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EXTRACTION AND RETENTION OF TEETH IN
THE LINE OF MANDIBULAR FRACTURE : A STUDY OF A WESTERN CAPE SAMPLE

BY

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Thesis submitted in partial fulfilment of the requirements for the degree of Magister Chirurgiae Dentium in the discipline of Maxillo-facial and Oral Surgery in the Faculty of Dentistry, University of the Western Cape.

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DECLARATION

I, *Mogamat Rashdi Henduis* declare that "EXTRACTION AND RETENTION OF TEETH IN THE LINE OF MANDIBULAR FRACTURE : A STUDY OF A WESTERN CAPE SAMPLE" is my own work and that all the sources I have quoted have been indicated and acknowledged by means of references.

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Signed: *[signature]*

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This thesis is dedicated to the following three people, whose dedication, co-operation and commitment towards a joint endeavour between the University of the Western Cape and the Groote Schuur Hospitals Complex, eventually realized this postgraduate programme:

LIONEL MILES

CECIL BLOCH

JAIRAM REDDY

ABSTRACT

Anecdotal and controversial discussion has always been prompted by the bias of the clinician in relation to whether teeth in the line of fracture should be extracted or retained. In recent years, it became evident to clinicians serving the Maxillofacial and Oral Surgery Clinic at Groote Schuur Hospital, Cape Town, that a tendency towards retaining teeth in the line of fracture did not seem to increase the possibility of infection, providing that circumspection was used.

A retrospective analysis of these cases was conducted in order to determine the outcome of our treatment. An independent sample of the 151 patients were investigated in relation to age, sex predilection, the effect timing has on the outcome of treatment and the incidence of infection when teeth in the line of mandibular fracture were extracted or retained.

The results of this study has shown that most of our patients were young (aged 20-29yrs) and therefore a tendency to retain teeth was found. In older patients, (aged 30-49yrs), the tendency was to extract teeth. Males presented more than females in a 3:1 ratio. Patients treated early ($<$24hrs) had most of their teeth retained while others treated after 7 days had their teeth extracted. The infection rate was 2 percent if teeth were retained and 5 percent if teeth were extracted. Although the difference was not statistically significant, it appeared that the retention of teeth in the line of fracture presented more advantages to both patient and clinician.

OPSOMMING

Die besluit of die tand in lyn van 'n fraktuur verwyder word, of behoue bly, lok gewoontlik kontroversiële bespreking uit.   Oor die afgelope jare het die chirurge werksaam in the Kaak- Gesigs en Mondchirurgie Eenheid te Groote Schuur Hospitaal, Kaapstad, agtergekom dat die behoud van tande in the fraktuurlyn nie noodwending die kanse tot infeksie verhoog nie, met sekere voorsorgmaatreëls.

'n Retrospektiewe analise van sulke gevalle is gedoen ten einde die resultate van sulke behandeling te bepaal.   'n Onafhanklike proefsteek van 151 manlike en vroulike pasiënte was nagegaan met betrekking tot ouderdom en geslagsverspreiding, die effek wat die tyd van behandling op die eindresultaat van sulke behandeling het, en die voorkoms van infeksie wanneer tande in die lyn van fraktuur verwyder of behou was.

Die uitslag van hierdie ondersoek het daarop gedui dat die meeste pasiënte jonk was (tussen 20-29jr) en daar dus 'n neiging was tot die behoud van tande.   In ouer pasiënte, was die neiging om tande te verwyder.   Die meerderheid pasiënte was van die manlike geslag (3:1).   Meer tande was behou wanneer die pasiënte binne 24 uur behandel is, terwyl tande verwyder is wanneer pasiënte eers na 7 dae behandel is.   Die infeksiesyfer was laag; 2 persent in gevalle waar die tand behou was, en 5 persent in gevalle waar die tand verwyder was.   Alhoewel die verskil tussen die twee groepe nie van statistieke belang was nie, wil dit voorkom asof die behoud van 'n tand in die fraktuurlyn meer voordele inhou vir beide pasiënt en klinikus.

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INTRODUCTION

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Fractures of the mandible constitute the bulk of the trauma treated by a Maxillo-facial and Oral trauma service (Kelley and Harrigan, 1975; Olson et al, 1982).

Recent studies have shown that second to nasal bone fractures, fractured mandibles occurred twice as frequently as fractures of the other bones of the midface (Kelley and Harrigan, 1975; Adekeye, 1980; Olson et al, 1982, Ellis et al, 1985).

