Whitney U was used to determine the significant difference between age and period of injury in the ORIF and ORIF/MMF group as well as the group with complications and the group without complications. The level of significance was set at a p-value less than 0.05.

3.1.13 Ethical Consideration

3.1.13.1 Consent

The researcher provided an introduction of the study for participants to be aware of what the study entailed. The contents of the consent form were fully explained to the participants and was available to the patients to read on their own.

The questionnaires/consent were available in English and translated into the local language of preference, ensuring that they fully understood the contents thereof.

Furthermore, only written informed consent was obtained from all the study respondents. Where participants were unsure or need more clarity, the questionnaire was explained to them verbally. Any mark or signature indicating their consent on paper was used on the consent form.

Participation in the study was voluntary and therefore, participants were free to withdraw from the study at any time without giving reasons and their treatment would not be compromised incurring any penalty. If at any point, a participant did not feel comfortable answering any question, they were at liberty to inform the researcher, and they were not pressured to answer.

There was no compensation or incentives that were offered to the participants.

3.1.13.2 Confidentiality

The researcher guaranteed anonymity and confidentiality by not gathering any personal information from the respondents, such as their names, date of birth, identification number and hospital file number and addresses. Each participants identity was coded, and this code was only known to the principal investigator.

3.1.13.3 Ethical Clearance

Ethical clearance was obtained from both the Human Research and Ethics Committee (HREC) of Witwatersrand University and the Wits Dental Hospital Research and Ethics Committee (Wits Oral Health Centre) prior to data collection. The HREC clearance certificate was issued with reference no: M181196 (see Annexure B). The Wits Dental Hospital Research and Ethics Committee reference no: HRRC/MAY/03/2019 (see Annexure C). Head of the Department of Maxillo-Facial and Oral Surgery also granted the permission to perform the study (see Annexure D). Strict confidentiality was adhered to. Codes were allocated to patients in order to protect patient's identity. All patient identifiers were removed and kept on a separate link form (see Annexure E). Patient identifiers are only accessible to the principal investigator.

3.1.14 Funding

There were no special funding requests anticipated to perform the study. Photocopying and printing of data collection and patient information sheets were done in-house.

CHAPTER 4

4.1 Sociodemographic profile of the participants

A total of 80 patients were recruited for the study and the median age of the patients was 29 (25-29) years and 95% were males. Seventy-four patients did not have any underlying systemic condition while 75 patients were not on any treatment. There was no significant difference and association between the ORIF and the ORIF with supplementary MMF as depicted in Table 4.1.

Table 4.1: Sociodemographic profile and medical history of the participants

Demographics	Total (N=80)	ORIF (n=42)	ORIF and MMF (n=38)	P-value
Gender				
Male	76(95%)	41(97.6%)	35(92.1%)	0.34
Female	4(5%)	1(2.4%)	3(7.9%)	
Age	29(25-37)	29.5(25.75-39)	28.5(23-35.25)	0.30
Medical history				
No relevant history	74(92.5%)	36(85.7%)	38(100%)	0.06
Hypertensive	3(3.8%)	3(7.1%)	-	
Epileptic	3(3.8%)	3(7.1%)	-	
Medication				
None	75(93.8%)	37(88.1%)	38(100%)	0.12
Anti-hypertensive	3(3.8%)	3(7.1%)	-	
Anti-convulsant	2(2.5%)	2(4.8%)	-	

Cause of injury and site of fracture

Assault (87.5%) was the most common cause of injury among the participants and the parasymphysis and angle was the most common site of fracture (38.8%) followed by the angle (30%) as shown in Table 4.2.

Table 4.2: Cause of injury and site of fracture

Injury	Total	ORIF	ORIF and MMF	P-value
Cause of injury				
Assault	70(87.5%)	33(78.6%)	37(97.4%)	0.03
Motor vehicle accident	5(6.3%)	5(11.9%)	-	
Epileptic seizure	1(1.3%)	1(2.4%)	-	
Fall	2(2.5%)	2(4.8%)	-	
Sports related	2(2.5%)	1(2.4%)	1(2.6%)	
Site of fracture				
Angle	24(30%)	12(28.6%)	12(31.6%)	0.65
Body	2(2.5%)	2(4.8%)		
Parasymphysis and angle	31(38.8%)	15(35.7%)	16(42.1)	
Parasymphysis and body	3(3.8%)	2(4.8%)	1(2.6%)	
Symphysis and angle	4(5%)	1(2.4%)	3(7.9%)	
Symphysis	1(1.3%)	1(2.4%)		
Parasymphysis	12(15%)	8(19%)	4(10.5%)	
Body and angle	3(3.8%)	1(2.4%)	2(5.3%)	
Injury period, Median (Interquartile range)	8(6-10)	9(6.75-10)	8(5-10)	0.22

Treatment and fixation type

Semi-rigid angle (32.5%), rigid-parasymphysis (22.5%) and rigid-symphysis (18.8%) were the most common fixation type (Table 4.3). There was a significant association between fixation type and treatment protocol, p-value=0.00 as shown in Table 4.3.

