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# Mandibular fracture patterns as related to mechanism and nature of injury-A prospective audit of Johannesburg patients

**Desai, Jameel**

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# CHAPTER 1: INTRODUCTION

## 1.1 **History of mandibular fractures and treatment**

There are two books that describe, in detail, historical aspects of maxillofacial and oral surgery [1, 2]. The facts in this section are based on these writings. The earliest record, describing mandibular fractures, dates back to 1650 BC. This was known as the 'Edwin Smith Papyrus', which was translated in 1930 by Breasted. The first description of the treatment of jaw fractures however, has to be credited to the 'Father of Medicine'… Hippocrates. He made use of bandages and single jaw fixation, to manually reduce fractures of the jaws.

Celsus (30 BC – 50 AD), a Roman physician, was one of the earliest to recognize the importance of establishing the occlusion in the treatment of fractures. His principle of fracture immobilization was the forerunner of intermaxillary fixation (IMF), still in use today. The Eleventh Century Italian influence on the treatment of mandibular fractures continued, primarily due to the work of clinicians in Salerno. In 1275 Guglielmo Salicetti wrote his book *Cyrurgia*, in which he recommended the wiring together of teeth adjacent to the fracture (tension band principle) followed by the wiring together of both jaws (IMF). This technique was crude by our methods, but remarkably insightful for the Thirteenth Century.

By the late 1700s and early 19$^{th}$ century, the development and use of extraoral splint techniques were in favour. Thomas Gunning, an Irish-American dentist was credited with the first intraoral splint; and ironically made one for himself after sustaining a mandibular fracture in a riding accident, in 1862. The concept of closed reduction of fractures persisted until the early 1900s. Buck, Kinlock, and Gilmer were probably the earliest to attempt open reductions;

whilst Schede is credited with the first use in 1888, of a true bone plate made of steel, and secured with four screws. In the 1960s, Luhr developed a Vitallium mandibular compression plate as a result of his work on rigid fixation. The 1970s saw Spiessl bringing the modifications of the orthopaedic principles to the discipline of maxillofacial trauma, under the auspices of Arbeitsgemeinschaft fur Ostesynthesefragen/Association for the Study of Internal Fixation (AO/ASIF). Champy also introduced his principles of rigid fixation, along lines of ideal osteosynthesis, using malleable non-compression plates; in the mid ‘70s. These principles and treatment modalities remain the benchmark, thirty years on.

**1.2 Classification of fractures**

Classification of disease or injuries forms the cornerstone of understanding and communicating, among all health personnel. Not surprisingly, there exists a vast selection of classification schemes for bony injuries; and the mandibular fracture is no exception. It is unfortunate that no singular universal classification exists, but some are more pragmatic than others; and hence, are more widely used. Perhaps the most important aspect of the mandibular fracture classification schemes available is that they suggest which modalities of treatment are the most appropriate. The following four systems are perhaps the most widely used in maxillofacial and oral surgery.

### 1.2.1 *Generic classification of bone fractures* [1]

- *Simple or Closed:* A single fracture line through the bone; that does not communicate with the external environment or oral cavity.
- *Compound or Open:* The fracture line does communicate with the external environment, and/or the oral cavity.
- *Greenstick:* The fracture involves only one cortical plate, whilst the opposing cortical plate is bent.
- *Comminuted:* There exists several fracture lines producing multiple fragments of bone.
- *Complicated:* The fracture produces significant injury to adjacent soft tissue or structures.
- *Pathologic:* The fracture line passes through an area previously weakened by some disease process.
- *Dislocation Fracture:* A fracture of a bone near an articulation, with resultant disarticulation.
- *Direct (coup):* A fracture occurring at the point of impact.
- *Indirect (contre coup):* A fracture occurring at a point distant to the impact point.
- *Impacted:* One fractured segment is driven into another.
- *Incomplete:* The fracture line does not traverse the entire bone.
- *Multiple:* Two or more lines of fracture, independent from each other, but occurring in the same bone.
- *Unstable:* The segments of the fracture have a tendency to displace away from each other after reduction.

1.2.2 *Classification of fractures by anatomic site* (Fig. 1.1)

- *Symphysis / Parasymphysis:* The Symphyseal fracture is a linear fracture in the midline of the mandible. The Parasymphysis is the anterior part of the mandible, bounded posteriorly by a line distal to the canines.
- *Alveolar Process:* That part of the bone encasing the teeth.
- *Body:* This extends from the parasmphyseal line to the angle of the mandible (anterior border of masseter muscle).
- *Angle:* A triangular region extending from anterior border of masseter muscle to a line drawn from the 3rd molar, to the posterosuperior attachment of masseter muscle.
- *Ramus:* Area superior to angle but inferior to the angle formed by 2 lines, originating at the sigmoid notch.
- *Coronoid:* Area superior, to the anterior line from sigmoid notch to anterior border of mandible.
- *Condyle:* Region superior, to the posterior line from sigmoid notch to posterior border of mandible.

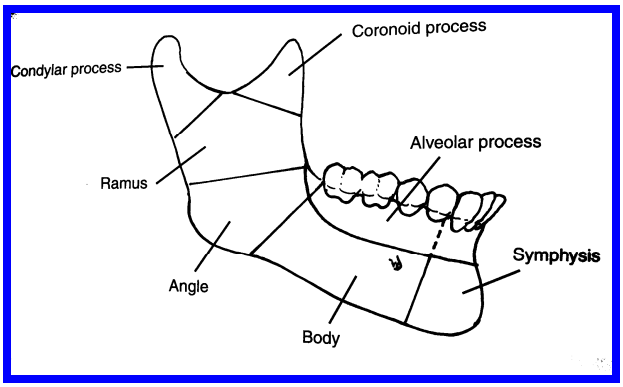



Fig. 1.1 Classification of fracture by anatomic site [2]

1.2.3 *Classification of fractures by reducibility* (Figs. 1.2; 1.3)

- *Horizontally Favourable:* The actions of masseter and temporalis muscles tend to reduce the fracture segments.
- *Horizontally Unfavourable:* The actions of masseter and temporalis muscle tend to displace the fracture segments.
- *Vertically Favourable:* The actions of the pterygoids tend to reduce the fracture segments.
- *Vertically Unfavourable:* The actions of the pterygoids tend to displace the fracture segments.