In terms of site predilection in mandible fractures, approximately 65 percent of fractures occur in relation to the dentition. (Olson et al, 1982; Ellis et al, 1985).

Melmed and Koonin (1975) conducted a retrospective analysis of 909 cases treated at the Plastic Surgery Department, Groote Schuur Hospital, Cape Town, during the period 1968 to 1973 and found that approximately 78 percent of fractures were related to the dentition. It is therefore quite evident that most mandible fractures occurring in dentate or partially dentate patients may have tooth involvement.

Although the approach adopted by clinicians in various parts of

the world in respect to the treatment of mandible fractures is fairly uniform, controversy exists as regards the fate of the teeth in the line of fracture.   The individual responsible for the management of the mandibular fracture is very often perplexed with the dilemma of whether or not the tooth in line of fracture should be retained or extracted.

Most clinicians are agreed that the involvement of a tooth in the line of fracture renders the fracture compound or complicated as a result of communication with the periodontal membrane (Kromer, 1953;   Rowe and Killey, 1955;   Walker and Bentz, 1966;   Thoma, 1969;   Schneider and Stern, 1971;   Archer, 1975;   Guralnick, 1976; Cawson, 1984;   Rowe and Williams, 1985).   Following the onset of the fracture of the mandible, bleeding around the neck of the tooth, a detached mucoperiosteal flap behind a second or third molar, and/or the obvious protrusion of bone into the oral cavity are fairly reliable signs that the fracture wound opens into the oral cavity.   Similarly, a fracture can also be compounded through a skin wound   (Walker and Bentz, 1966).

Infection of the fracture haematoma, to a minor extent, is inevitable when the fracture is compounded into the mouth (Rowe and Williams, 1985).   The latter authors further suggest that the liability of infection is increased by the natural reluctance of the patient to swallow or move the tongue freely, so that stasis

develops with a consequent accummulation of débris in the region
of the fracture line.   This encourages the multiplication of
bacteria (Topazian and Goldberg, 1981; Bochlogyros, 1985) and,
the greater the delay in obtaining reduction and immobilization,
the more likely infection is to develop in the bone ends adjacent
to the fracture line.   According to Rowe and Williams,
complications are less common when these fractures are treated
within 24 hours.

It is well known that a tooth directly involved in a fracture will
have been stripped off its periodontal membrane along the side
adjacent to the fracture line and that devitalization may occur
due to severing of vascular communications or thrombosis of the
feeding vessels (Rowe and Killey, 1968; Schneider and Stern,
1971; Rowe and Williams, 1985)

Certain clinicians are quite emphatic about such teeth acting as a
foreign body as a result of pulp necrosis (Kelsey Fry and Ward,
1956; Clark, 1959; Clark, 1965; Kerr, 1966; Rowe and Killey,
1968; Cawson, 1984) and therefore consider such teeth as possible
sources of infection that may complicate the satisfactory healing
of a fracture.

However, it is now well-known that such injured pulps can recover
(Kelsey Fry and Ward, 1956; Archer, 1975).   Recent studies,

conducted by Kahnberg and Ridell (1979) showed complete recovery of tooth vitality in 59 percent of cases.

A histological study conducted by Phillips and Van Wyk (1984) showed that 50 percent of teeth in the line of fracture may recover. Although the pulp may also become necrotic in 50 percent of cases, this will depend on the severity of the haemorrhage, whether or not the apex of the tooth was completely formed, and on the establishment of infection. The authors stated that in teeth with incomplete root formation, the incidence of pulp regeneration was enhanced.

Castelli et al (1975) added that the regenerative capacity of the pulp tissue was indicated by the connective tissue cells which, by a process of cytodifferentiation, permitted the repopulation of the odontoblast cells. In this study, conducted in rabbit models, they showed that collateral blood supply to the area distal to the fracture site including the tooth in line of fracture was re-established within 24 hours to 5 days. Full recovery of the pulp was seen after 3 weeks on histologic studies.

Indresano and Lundell (1982), basing their investigations on the work of Castelli et al (1975) did blood flow readings within 5 minutes using the Hydrogen "washout" technique and found that, following interruption of the inferior alveolar artery, namely

during fracture, the collateral vessel back flow may be immediate. This initial reaction prevents bone infarction and provides the basic nutritional needs to the pulp and bone.