Table 4.3: Treatment and fixation type

Fixation type	Total	ORIF	ORIF and MMF	P-value
Semi-rigid angle	26(32.5%)	14(33.3%)	12(31.6%)	0.00
Rigid-parasymphysis	12(15%)	10(23.8%)	2(5.3%)	
Rigid-symphysis	15(18.8%)	11(26.2%)	4(10.5%)	
Semi rigid-angle, rigid-parasymphysis	18(22.5%)	3(7.1%)	15(39.5%)	
Semi rigid-angle, rigid-symphysis	3(3.8%)	1(2.4%)	2(5.3%)	
Rigid-parasymphysis and body	2(2.5%)	1(2.4%)	1(2.6%)	
Semi rigid body, rigid parasymphysis	1(1.3%)	1(2.4%)	-	
Semi rigid-angle, rigid-body	1(1.3%)	1(2.4%)	-	
Semi rigid-angle, semi rigid-body	2(2.5%)	-	2(5.3%)	
Intraoperative MMF				
Yes	80(100%)	42(100%)	38(100%)	n/a
No	-	-	-	

Tooth characteristics

Tooth in fracture line was extracted in 95% of the participants (Table 4.4). There was no significant association between tooth in fracture line and the procedure, p-value=0.12 (Table 4.4).

Table 4.4: Tooth characteristics

Tooth characteristics	Total	ORIF	ORIF and MMF	P-value
Tooth in fracture line				
Extracted	76(95%)	38(90.5%)	38(100%)	0.12
Not extracted	4(5%)	4(9.5%)		

Complications

There was no significant association between complications and the procedure, p-value=1.00 as depicted in Table 4.5.

Table 4.5: Presence of complications

Complications	Total	ORIF	ORIF & MMF	P-value
Yes	5(6.3%)	3(7.1%)	2(5.3%)	1.00
No	77(93.8%)	39(92.9%)	36(94.7%)	

4.2 Complications and factors associated with complications

Presence of complications

Complications were presented in five patients (6.3%) of the participants, four patients had infections (80%) and one patient (20%) had hardware failure (see Figure 4.1).

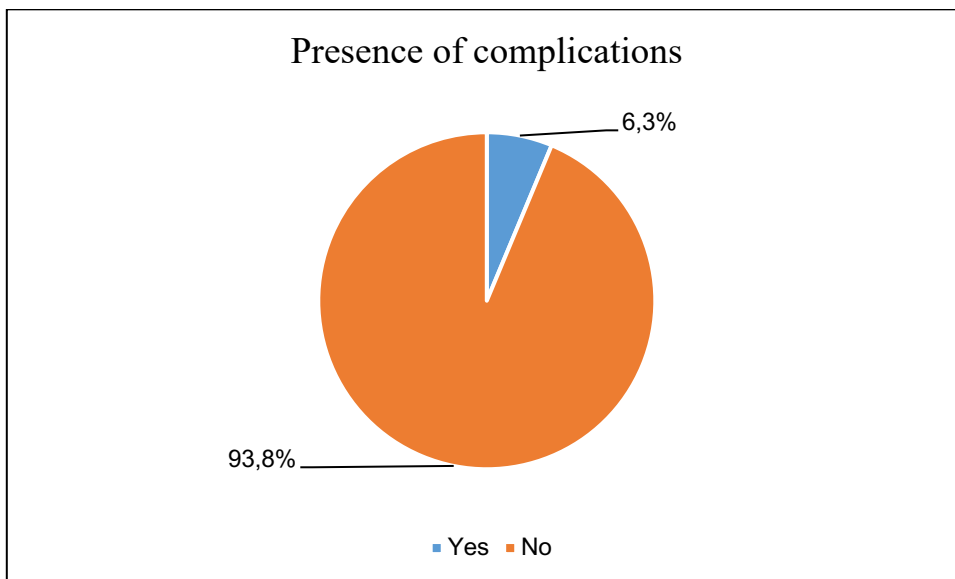


Figure 4.1 Presence of complications

Association between complications and demographic and medical history

There was no significant association between complications and demographics and medical history, p -value >0.05 as shown in Table 4.6.