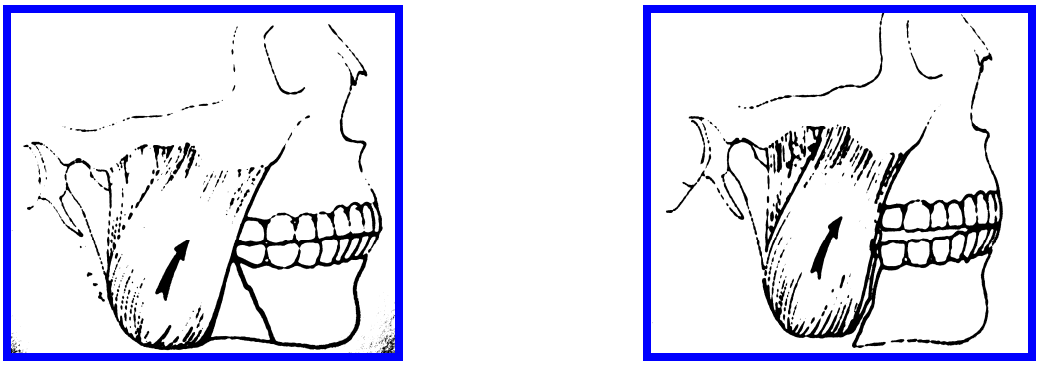


Fig.1.2. Horizontally favourable fracture (left) and horizontally unfavourable fracture (right).[2]

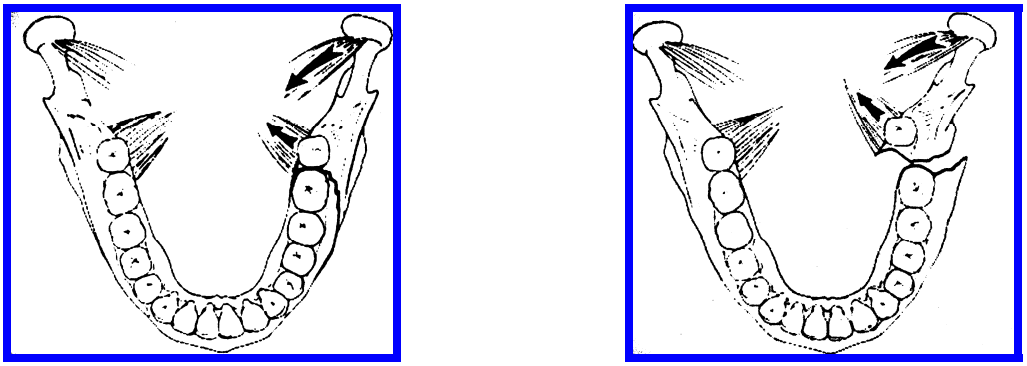


Fig. 1.3 Vertically favourable fracture (left) and vertically unfavourable fracture (right).[2]

1.2.4 *Classification based on dentate/edentate segments* (Fig. 1.4)

- *Class I:* Teeth are present on both sides of the fracture line.
- *Class II:* Teeth are present on one side of fracture line only.
- *Class III:* Both sides of the fracture are edentate.

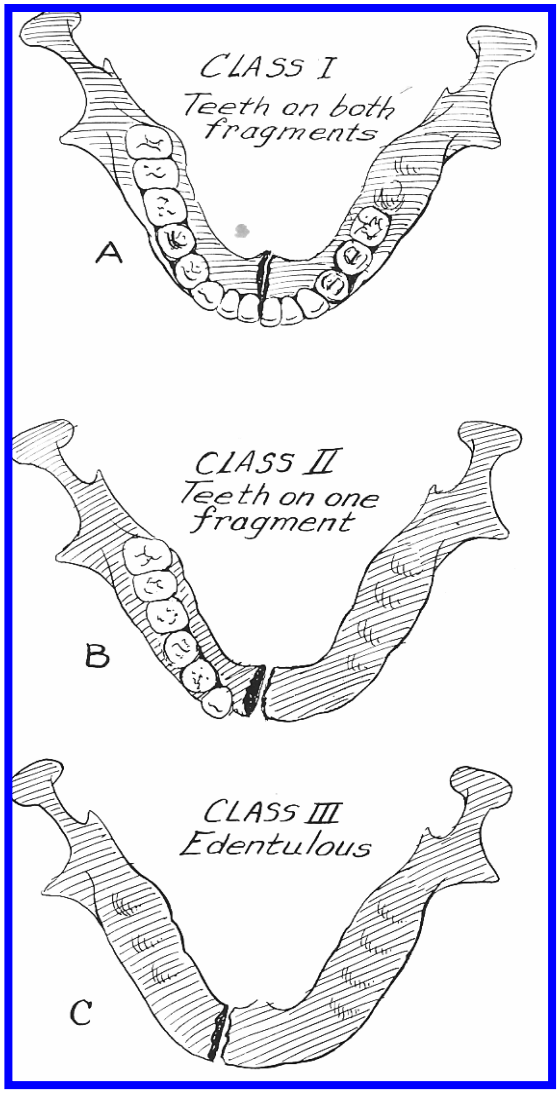



Fig.1.4 Classification of fractures by dentate/edentate segments [3]

### 1.3 Treatment of fractures

The treatment of mandibular fractures is varied, and depends primarily on several characteristics of the fracture. The anatomic location, degree of displacement, favourability, continuity or defects, the number of fractures, and age of the patient; have all to be considered prior to treatment planning. The actual principles of treatment however, are universal and remain unchanged for all fractures involving the facial skeleton. These principles are reduction, alignment, fixation and immobilization. The reduction and alignment of mandibular fractures hinges on the establishing of a pre-injury occlusion in the dentate patient. In edentulous states, this is more subjective and depends largely on a visual anatomical reduction.