Historically, teeth in the line of fracture are generally condemned because of the potential for untoward sequelae namely, infection, mal-union and osteomyelitis, to arise. These teeth, were subjected to extraction, some even "prophylactically" at the time of reduction of the fractures (Colyer, 1917; Clark, 1959; Lewis and Perutsea, 1959; Clark, 1965; Bradley, 1965; Kerr, 966; Thoma, 1969; Guralnick, 1976; Irby, 1979; Kruger, 1979).

However, the discovery of antibiotic chemotherapy changed the whole perspective of the approach to the management of teeth in the fracture line (Edgerton and Hill, 1952; Wilkie, Diecidue and Simses, 1953; Rowe and Killey, 1968; Schneider and Stern, 1971; Zallen and Curry, 1975; Kruger, 1979; Greenberg et al 1979; Wolujewicz, 1980; Topazian and Goldberg, 1981; Mathog, 1984; Rowe and Williams, 1985).

Some clinicians were literally coerced into retaining teeth in the line of fracture for a short period of time. In 1946, during the Second World War, Sturgis and Holland retained teeth in the

fracture line for a limited period, under cover of Penicillin and the Sulphonamides. They found that they could actually defer the infection to a later period. Other protagonists for extraction (Kelsey Fry and Ward, 1956; Lewis and Perutsea, 1959; Cawson, 1984) followed in this tradition. However, these authors believed that once the fracture had healed, the tooth in the line of fracture had to be extracted.

A study by Greenberg et al (1979) showed that the incidence of post-operative wound infection after compound mandibular fractures was decreased by the use of prophylactic antibiotics.In an analysis of 230 mandible fractures treated at New Orleans, they found an infection rate of 7,39 percent in patients receiving the following antibiotic regimen. For in-patients, they used 2 million units of Penicillin G intraveneously every four hours and for outpatients they used Penicillin VK, 500 milligrams every 6 hours for a week. They also used cephalosporins or doxycycline in a similar scheme.

Zallen and Curry (1975) compared the effects of antibiotic usage in 62 patients with compound mandible fractures and found that in 30 patients who did not receive antibiotic cover, the infection rate was very high (50,33 percent).

Schneider and Stern (1971) retained all clinically intact teeth in line of fracture and covered the patients with suitable

antibiotics.   They found a low complication rate of 5 percent.

It can therefore be seen that the morbidity of post-traumatic infection was significantly reduced by the rationalized and judicious administration of antibiotic therapy   (Archer, 1975; Chan et al, 1984).   However, it has been stated that the use of antibiotics was no substitute for sound surgical judgement (Sturgis and Holland, 1946; Steiner and Thompson, 1977).

The principle of antibiotic therapy, together with the application of timeous and optimal reduction and fixation of fractures, led to a lower infection rate and therefore a more conservative approach to the appraisal of fracture management concerning teeth in the line of fracture (Edgerton and Hill, 1952; Kromer, 1953; Wilkie et al 1953; Rowe and Killey, 1968).

Fractures treated within 48 hours were found to have a lower incidence of infection of the teeth in the line of fracture if compared with fractures treated between 2 and 7 days (Kromer, 1953).   Although no studies to date have been conducted to determine the viability of the cementocytes if exposed to the oral environment in the case of a mandibular fracture, it can be deduced that 48 hours seems to be a reasonable period as Heslop (1985) suggested this period to be the maximum time that an avulsed tooth can be kept extra-orally before re-implantation.

Andreasen and Hjorting-Hansen (1966), in a follow-up study of 110 replanted teeth, reported that when these teeth had been out of the mouth for a period exceeding 2 hours, this resulted in resorption of the roots in 95 percent of cases whereas only 10 percent of replanted cases showed resorption if they were reimplanted within 30 minutes.

Work done by Söder et al (1977) showed that cementocytes could only survive in a dry extra-alveolar environment for 2 hours. Schultz (1977) stated that the prognosis of retained teeth in line of fracture was favourable if less than 50 percent of the cementum was exposed to the oral environment.

Recent studies have shown good results if teeth in the fracture line were retained and fractures were treated early i.e. within the first 48 hours (Edgerton and Hill, 1952; Kromer, 1953; Digman and Natvig, 1964; Roed-Pietersen and Andreasen, 1970; Archer, 1975; Ridell and Astrand, 1971; Larsen and Nielsen, 1976; Kahnberg and Ridell, 1979; Kahnberg, 1979; Wolujewicz, 1980; Mathog, 1984; Winstanley, 1984; Rowe and Williams, 1985).