Table 4.6: Sociodemographic characteristics

Demographics	Complications			<i>P</i> -value
	Total	Yes	No	
Gender				
Male	76(95%)	5(100%)	71(94.7%)	1.00
Female	4(5%)	-	4(5.3%)	
Age	29(25-37)	31(29-31.5)	29(25-38)	0.52
Medical history				1.00
Clear	74(92.5%)	5(100%)	69(92%)	1.00
Hypertensive	3(3.8%)	-	3(4%)	
Epileptic	3(3.8%)	-	3(4%)	
Medication				
None	75(93.8%)	5(100%)	70(93.3%)	1.00
Anti-hypertensive	3(3.8%)	-	3(4%)	
Anti-convulsant	2(2.5%)	-	2(2.7%)	

4.3 Association between complications and cause of injury and site of fracture

There was no significant association between complications and cause of injury and site of fracture, p-value >0.05 as shown in Table 4.7.

Table 4.7: Cause of injury and site of fracture

Injury	Total	Complications		P-value
		Yes	No	
Cause of injury				
Assault	70(87.5%)	5(100%)	65(86.7%)	1.00
MVA	5(6.3%)	-	5(6.7%)	
Epileptic seizure	1(1.3%)	-	1(1.3%)	
Fall	2(2.5%)	-	2(2.7%)	
Sports-related	2(2.5%)	-	2(2.7%)	
Site of fracture				
Angle	24(30%)	1(20%)	23(30.7%)	0.94
Body	2(2.5%)	-	2(2.7%)	
Parasymphysis and angle	31(38.8%)	3(60%)	28(37.3%)	
Parasymphysis and body	3(3.8%)	-	3(4%)	
Symphysis and angle	4(5%)	-	-	
Symphysis	1(1.3%)	-	-	0.16
Parasymphysis	12(15%)	1(20%)	-	
Body and angle	3(3.8%)	-	-	
Injury period	8(6-10)	7(5.5-8)	9(6-10)	

Association between complications and treatment procedures

There was no significant association between complications and treatment, fixation type, p-value >0.05 as shown in Table 4.8.

Table 4.8: Complications and treatment procedures

Fixation type	Complications			<i>P</i> -value
	Total	Yes	No	
Semi-rigid, angle	26(32.5%)	1(20%)	25(33.3%)	0.75
Rigid-parasymphysis	12(15%)	-	10(13.3%)	
Rigid symphysis	15(18.8%)	1(20%)	14(18.7%)	
Semi rigid-angle, rigid-parasymphysis	18(22.5%)	2(40%)	17(22.7%)	
Semi rigid-angle, rigid-symphysis	3(3.8%)	1(20%)	3(4%)	
Rigid-parasymphysis and body	2(2.5%)	-	2(2.7%)	
Semi rigid body, rigid parasymphysis	1(1.3%)	-	1(1.3%)	
Semi rigid-angle, rigid-body	1(1.3%)	-	1(1.3%)	
Semi rigid-angle, semi rigid-body	2(2.5%)		2(2.7%)	
Intraoperative MMF				
Yes	80(100%)	-	-	
No	0	-	-	
Treatment				
ORIF	42(52.5%)	3(60%)	39(52%)	1.00
ORIF AND MMF	38(47.5%)	2(40%)	36(48%)	

Association between complications and tooth characteristics

There was no significant association between complications and tooth characteristics, *p*-value >0.05 as shown in Table 4.9.

Table 4.9: Tooth characteristics

Tooth characteristics	Complications			<i>P</i> -value
	Total	Yes	No	
Tooth in the fracture line				
Extracted	76(95%)	1(20%)	3(4%)	0.23
Not extracted	4(5%)	4(80%)	72(96%)	

Chapter 5

5.1 Discussion

5.1.1 Gender

In this study, of 80 subjects, 76 were males. The study concurs with other studies that reported males to be more prone to sustain mandibular fractures (Prabhakar, 2011; Saman, 2014; Hassanein, 2019; Rout, 2021). Forty-one male subjects were managed with ORIF only while 35 were managed with ORIF and additional MMF. There was no statistically significant association between complications and gender. Males were reported to be more prone to mandibular fractures as they are most active group in society (Sirimaharaj and Pyungtanasup, 2008). The following reasons are reported as contributory factors leading to males sustaining mandibular fracture: driving motor vehicles carelessly and engaging in interpersonal violence (Dibaie *et al*, 2009), and alcohol abuse (Patrocinio *et al*, 2005). Chandra Shekar and Reddy (2008) observed females to be less likely to sustain mandibular fracture due to less vehicle driving, less exposed to accidents, interpersonal violence, industrial works, and confined to housework.