Treatments may vary from conservative management, involving several weeks of liquid or semi-solid food; to closed reduction, involving intermaxillary fixation (IMF); and finally, to open reduction with or without internal fixation. Modalities of treatment, of historic interest include intraoral or extraoral splints, and external pin fixation. Adjunctive treatments such as autogenous bone grafting with the aid of ‘reconstruction plates’, has also an important role in the rehabilitation of the severely fractured mandible. The use of compression plates, mini bone plates, intraosseous wires, reconstruction plates, and lag screws, are common in techniques of internal fixation. Whilst, Erich arch bars, Ivy loops and Cap stem screws, Gunning splints and Barton’s bandage; have all been used to secure IMF, with varying degrees of immobilization. The above treatment options may be applied singularly, or in combination with each other.

## 1.4 Review of relevant literature

The Division of Maxillofacial and Oral Surgery of the University of the Witwatersrand provide services to the Chris Hani Baragwanath, Helen Joseph and Johannesburg Hospitals. These hospitals, in turn, accept referrals and patient transfers from virtually the entire Gauteng Province south of the Jukskei River as well as neighbouring provinces without maxillofacial and oral surgery services. The Division renders a full spectrum of maxillofacial services, but trauma cases comprise the bulk of the total case load. The treatment of mandibular fractures, in turn, constitutes the majority of trauma cases. Because of this it becomes crucial that the epidemiology of mandibular fractures be well recorded, understood and frequently updated. This unfortunately has not been the case since the most recent data on mandibular fractures dates back to studies done by Rosenberg & Smith in 1976 [4] and to a lesser degree Beaumont et *al*. 1985 [5].

Beaumont *et al*.[5] did a retrospective analysis of 389 Johannesburg patients with facial fractures and found that 81 % of all patients were male and that 74% were black. Among female patients, coloured and Indian ethnic groups made up the largest percentage (19%). Of the facial fractures, 75% were mandibular fractures caused in descending order by assault, motor vehicle accidents and sport injuries. Rosenberg & Smith [4] undertook a study on fractured mandibles and reported that the male to female patient ratio was 8.5:1. They also studied the relationship between site of impact and the resulting type of fracture and degree of displacement produced. Their results indicate that site, force and direction of impact were more important than the action of muscle pull on fractured segments; when trying to predict favourability of fractures.

In 1985 Ellis and co-workers [6] reported their findings of a retrospective 10 year audit of 2137 Scottish patients with traumatic injuries; their findings had striking similarities to previous South African studies. They found that fractured mandibles comprised 45.4% of all maxillofacial injuries and 76% of these were in male patients. Injuries peaked in the second and third decades for males and in the third to fourth for females. On average they saw 200 fractured mandibles per annum, with a peak during the summer month of July. Interpersonal violence was the cause of more than half of the fractures seen, and 75% of assaults occurred at drinking establishments. Ellis *et al*. [6] also noted a mean of 1.6 fractures per mandible, with the majority occurring in the body region, followed by condylar and angle fractures. Perhaps the most interesting finding is that roughly a third of fractures required no active treatment save for observation, whilst the other two- thirds were treated either with closed reductions or open, with internal fixation.

Passeri [7] highlighted the importance of understanding mandibular fracture patterns in order to plan correctly for treatment. He reported a mean time of 3 days between injury and presentation, 0.8 days between presentation and treatment and an average of 1.5 days post-surgical hospitalization. Therefore patients were seen, treated and discharged after a mean of 5.3 days at a Texas hospital. In 1999, Oji [8] conducted a ten year retrospective analysis of mandibular fractures, in Nigeria. His sample size comprised 900 patients, and 83 % were due to road traffic accidents; whilst only 8.4 % were as a result of interpersonal violence. Sport and occupational injuries only accounted for 4.3 % of the total. Most fractures occurred in the 21-30 years age group, and 75 % were male.

Bochlogyros [9] examined a series of 1,512 mandibular fractures in West Germany, and he too reported a 3:1 ratio of male to female patients. Remarkably only 6.8 % of these fractures were attributed to interpersonal altercations. Again, the peak age for fractures occurred in the 20-29 years category. Haug [10] and his colleagues from Cleveland, Ohio; reported that mandibular outranked zygomatic and maxillary fractures (6:2:1). The anatomic order of frequency of mandibular fractures was the body (29.5%), angle (27.3%), condyle (21.1%), symphysis (19.5%), ramus (2.4%) and coronoid (0.2%) [10].

Snijman[11] and Duvenhage [12] conducted studies in the Pretoria district of Gauteng, South Africa. They reported similar statistics to those of the Johannesburg studies, but these results too are well over twenty years old.

There has been a perceived increase in crime, violence and violent crimes throughout South Africa over the last decade. Johannesburg is the financial hub of the country and is the most densely populated city; so clearly there is a need for a study on facial trauma in our department, hospital, and city, to determine current maxillofacial trauma rates. With this in mind, specific aims and objectives were conceived, to study fractures of the mandible in the Johannesburg region.

**Aims and objectives**

- To determine the prevalence of mandibular fractures in the Johannesburg region.
- To record the association between mandibular fractures, and the nature and mechanism of the causative injury.