However, certain criteria had to be met in order to avoid untoward sequelae. Teeth indicated for extraction are:
1) loose teeth
2) non-vital teeth

3) teeth with fractured roots (Irby, 1979).

4) teeth with advanced periodontal disease.

5) deeply carious teeth and those showing pulpal involvement (Wilkie et al 1953; Archer, 1975; Kruger, 1979).

6) Avulsed teeth with more than 50 percent cementum exposure (Schultz, 1977; Kahnberg, 1979; Heslop, 1985).

7) teeth exposed for more than 48 hours to the oral environment (Ridell and Astrand, 1971).

It has also been shown that complications could be avoided if certain principles were adhered to.   A study done by Fischer-Brandies and Dielert (1984) on the cause of infection after mandibular fracture has shown that inadequate primary care played a major role in the sepsis rate.   Another factor was sub-optimal fracture reduction.   Roed-Pietersen and Andreasen (1970) demonstrated a 12 percent loss of marginal bone support and vertical bone defects in cases where reduction was inadequate. Finnegan (1983) stated that occlusal trauma acting on the teeth in line of fracture after inadequate reduction and immobilization resulted in loss of periodontal attachment apparatus and therefore subsequent infection.   He also blamed the interdental eyelet wire for plaque accummulation and suggested that the tooth in line of fracture should not have any wires attached to it.

Cannell and Boyd (1985) stated that movement at the fracture site due to loss of tension in the fixation is a most likely precursor

to infection in bone. However, Winstanley (1984) warned against the elimination of all movement at the fracture site. He quoted the studies of McKibbin (1978) and said that it was not only unnecessary but in some instances undesirable to have complete immobilization and this did not favour bone formation.

The effect of systemic conditions on the healing of mandibular fractures must not be overlooked. Bochlogyros (1985) stated that general factors such as nutritional, metabolic and specific bone diseases could bring about infection and non-union of the mandible. These are Diabetes Mellitus, Cushing's Disease, Chronic Renal Disease, Tuberculosis and Syphylis. Primary bone diseases are Osteogenesis Imperfecta, Osteoporosis, Osteopetrosis and Fibrous Dysplasia. Vitamin and trace element deficiencies eg. Vitamin D deficiency results in depressed calcification; Vitamin C deficiency causes inhibition of the development of a fibrous matrix and Magnesium and Calcium plays a role in Parathormone and alkaline phosphatase metabolism.

Cannell and Boyd (1985) made suggestions for the frequency of infections of bone in fractured mandibles of alcoholics as described by Silverman et al (1974). They postulated that accumulation of hepatic fat might lead to diffusion of numerous fatty emboli capable of impairing local blood supply. If emboli

produce micro-infarcts in the bone of the mandible, then the likelihood of anaerobic conditions in the thrombosed marrow spaces is increased.

Local factors responsible for infection and non-union in mandible fractures are:

1) inadequate reduction

2) inadequate immobilization

3) interpositioning of foreign material between the fracture segments

4) loss of fracture haematoma

5) incorrect use of compression or other plates.

(Bochlogyros 1985)).
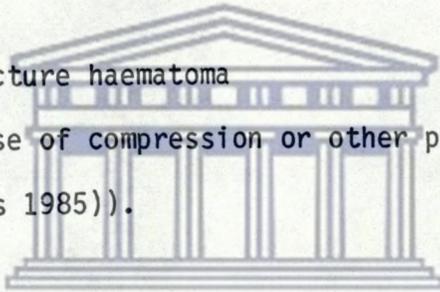
Finally, a recent study done by Hoffmeister (1985) supported very strongly the retention of teeth in the fracture line. In this study, all the teeth in the fracture line were retained and a comparison made between the mobility of the tooth in the line of fracture compared to a control side on the opposite side of the mandible. They also looked at the stability of the tooth in line of fracture if conservative treatment (closed reduction) was compared to surgical treatment (open reduction with compression plating) using Mühlemann Periodontometry. The results of their study showed than horizontal movement of the 39 teeth in line of fracture was well within physiological limits. Also no significant differences could be established in tooth mobility

when the fracture was treated conservatively or surgically. They therefore concluded that conservative management (closed reduction) of teeth in the line of fracture was preferable. This finding corroborated an earlier appeal made by Winstanley (1984) who supported the Melmed and Koonin (1975) study that the majority of mandibular fractures respond to simple treatment and that there is no need for fundamental change from the closed or semi-closed procedures in the management of mandibular fractures.