5.1.2 Site of fracture

The anatomic distribution of mandible fractures includes angle, symphysis, condyle and body (Morris *et al*, 2015). Aleysson *et al* (2008) reported mandibular angle as the most affected site of mandibular fracture, however Gutta *et al* (2014) noted multiple fractures (angle and body) were more common than isolated fractures. In this study, angle and parasymphysis of mandible contributed 38.8% of mandibular fractures concurring with the study conducted by Gutta *et al* (2014). Most authors reported fractured angle mandible to be associated with high postoperative complications (Wagner *et al*, 1979; James *et al*, 1981, Chuong *et al*, 1983; Iizuka *et al*, 1991; Anderson and Alpert, 1992). There was no significant association between complications and site of fracture.

5.1.3 Aetiology of mandible fracture

The aetiology of mandible fracture includes, assaults, traffic accidents, accidental falls, and sports related injuries (Telfer, 1991). The causes of mandibular fractures differ from one country to another because of social, cultural, and environmental factors (Goodday, 2013). Studies from New Zealand (Lee, 2008), United States of America (Gutta *et al*, 2014) reported assault to be the most common aetiology for mandible fractures. Goodday (2013) noted that assaults are influenced by drugs and alcohol abuse. Countries such as India (Michelet, 2019), Nigeria (Abiose, 1986) noted most mandibular fractures to be caused by traffic accidents. Reported factors attributing to mandibular fractures secondary to traffic accidents are impatient driving, driving under the influence of alcohol, failure to wear helmets, and poor road maintenance (Al Ahmed *et al*, 2004; Krishnaraj and Chinnasamy, 2007).

Assault or traffic accidents contributes to majority of mandibular fractures. In this study assault contributed 87.5% of mandible fractures. This observation corroborates with those of Lee (2008) and Gutta *et al* (2013).

5.1.4 Tooth in the mandible fracture line

There has been no consensus about retaining or removing teeth in line of mandible fracture (Shetty and Freymiller, 1989; Goodday, 2013). The following were reported as indications for a tooth removal in the line of mandible fracture at the time of surgery: fractured teeth, pericoronal/periodontal infection, grossly carious teeth, tooth mobility, exposure of the apical half or more of the root (including the apex), and inability to reduce the fracture without tooth removal (Ellis, 2002). While Samson *et al* (2010) recommend teeth extraction in line of mandible fracture if they show no response to pulp vitality test, Bang *et al* (2018) suggested no need for teeth extraction in line of mandibular fracture for prophylactic purposes. In this study 95% of teeth in line of mandible fracture were extracted. Of the 5% of teeth left in line of mandibular fracture in the group A, all resulted with infections which resolved on antibiotic treatment. There was no significant association between complications and tooth characteristics. Teeth in line of mandibular fracture can result in increased rate of postoperative complications. This study is in agreement with Ellis (2002) study that reported no statistical significance to postoperative

complications when a tooth is present in fractured angle mandible. However, there is an increased risk of infection when teeth are retained in the line of fracture.

5.1.5 Timing of mandibular repair

There is no unanimity regarding the timing of management of mandibular fractures. Maloney *et al* (1991) advocated early immobilization of mandibular fractures within 72 hours of the initial trauma. Gazal (2015) suggested that early repair of mandibular fractures can ease the rate of infection and postoperative complications. However, James *et al* (2020) reported no significant association between the timing of the repair of mandibular fractures and complications. They stated the following reasons for a delay in treatment of mandibular fractures: patient delays in seeking treatment, lack of funding or operating room time, and polytrauma patients with concomitant injuries that preclude early management of mandibular fractures.

In this study the timing of mandibular fracture was performed within 8 days post injury. There was not statistically significant between the two groups with P-value of 0.16.