- To provide data that may be used to predict treatment requirements, thereby allowing for an improved matching of financial, and professional resources to patients treatment needs.

# CHAPTER 2: MATERIALS AND METHODS

## 2.1 Ethics approval

This study involved the clinical evaluation and treatment of patients, hence an approval from the Committee for Research on Human Subjects (Medical) of the University of the Witwatersrand was sought; and received - protocol no. M040324 (Appendix C). Patients, who fulfilled the inclusion criteria for the study, were given a written and verbal explanation of the study. A signed consent was then obtained from each individual participating in the study. (Appendix A)

## 2.2 The clinical study

The study was undertaken in the Division of Oral and Maxillofacial Surgery, Department of Surgery, University of the Witwatersrand; at the Johannesburg Hospital, Johannesburg, South Africa.

This was a prospective study of a sample of 133 adult patients that presented to the out-patient clinic of the maxillofacial and oral surgery division. This sample represented approximately 70% of the total number of patients with mandibular fractures seen in the division over the period of data collection. Individuals 16 years (age when physical maturity is largely complete) and older, both male and female, with fractured mandibles were included in the

study. The data was collected and recorded by a single clinician (to ensure data quality), over a six month period (March to August 2004).

All patients received a detailed clinical examination that included a history taking, physical examination, and a viewing of radiographs. The radiographs included Orthopantomographs (OPG) (Fig. 2.1), Posterior-Anterior views of the Mandible (PA mandible) (Fig. 2.2), and Reverse Towne's view (Fig. 2.3). Reverse Towne's views were used only in those patients where a suspected condyle fracture was not discernable on the OPG or PA views. All relevant findings were then recorded on the patient information data sheet. (Appendix B)



Figure 2.1 Orthopantomograph (OPG) is used for an overall assessment of the mandible, and for fractures that are horizontally favourable/unfavourable.

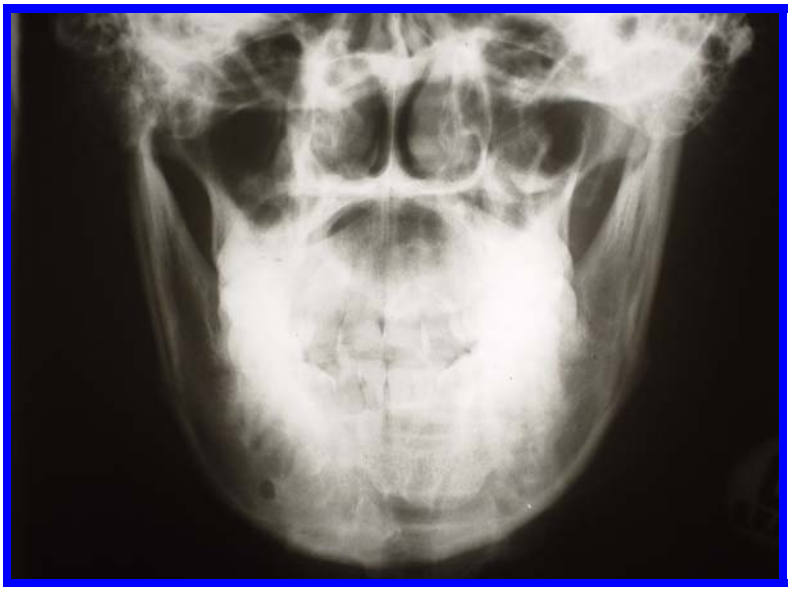


Figure 2.2 Postero-Anterior mandible (PA) is used for assessing fractures that are vertically favourable/unfavourable.

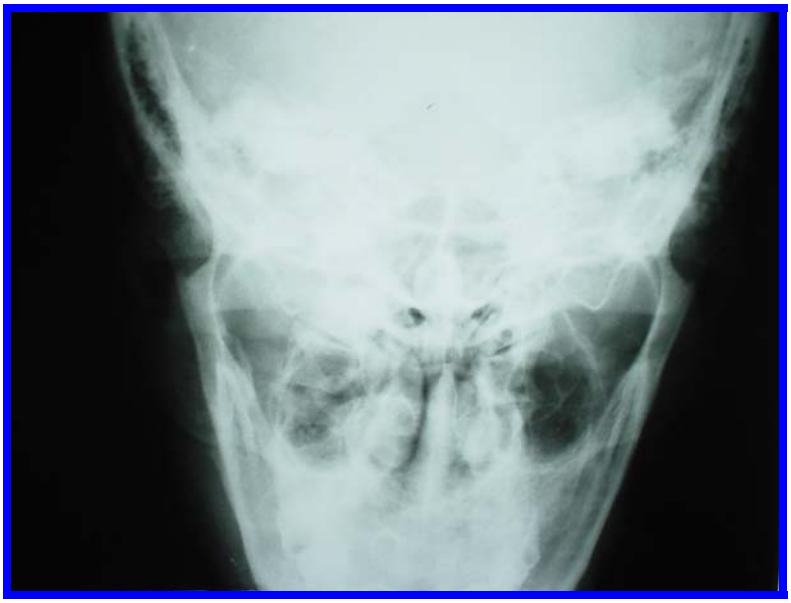


Figure 2.3 Reverse Towne's view is used to detect fractures as well as displacement of the mandibular condylar processes.

The histories recorded included details about the injury, and also a comprehensive medical and surgical history. The clinical examination started with a general evaluation, and proceeded to a specific orofacial assessment. This orofacial evaluation looked at the soft and hard tissues as well as a neurological profile of cranial nerves I – VII. Intra-orally, any occlusal steps, mobility of individual teeth and segments, mucosae and tongue; were all assessed and documented. The radiographs were scrutinized for fracture lines, and favourability of fractures was noted in the horizontal and vertical planes. Teeth occurring in fracture lines were so noted. Fractures were classified as per simple/closed, open/compound, coup/contrecoup; and horizontally/vertically favourable or unfavourable. Patients were then admitted to our hospital ward, and the appropriate treatment rendered.