However, in spite of the abundant evidence supporting the retention of teeth in the line of fracture, certain schools of thought in this country, and worldwide, still advocate the extraction of involved teeth. At our institution, namely, the Maxillo-facial and Oral Surgery department based at Groote Schuur Hospital, different opinions are entertained and the decision as to whether to extract or retain the tooth in line of fracture is left up to the discretion of the clinician in charge of the case.

In the Western Cape, a large proportion of our patients come from disadvantaged backgrounds and are also poorly compliant. We therefore decided to investigate the outcome of our treatment rendered for the past three and a half years.

REVIEW OF LITERATURE

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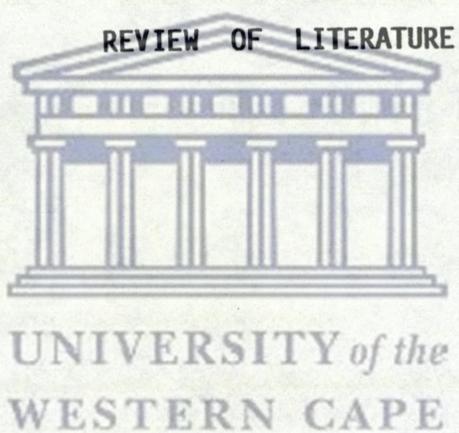
8.1 <u>EXTRACTION OF TEETH IN LINE OF FRACTURE</u>

Colyer (1917) stated that the removal of the tooth, or teeth, in the fracture line was a sine qua non to proper management of the fractured mandible. As the Consulting Dental Surgeon to the Croydon War Hospital, he had the disadvantage of examining his war patients for the first time about 4 weeks after the injury, whereupon sepsis already prevailed and antibiotic therapy was as yet undiscovered. He believed that when the line of fracture passed through the socket of a tooth, the periosteum of the root (periodontal membrane) was detached and a pocket was formed which became filled with septic matter. The result was that infection permeated from this permanent pocket to the fracture area. The removal of the tooth eliminated this focus of infection. In cases of delayed fibrous union, the removal of the tooth in line of fracture was followed by rapid healing. Colyer therefore concluded that the prevention of bony union was due to the presence of the tooth in line of fracture. The average treatment time was about 8 weeks of immobilization of the jaws, using a supportive head cap with cord or tape resulting in an upward and backward pull.

During the 2nd World War, Sturgis and Holland (1946) adopted a conservative approach to the then controversial subject of teeth in the fracture line.

Whenever a tooth was considered important, either for reduction of the fracture, or maintaining good alignment of the fractured segments (even though the apex of the tooth was exposed to the fracture line), the tooth was temporarily retained. However, prophylactic extraction was carried out if the role of the tooth in the fracture line was not considered essential for adequate treatment. Subsequently, the incidence of continued suppuration and delayed union, and a few cases of non-union, were attributed directly to teeth retained in the line of fracture.
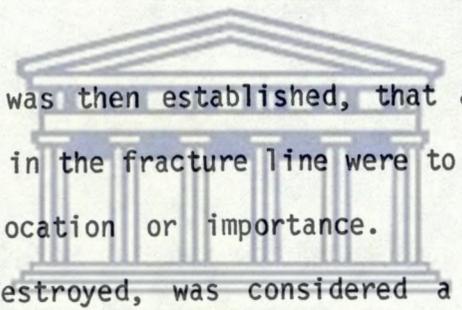
A fixed policy was then established, that any or all teeth with apices included in the fracture line were to be removed regardless of strategic location or importance. Any tooth, in which vitality was destroyed, was considered a potential source of infection and a definite deterrent to normal bone repair. It was felt that under no circumstances was the temporary retention of potential sources of sepsis justified, even though chemotherapeutic agents such as Penicillin and the Sulphonamides tended to suppress overt signs of infection. As different methods of treating fractured mandibles existed, the retention of such teeth was deemed unnecessary.