5.1.6 ORIF VS ORIF with supplementary MMF

There are differences in opinion regard the placement of MMF post open reduction and internal fixation (ORIF) (Rodman and Kellman, 2016). Those in support of ORIF without supplementary MMF postoperatively, noted no significant difference with or without supplemental MMF (Kaplan *et al*, 2001; Kumar *et al*, 2011; Sasman *et al*, 2014; Rout, 2021). They argued that the degree of pain and swelling, both from the original trauma as well as from surgery, serves to keep them in a physiological MMF. The advantages of eliminating supplementary MMF post ORIF include decreased postoperative discomfort, earlier return to normal jaw function, easier maintenance of oral hygiene, elimination of additional surgery (removal of wires) and better nutrition (Dodson *et al*, 1990).

Authors in support of MMF post ORIF suggested that MMF is needed because it allows reattachment of the soft tissue, stabilizes the occlusion and thereby decreases the incidence of complications (Bolourian *et al*, 2002; Chritah *et al*, 2005, Longwe *et al*, 2010). They also argue that two weeks of MMF does not results in deleterious complications such as trismus (from prolonged immobilisation) and dental caries (from poor oral hygiene). Of 42 patients who had

undergone ORIF, only 3 had complications, while of the 38 patients who had ORIF with supplementary MMF, 2 had complications. There was no statistical difference between the two groups. This study was in agreement with Kaplan *et al*, 2001; Kumar *et al*, 2011; Sasman *et al*, 2014; Rout, 2021.

This study disagrees with the advocates of MMF post ORIF, as the results indicated same number of complications in both groups. So, supplementary MMF post ORIF does not necessarily decrease the incidence of complications. Eliminating MMF postoperatively will assist in decreasing theatre time, render patient comfort and reduce the incidence of wire stick injuries.

5.1.7 Complications

The following complications are associated with both protocols of mandibular repair, wound dehiscence, infection, malocclusion, non-union, malunion and hardware failure (Kaplan *et al*, 2001; Kumar *et al*, 2011; Sasman *et al*, 2014). In this study, only 6.3% of the participants presented with post-operative complications, four patients had infection which were treated with antibiotics. One patient had a hardware failure which was removed at six weeks post treatment. No further treatment was required as the fracture had already healed. Of the 5 patients who had complications, 3 (2 infection and 1 hardware failure) had only ORIF, whereas 2 (both infections) had ORIF with supplementary MMF. Prabhakar *et al* (2021) noted postoperative complications of 6.25%, this concurred with our study.

Even though in this study infection was noted to be the most associated complication in both groups, this finding did not have any statistical significance. Ravikumar and Bhoj (2019), in their retrospective study, also reported infection to be the most postoperative complication following ORIF mandible. The following factors are associated with increased risk of infection: inadequate immobilisations of fractured mandible, a prolonged delay in fractured mandibular repair, inexperienced surgeons, trauma severity, underlying systemic factors and patient factors such as smoking, poor oral hygiene, chronic abuse of alcohol and drugs (Paza *et al*, 2008).

Other complications such as exposure or fracture of hardware may arise after months or years post-surgical repair of mandibular fracture (Al-Moraissi and Ellis III, 2014). Unfortunately, in

this study subjects were only followed up for a short period of six weeks. Long term follow-up can assist with monitoring complication rate (Barry and Kearns, 2007).

5.2 Limitation

Short follow up period affected the strength of the study. Also, sample size may not have been large enough to detect the differences in infection rate necessary to reach statistical significance. Outcome of this study should thus be interpreted with caution due to the small sample size. The duration of surgery was not documented. Multiple operating surgeons were also involved in both groups.

5.3 Conclusion and recommendation

There was no statistical difference between the two groups. The Null hypotheses was supported by our findings. Although infections attributed majority of complications in both groups, this was not statistically significant associated with the complications. Infection was preceded by teeth (5%) not extracted in line of fracture. Even though there was no statistical significance associated with teeth in fracture line, teeth in fracture line increase risk of complications.

From the findings of the present study, revealing no difference between ORIF only and ORIF with supplemental MMF, we conclude that supplemental MMF appear to offer no additional benefits in reducing postoperative complications of mandibular fractures treated by ORIF. Future prospective randomized controlled studies, involving a larger number of patients, as well as longer follow-up period that will include data such as smoking, fracture displacement and duration of surgery are recommended to further strengthen the findings of this study

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Annexure A

Proforma

Patient code

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Age

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Gender

Male	Female
------	--------

Medical history

Clear	Present
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Medication

None	Name
------	------

Aetiology

Assault	Motor vehicle accidents	Fall	Sport related injury	other
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Injury period

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(Day)