**2.3 Data analysis**

Data was analysed with SAS for Windows version 9.02 (SAS Institute Inc, Cary NC, USA) and Instat version 3 (Graphpad Software Inc, San Diego, CA, USA). Descriptive statistics are presented.

# CHAPTER 3: RESULTS

## 3.1 Demography of sample

Of the 133 patients with fractured mandibles examined 75% were Black. Male patients comprised the bulk of the patient sample with a male to female ratio of 6.4:1. Most of the patients were in their 3rd or 4th decades (Table 3.1). The age of patients ranged from a minimum of 16 to a maximum of 58 years. Coloured patients on average were younger; whilst the Indian sample was the oldest (Table 3.2). The bulk of our patient pool, was either unemployed, worked as manual labour, or was employed in an informal private sector (Table 3.3). From the patient histories, most of the injuries occurred after dark, and at drinking establishments; especially on weekends.

Table 3.1 Frequency distribution by age in decades; gender and race group (N=133)

| | | N | % |
|---|---|---|---|
| **Decade** (years) | 10-19 | 6 | 4.5 |
| | 20-29 | 51 | 38.4 |
| | 30-39 | 52 | 39.1 |
| | 40-49 | 21 | 15.8 |
| | 50-59 | 3 | 2.3 |
| **Race group** | black | 100 | 75.2 |
| | other | 33 | 24.8 |
| **Gender** | male | 115 | 86.5 |
| | female | 18 | 13.5 |

Table 3.2 Details of age in years by race group (N=133)

| | Black | Coloured | Indian | White |
|---|---|---|---|---|
| Frequency | 100 | 10 | 2 | 21 |
| Mean | 31.5 | 27.5 | 38.5 | 32.3 |
| Std Dev | 8.5 | 7.8 | 4.9 | 10.0 |
| Minimum | 18 | 16 | 35 | 20 |
| Maximum | 53 | 41 | 42 | 58 |

### 3.2 Nature and mechanism of injury

A total of 115 patients (86.5%) sustained their injuries as a result of inter-personal altercation, whilst 18 (13.5%) were accidental injuries (rta-16; sport-2) (table 3.3). Only 6/115 patients had sustained their injuries as a result of penetrating trauma (5- high-velocity gun shots; 1-low-velocity knife wound). A total of 127/133 patients were injured as a consequence of blunt trauma (16- high-velocity rta; 111- blunt objects or body parts). Single and multiple (2 or more) fractures had similar prevalences (Table 3.4).

Table 3.3 Frequency distribution by occupation and nature of injury (N=133)

| | N | % |
|---|---|---|
| **Occupation** | | |
| labourer | 34 | 25.6 |
| state | 4 | 3.0 |
| private | 38 | 28.6 |
| professional | 1 | 0.8 |
| unemployed | 46 | 34.6 |
| student | 10 | 7.5 |
| **Nature of Injury** | | |
| accidental | 18 | 13.5 |
| inter-personal | 115 | 86.5 |

Table 3.4 Frequency of single and multiple fractures (2 or more) per mandible (N=133)

| No. Fractures | N | % |
|---|---|---|
| Single | 64 | 48.1 |
| Multiple | 69 | 51.9 |

### 3.3 Fracture patterns

Open fractures outnumbered closed in a ratio of 3:1. In the Black sample, most individuals (49%) were struck on the left side of the face, while in the combined 'other' group (White, Coloured & Indian) the converse was true; i.e. 42% were struck on the right side (Table 3.5). For the pooled sample 45% of impact occurred on the left. Associated injuries were lacerations and abrasions, swelling, sepsis and haemorrhage; a total of 30% of the sample sustained some form of these associated injuries (Figs. 3.1, 3.2, 3.3). Compound or open fractures occurred with similar frequency in Blacks and other racial groups. The overall frequency of open fracture was 76% (n=133) (Table 3.5). The role of alcohol consumption at the time of injury, was also assessed via the history (Table 3.6), and was found to be lowest in the 2$^{nd}$ and 6$^{th}$ decades. The peak age group (mode) for the use of alcohol was the 4$^{th}$ decade, and the total alcohol consumption for the sample (n=133); was 65%. In the group of patients who had consumed alcohol, 73% were black; whilst 27% were from 'other' racial grouping (Table 3.7). Of the total sample (n=133), 47.4% were black patients that consumed alcohol at the time of injury and 17.3% were of the 'other' category. A total of 52 patients (n=133), i.e. 39% reported a loss of consciousness (L.O.C.) at the time of injury (Table 3.7).



Fig.3.1 Swelling of the face.



Fig.3.2 Abrasions of the torso.



Fig.3.3 Laceration of the face associated with fractured mandible.



Fig. 3.4 Mandibular fracture sites and frequencies in 133 patients.

Key: Total number of fractures= 203 (100%)

Blue= condyle 33 (16.8%), Orange= coronoid 0 (0%)

Green= ramus 0 (0%), Red= angle 79 (38.9%)

Pink= body 36 (17.7%), Brown= dentoalveolus 5 (2.5%)

Yellow= Parasymphysis 39 (19.2%), Black= symphysis 11 (5.4%)

A total of 203 fractures were recorded in the sample, a mean of 1.5 fractures per mandible. Angle fractures were most common, followed by parasymphyseal; body; condyle; symphysis and dentoalveolar, respectively (Fig. 3.4). Ramus and coronoid fractures were not seen in this sample group.