William Kelsey Fry and Terence Ward (1956) suggested that, as it was not possible to ascertain the vitality of the pulp of the tooth in line of fracture (due to the interference with the inferior alveolar nerve conduction), it was best to presume the

death of the pulp. They contended that the effect of a necrotic pulp in a tooth whose apex was close to, or actually in a fracture line, was so "disastrous" that compromise should seldom be entertained. They also stated that the necrotic pulp showered a constant stream of infection which perpetuated the inflammatory reaction, resulting in bone resorption and prevention of bony repair and therefore constituted the most common cause of non-union.

Lewis and Perutsea (1959) stated that, in contradistinction to a fragment of bone with the slightest attachment of soft-tissue, a tooth in a fracture line could never be regarded as a centre of ossification and therefore was best removed. These authors followed the teachings of Kelsey Fry and Ward (1956) very closely and endorsed the belief that teeth in the fracture line acted as septic foci. They concluded that, as it was not advisable to wait and see whether teeth in the line of fracture would cause complications, extraction was the best precaution as considerable damage could occur before clinical evidence of infection became apparent.

Clark (1965) stated that the apex or lateral root surface of a tooth exposed to the fracture line constituted a foreign body which produced infection and non-union. He felt that, although the use of prophylactic antibiotic therapy could not be disputed in reducing the hazard of infection, the prolonged use of these

drugs was questionable in an attempt to save a tooth, which would have to be sacrificed anyway. He further stated that as the patient should be given the best chance to heal as a result of primary treatment, all teeth in line of fracture were to be removed at the first visit even if this procedure necessitated a subsequent special procedure (open reduction) to reduce and fix the associated bone fragments.

Kerr (1966) examined a series of mandibular fractures treated at the Plastic and Jaw Department, Sheffield. He found a 2 percent infection rate in a series of 755 fractures seen between the period 1959-1965. He found that, contrary to the earlier belief that any delay in treatment of mandible fractures greatly increased the propensity for infection, if antibiotic cover was suitable a reasonable delay in treatment did not materially increase the danger of infection. All his patients received 1.2 Mega Units of Procaine Penicillin intramuscularly every twelve hours from the time of first admission. He blamed the infection on Staphyloccocus pyogenes, which he identified, and indicated that infection only resolved once the foreign body (i.e. the tooth) had been removed from the fracture line. He supported the view of Clark (1965) that the widespread use of open reduction decreased the risk of retaining teeth in the line of fracture. In relation to the latter statement, Thoma (1969) supported this approach to treatment viz. open reduction, and admitted that he

always prescribed a radical approach towards teeth in the fracture line. He endorsed the original viewpoint held by Colyer (1917) and found, in his experience, that any fracture through an alveolar socket or crypt of an impacted tooth rendered the fracture complicated or compound. This view is shared by many authors (Kromer, 1953; Rowe and Killey, 1955; Walker and Bentz, 1966; Schneider and Stern, 1971; Archer, 1975; Guralnick, 1976; Cawson, 1984). Thoma (1969) advocated prompt extraction of such teeth in order to prevent infection. Guralnick (1976) agreed with the latter author and regarded teeth in the fracture line as "hazardous".
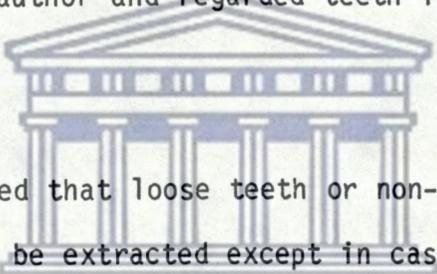
Irby (1979) stated that loose teeth or non-vital teeth in line of fracture were to be extracted except in cases where a vital tooth was firm in its socket. However, he advocated the extraction of the tooth if more that 50 percent of root surface was exposed. He further added that all third molar teeth in line of fracture which communicated with the oral cavity had to be extracted. His reason was that they predisposed to debris collection and that an exposed haematoma served as a good culture medium. In addition to this, when appropriate antibiotic cover was stopped, infection would follow. He therefore prescribed open reduction and internal fixation in the case of a mandibular fracture involving the third molar tooth.

Cawson (1984) reiterated the views of earlier writers and advocated extraction of teeth in line of fracture because he believed that infection tracked down the gingival margin, entering the periodontal ligament, and, in cases where pulp death ensued after damage to the apical vasculature, provided a nidus of necrotic and infected material within the fracture.

It is therefore apparent that since the beginning of the 20th century until the present time, certain workers have recommended the extraction of teeth in line of fracture.