Site of fracture/s

Symphysis	Parasymphysis	Body	Angle
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Treatment

ORIF	ORIF and MMF
------	--------------

Tooth in fracture line

Extracted	Not extracted
-----------	---------------

Intraoperative MMF

Yes	No
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Fixation type

rigid	Semi-rigid
-------	------------

Complications

infections	malocclusion	Hardware failure	Malunion/Nonunion
Wound dehiscence	other		

Review period (in weeks)

1	4	6

Annexure B



R14/49 Dr NH Chokoe

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL) CLEARANCE CERTIFICATE NO. M181196

NAME: Dr NH Chokoe
(Principal Investigator)
DEPARTMENT: School of Oral Health Sciences
Department of Maxillo-facial and Oral Surgery
Wits Oral Health Centre
University

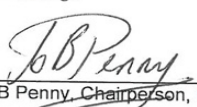
PROJECT TITLE: The success rate of osteosynthesis plating without post-operative maxillomandibular fixation in management of mandibular fractures: a randomised clinical trial

DATE CONSIDERED: 30/11/2018

DECISION: Approved unconditionally

CONDITIONS:

SUPERVISOR: Dr M Mabongo

APPROVED BY: 
Dr CB Penny, Chairperson, HREC (Medical)

DATE OF APPROVAL: 30/04/2019

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 3rd Floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

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 submit details to the Committee. I agree to submit a yearly progress report. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in November and will therefore reports and re-certification will be due early in the month of November each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

Date

PLEASE QUOTE THE CLEARANCE CERTIFICATE NUMBER IN ALL ENQUIRIES

Annexure C



Department of Oral Biological Sciences, 7 York Road, Parktown, 2193. Tel: 011 717 2045 Fax: 086 553 3890 Email: Julitha.Molepo@wits.ac.za

06 May 2019

Dr N. Chokoe
Maxillo-facial and Oral Surgery
Faculty of Health Sciences
University of the Witwatersrand
Johannesburg

RE: PERMISSION TO CONDUCT RESEARCH

REFERENCE: HRRC/MAY/03/2019

It is my pleasure to grant final approval to conduct your research at Wits Oral Health Centre titled "The success rate of osteosynthesis plating without post-operative maxillomandibular fixation in management of mandibular fractures: a randomised clinical trial".

The Hospital Research and Risk Committee allocated a unique reference number to this application – Kindly quote this reference number in all future correspondence regarding this research.

Please note that the Hospital Research and Risk Committee should be informed of the estimated date the research will commence, as well as regular status reports until the research has been concluded. Within a month after conclusion of the research project, a written report must be submitted to the Head of School/CEO, summarizing the final result/outcome as well as the recommendations made based on the research concluded.

Regards,



Prof. M. S. Nemutandani
CEO/Head of School
Date: 15/05/2019

Annexure D



7 York Road, Parktown, 2193 South Africa • Telegrams "Witsmed" • Telephone (011) 717-2000 • Fax (011) 484-2717

Department of Maxillofacial and Oral Surgery
Telephone 011 717 2130
Fax: 086 765 4436
E-Mail: liza.huygen@wits.ac.za
07 November 2018

Dear Dr. N Chokoe

As per your request for your study entitled "*Maxillomandibular fixation: is there an indication for it postoperative osteosynthesis plating of mandibular fractures.*" approval is hereby granted for you to access records of patients who were treated for mandibular fractures.

Although these patients have given consent for treatment at Wits Oral Health Centre, their privacy and confidentiality however need to be respected at all times and at no stage should these patients be identified by their names in the ultimate collection and analysis of the data.

Yours sincerely

A handwritten signature in black ink, appearing to read "RE Rikhotso".

Prof. RE Rikhotso
Head of Department MaxilloFacial and Oral Surgery
University of Witwatersrand

Annexure E

Patient code.....

Patient Name.....

Medical record number / File number.....

Annexure F

Dr			
ORIGINALITY REPORT			
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| 10 | Edward Ellis. "Outcomes of patients with teeth in the line of mandibular angle fractures treated with stable internal fixation", Journal of Oral and Maxillofacial Surgery, 2002
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| 11 | Rajesh Gutta, Kyle Tracy, Christopher Johnson, Laura E. James, Deepak G. Krishnan, Robert D. Marciani. "Outcomes of Mandible Fracture Treatment at an Academic Tertiary Hospital: A 5-Year Analysis", Journal of Oral and Maxillofacial Surgery, 2014
Publication | 1 % |

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