Table 3.5 Fracture characteristics by race group (N=133)

| | | Black n=100 | | Other n=33 | | Total n=133 | |
|---|---|---|---|---|---|---|---|
| | | **N** | **%** | **N** | **%** | **N** | **%** |
| **Impact Site** | left | 49 | 49 | 10 | 30 | 59 | 45 |
| | midline | 19 | 19 | 9 | 27 | 28 | 21 |
| | right | 32 | 32 | 14 | 42 | 46 | 34 |
| **Fracture Type** | open | 75 | 75 | 26 | 79 | 101 | 76 |
| | closed | 25 | 25 | 7 | 21 | 32 | 24 |
| **Associated injuries** | | 31 | 31 | 9 | 27 | 40 | 30 |

Table 3.6 Frequency distribution of fracture type, associated injury and alcohol consumption by decade. (N=133)

| **Decade** (years) | **Fracture Type** | | | | **Associated Injury** | | **Alcohol Consumed** | |
|---|---|---|---|---|---|---|---|---|
| | **open** | | **closed** | | | | | |
| | N | % | N | % | N | % | N | % |
| **2**(10-19) | 6 | 5.9 | 0 | 0 | 1 | 2.5 | 3 | 3.5 |
| **3**(20-29) | 38 | 37.6 | 13 | 37.5 | 15 | 37.5 | 30 | 34.9 |
| **4**(30-39) | 39 | 38.6 | 13 | 37.5 | 15 | 37.5 | 35 | 40.7 |
| **5**(40-49) | 16 | 15.8 | 5 | 15.6 | 8 | 20.0 | 16 | 18.6 |
| **6**(50-59) | 2 | 2.0 | 1 | 3.1 | 1 | 2.5 | 2 | 2.3 |
| **Total** | 101 | | 32 | | 40 | | 86 | |

Table 3.7 Frequency distribution of alcohol consumption and loss of consciousness (LOC) by race group (N=133)

| Race group | Alcohol | | LOC | |
|---|---|---|---|---|
| | N | % | N | % |
| **Black** | 63 | 47.4 | 35 | 26 |
| **Other** | 23 | 17.3 | 17 | 13 |
| **Total** | 86 | 64.7 | 52 | 39 |

Table 3.8 Frequency distribution of tooth in fracture line; nerve damage; displaced fracture; fracture type, and treatment rendered (N=133)

| | N | % |
|---|---|---|
| **Tooth in fracture line** | 102 | 76.7 |
| **Nerve damage** | 77 | 57.9 |
| **Displaced fracture** | 98 | 73.7 |
| **Fracture type** | | |
| open | 101 | 75.9 |
| closed | 32 | 24.1 |
| **Treatment** | | |
| none | 7 | 5.3 |
| closed reduction | 27 | 20.3 |
| open reduction | 99 | 74.4 |

### 3.4 Treatments and cost of hardware

Fractures of the mandible were displaced in 73.7% of cases; with associated nerve paraesthesia in 57.9% of cases, and 76.7% of fractures contained a tooth within the line of fracture (Table 3.8). Furthermore, 5.3% of patients required no form of surgery, whilst 20.3% were treated by closed reduction and fixation of mandible (CRFM) and 74.4% were managed via open reduction with internal fixation (ORIF).

An audit of departmental records for the statistics on fractured mandibles for the years 2002-2004, confirmed that a total of 198 (2002); 133 (2003); and 217 (2004) ORIF's were done at the Johannesburg hospital. This equates to a total of 548 ORIF's for the last three years, a mean of 182.6 ORIF's per annum.

The rigid fixation systems of four companies were used in these open reductions (ORIF's). All comprised of 4-hole extended mini-plates and 2.0mm diameter screws (Fig 3.5). Due to a verbal undertaking not to divulge the details of the cost of the products of individual suppliers, an average costing across all four is presented: screws @ R97.79 per unit, 4-hole extended plate @ R313.56 per unit.

From the current study (Table 3.4), 48.1% of ORIF's were single and 51.9% were multiple i.e. a minimum of two fracture sites per mandible. Thus, of the 182.6 ORIF's done per annum (average no. ORIF's per annum from department statistics 2002-4) 87.8 (182.6 x 48.1%) will require a single mini-plate and 4 screws; whilst 94.7 (182.6 x 51.9%) will require a minimum

of 2 mini-plates and 8 screws. The trends of fracture number have been applied to department stats. 2002-4. Therefore direct cost of 'hardware' is as follows:

87.8 x 1 mini-plate @ R313.56 each = R27 530.57
87.8 x 4 screws @ R97.79 each = R34 343.85

94.7 x 2 mini-plates @ R313.56 each = R59 388.26

94.7 x 4 screws @ R97.79 each = R37 042.85

Therefore mean cost of 'hardware' for ORIF's per annum = R158 305.53 or US$ 25 048 (rate US$ 1 = R 6.32). It should be emphasized that the aforementioned costing does not include surgical, anaesthetic, hospitalization, and consumables other than plates and screws.

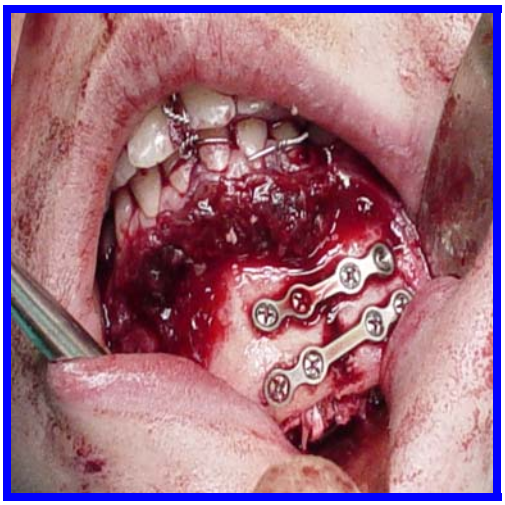


Fig. 3.5 'ORIF' shows two 4-hole extended mini-plates and their 2.0mm screws.

# CHAPTER 4: DISCUSSION

## 4.1 General

The Johannesburg Hospital provides care for patients without private health insurance, and thus mainly caters for the health needs of the poorer members of our communities. At least three quarters of the patients treated in this study were Black. Historically, the Black population has been underprivileged and although there appears to be an emerging Black middle-class since democratic reformation in South Africa; the bulk of the Black population still appears to be the neediest in our country.

Furthermore, young healthy males comprise the bulk of the current study sample; a finding that has not changed since earlier studies [4,5,11,12,13,16]. The obvious explanation for this would be that these males are of working age and are interacting amongst each other, with altercations being common. The reality however, is that a staggering amount of mandibular fractures are as a result of criminally motivated trauma. The level of inter-personal violence is an unacceptable 86.5%; with most of these being robberies. From my interaction with the patients, and from the social history taking; it is almost uniformly the same modus operandi by the criminal element. Patients are most frequently attacked on Friday and Saturday evenings (when most labourers receive their weekly wage) after a spell of alcohol consumption at informal drinking establishments (known as Shebeens). The victims are ambushed and struck in the face with blunt objects (usually rocks, sticks or the butt of a handgun). This has the effect of dazing or rendering the victim unconscious, so that the robbing of money and possessions proceeds unhindered. Often, these attacks are so brutal that they result in significant co-injury, such as head injury; extensive soft tissue laceration and

limb fracture (Figures 3.1-3.3). This is of importance, as some of these patients will be kept at peripheral hospitals and only referred once the other injuries have been stabilized (up to 2 weeks at times). Abiose [14] from Nigeria, reports that in the western states of his country, 4.81% of maxillofacial trauma was due to violent crime, whilst 80.77% was attributed to road traffic accidents. In our sample the converse was true, with only 13.5% being accidental.

Returning to the current South African sample; the potential role that alcohol plays in the contribution to the trauma rate, can not be emphasized enough. At least 65% of all patients who sustained fractured mandibles did so whilst intoxicated. Almost the entire spectrum of the sample admitted to the frequent consumption of alcohol, and whether those that denied intoxication at time of injury, were being sincere or not we will never know. A further dilemma regarding the role of alcohol becomes apparent, when the head injury statistic is closely scrutinized. The transient loss of consciousness (LOC) implies at the very least, a mild head injury [17]. Approximately 39% of patients reported a LOC. with many unable to specify the duration of LOC. As many of these patients were also intoxicated at the time, the patient's interpretation of what constituted a LOC; and a mere 'passing out', may have been confused; thereby making the head injury statistic an unreliable one.

Another interesting statistic is the low prevalence of sporting injury in the sample 2/133 (1.5%). One may speculate that sporting injury may be higher among the private medical facilities; or that fewer youth in the poorer communities are participating in contact sport, or that soccer (the preferred sport of the Black population) has a much lower prevalence of facial trauma than say rugby or cricket (traditionally favoured by 'other' population groups). In

Europe, the prevalence of sport related fractures seems to be much higher. For example, in Greece soccer accounts for up to 64% of sport related facial fractures in which the zygoma was more commonly fractured than the mandible [15].

In 1978, Reitzik and co-workers [18] performed experiments on the force required to fracture monkey mandibles. The findings of their study suggest that mandibles with unerrupted third molars, require 40% less force to cause a fracture in the angle region. In fact, the more severe the impaction of the third molar, the greater the chance of fracture as a consequence of blunt trauma [19]. Since the bulk of our patients were in their 3rd and 4th decades, and mostly did not have lower 3rd molars; and since angle fractures were the most common type, it may be deduced that the blows received must have been of considerable magnitude. The blows received were forceful enough, as 76% of all fractures in the series were open (compound); and these open fractures out-numbered closed (simple) fractures by a ratio of 3:1. Open fractures need not be frankly compound into the oral cavity, or onto the skin; but even extension of the fracture line into the periodontium of a tooth qualifies as an open fracture. In this study, at least 77% of teeth were in the line of fracture; and this invariably incorporated lower anterior teeth in symphyseal or parasymphyseal fractures. Unfortunately, these teeth were all removed as part of treatment protocol in the prevention of post surgical sepsis. Edward Ellis *III* [20] and Alpert [21] both report that there is a greater chance of sepsis if a tooth is retained, but this risk is not significant. Admittedly, our patients do not display the finest oral hygiene, but perhaps aesthetically important anterior teeth should be retained in open fractures that are rigidly fixed; and the post-operative vitality of these teeth should be monitored.

Another statistic that appears to correlate closely is the displacement of fracture segments and the presence of neurological fall out; although this is not statistically significant (table 3.4.1). The larger the displacement of proximal and distal fracture segments, the more likely one is to find nerve damage, as tugging or even severing of the inferior alveolar nerve will produce paraesthesia or anaesthesia respectively.

The treatment of fractures in this series ranged from conservative to CRFM, to ORIF. Conservative management, in essence, is a soft diet with no surgical intervention; and is the treatment of choice for fractures that are undisplaced, primarily asymptomatic and with no neurological compromise. Closed reductions (CRFM) were used in class I fractures that were only mildly displaced, but had to be no older than 72 hrs; or for grossly comminuted fractures. The indications for open reductions (ORIF) in this series were: nerve paraesthesia; moderate to severely displaced fracture segments; older fractures (>1 week post-injury); class III fractures; bilateral fractures, especially one with a high condylar fracture requiring early mobilization; and where CRFM was contraindicated e.g. epileptics. The bulk of our patients presented late; then, were kept waiting for surgery due to overcrowded operating lists, and hence were mandatory open reductions. The Champy miniplate placed along the line of ideal osteosynthesis [22], using monocortical screws; was the preferred method of open rigid fixation. Alternative techniques include the AO/ASIF system of compression or reconstruction plates with bicortical screws; the bicortical Luhr system, using vitallium plates [23]; and lag-screw osteosynthesis [24].

The role of human immunodeficiency virus (HIV) on the postoperative healing of treated fractures was not studied in this research but should be evaluated in future. In South Africa, as in most of Sub-Saharan Africa, HIV has become a major factor in the pathogenesis of disease and trauma. In our institution, anecdotal evidence is suggestive of increased postoperative sepsis in open reductions of mandibular fractures. Credibility to the aforementioned statement is offered by a study done on HIV patients in San Francisco [25]. In this study, an overall sepsis rate of 30% for HIV positive patients was recorded, opposed to 9.5% in the HIV negative control. Sepsis when it did occur was statistically significant for bone rather than soft tissue. The rate of sepsis in both sample and control were higher for ORIF (16%) than for CRFM (3.1%). Further, the overall sepsis rate for ORIF in HIV positive patients; was 45% as compared to 13.9% in the control group. These statistics also mitigate in favour of early intervention, by way of CRFM, in our patients.

### 4.2 Matching resources to treatment needs

From this study, indications are that there is an upward trend in the number of mandibular fractures treated at the Johannesburg Hospital. The concomitant rise in other trauma especially the life and limb threatening variety; means that fractured mandibles have to compete for operating theatre time, and are thus treated ‘cold’. There can be no justification in general, to give fractured mandibles priority on after-hours emergency theatre lists. Furthermore, we at the Johannesburg hospital are short on emergency theatre staff, including anaesthetists. Thus, the elective repair of mandibular fractures means that a large proportion of these cases require ORIF. Were these cases treated within 72 hrs of injury, then the bulk of them would be done as CRFM; a considerably cheaper treatment modality. The closed

reductions (CRFM) require little of the costly hardware (see section 3.4) that ORIF's do, and the overall hospitalization is about half as long. Further, the CRFM may be done in half the time that it takes to complete an ORIF, and may be done by one operator; whereas the open reduction requires two surgeons. Because of the number of patients awaiting surgery, often a fractured mandible can only be treated 4-6 weeks post-injury. In the 70's and 80's, maxillofacial surgeons were stationed at fully functional units located at peripheral hospitals. This meant that facial trauma was being attended to sooner, with presumably larger savings on direct treatment costs. These posts have in more recent years been discontinued. Is there perhaps an argument for the recreation of posts, and equipping of facilities at peripheral hospitals? Perhaps state patients could be treated in the private sector at a negotiated tariff, to alleviate the burden placed on state hospitals?

**4.3 Socio-economic upliftment strategies**

A total of 18/133 patients, or 13.5% in this series were female. This is an increase in the number of females treated, when compared to previous Johannesburg studies [5, 13]. A male to female ratio of 6.4:1 was recorded in this study, and this is a considerable increase in the number of female patients, on the previous ratio of 8.5:1 documented by Rosenberg and Smith in 1975 [4]. A staggering 88% of women (n=16) were victims of domestic abuse; being assaulted by their partners. In a society where the abuse of women and children has been attracting an increase in attention; this statistic does not flatter! Even more discouraging, was the unwillingness of these patients to report the abuse to the South African Police Services (SAPS) or to be referred to social services at the hospital. Whether it is the ignorance of the victims or intimidation by the abusers, that protects these perpetrators; something has to be

done. The women of our country have to be educated regarding their rights to safety, and the law enforcement agencies need to guarantee protection to women, that report their abusers to the authorities.

Other members of our society that are particularly vulnerable to criminal abuse are the informal labour of our country. These individuals are often illiterate, impoverished and are paid by their employers on a weekly basis-usually with banknotes as tender. The lack of formal payment into banking accounts, make these individuals a predictably soft target for muggers. Finally, the informal townships that lay scattered around our province are usually the setting for criminally motivated trauma. These settlements are to be targeted by local government, to improve amenities such as street lighting etc. thereby creating a safer environment for those that dwell in them.

### 4.4 Conclusion

The findings of this report suggest that the proportions of causes of mandibular fractures are largely unchanged from earlier audits [5, 11, 13]. There is however an increase in the total number of fractures to the mandible, with particular increase in the female population. From the data collected, fractures were being treated after varying delays, which ultimately resulted in more complicated and costly treatment modalities.

The unacceptably high incidence of crime and alcohol related trauma is no doubt placing enormous strain on the financial and personnel resources, of both provincial and state health departments. Local government are mandated to provide safety and security for its

constituents, and endeavours in this regard may alleviate an already overburdened public health sector. Clinicians working in these public health institutions, have also their part to play in providing adequate services to trauma patients. It is upon the judgement of the treating clinician to decide on the most appropriate methods to be used in the management of maxillofacial fractures. This decision, has to consider many factors such as the class of fracture, the state of the bone and dentition, the co-morbidities of the patient and also the 'hardware' at the disposal of the surgeon. The soaring costs of materials in use today, mandate surgeons to be circumspect and to engineer appropriate yet cost-efficient treatment protocols for our patients.

### 4.5 Further research requirements

Further research is required, to identify feasible methods of decreasing the number of mandatory ORIF's done in our units. Furthermore, research into alternative techniques of internal fixation of jaw fractures, is conceivable. And finally, medium to longer-term prospective studies on the post-ORIF sepsis rates, when teeth within the line of fracture are retained; would be an invaluable study; as would formal post-operative sepsis rates on HIV positive patients, undergoing mandibular repair.