However, a period of temporization arose and brought about a different dimension to their points of view.

In 1946, during the 2nd World War, Sturgis and Holland considered the use of retaining teeth in the fracture line for a limited period in order to maintain good fracture alignment. With the judicious use of antibiotics, they could defer infection to a later stage when sufficient union had occurred, and the teeth could be removed after they had served their purpose.

Kelsy Fry and Ward (1956) stated that while the death of the pulp had to be presumed when the fracture passed through the tooth socket, it in fact did not always occur. They repeatedly demonstrated that some of the simpler fractures did unite in the presence of teeth in the line of fracture.

Lewis and Perutsea (1959) felt that certain cases deserved retention of teeth for a limited period. They believed that the act of extraction in the third molar area, being a difficult procedure, delivered infection from the oral cavity to the bone. However, they stated that retention of such a tooth usually led to loosening of the tooth after a week whereupon it could be extracted with ease.

Cawson (1984), although being a strong campaigner for extraction of teeth in line of fracture, also added that retention of such teeth could be exercised for a limited period for control of the bony fragments.

However, the period of temporization became more and more apparent as clinicians (Sturgis and Holland, 1946; Edgerton and Hill, 1952; Kelsey Fry and Ward, 1956; Lewis and Perutsea, 1959; Wolujewicz, 1980; Topazian and Goldberg, 1981; Cawson, 1984). were faced with the problem of the impacted third molar. Most of these authors who advocated extraction of teeth in line of fracture did not know what to do with the impacted third 3rd molar, as it posed a technical problem in removal. It was therefore suggested that by the judicious use of antibiotic therapy coupled with proper early reduction and fixation of fractures, infection could usually be deferred until healing was complete. Many still believe that these retained teeth should be extracted after they have served their purpose.

Archer (1975:1069), stated that "Simply because a tooth is in the line of fracture does not prove that this tooth will become a source of infection". This statement has been corroborated by subsequent studies (Digman and Natvig, 1964; Roed-Pietersen and Andreasen, 1970; Ridell and Astrand, 1971; Schneider and Stern, 1971; Steiner and Thompson, 1977; Kahnberg and Ridell, 1979; Kahnberg, 1979). Interestingly, and to the contrary, some authors found that removal of the teeth in line of fracture did not reduce morbidity. Neil, Wagner and Alpert (1978) reviewed 207 fractures with teeth in the fracture line. Seventy five cases of mandibular fractures had the teeth in line of fracture extracted, and showed a complication rate (infection and delayed union) in 37,3 percent of cases. The other 132 fractures in which the teeth in line of fracture were retained showed a complication rate of 29,5 percent. They therefore concluded that removal of teeth in line of fracture did not minimize morbidity.

Another factor involved in the removal of teeth in line of fracture was trauma to the surrounding bone. In the case of the unerupted third molar, many clinicians (Wilkie et al, 1953; Dingman and Natvig, 1964; Archer 1975; Steiner and Thompson, 1977; Kahnberg, 1979; Wagner, Neal and Alpert, 1979; Kahnberg and Ridell, 1979; Wolujewicz, 1980; Heslop 1985) tended to

retain these teeth, as associated problems such as dislocation,
displacement of fragments, arch collapse and comminution of
fragments posed difficult additional problems.

8.2 THE PROBLEM OF EXTRACTION OR RETENTION OF TEETH IN LINE OF FRACTURE

Many clinicians were not emphatic on either extraction or retention of teeth in the line of mandibular fracture.

Edgerton and Hill (1952) experimented with 5 cases in a series of 434 cases of fractured mandibles. They deliberately retained the teeth in line of fracture and carried out "prophylactic" external drainage. The patients were covered with Penicillin for 7 consecutive days. All the fractures healed without complications. However, where fresh angle fractures (less that 48 hours) involved at least one root of a molar tooth in which there was no displacement of the fracture line, the prescribed treatment was removal of the tooth in line of fracture. Other factors prompting removal were pulpal and periapical pathology.

Rowe and Killey (1955, 1968) described in detail the pathogenesis of fracture infection from teeth in the line of fracture. Although they advocated extraction of teeth, they conceded that with the use of antibiotic therapy, teeth that formerly would have been extracted could now be retained but this depended on sound clinical judgement. They added that where doubt prevailed, it was wiser to extract. This viewpoint has changed somewhat as will be borne out by further discussion.

Kruger (1979) agreed with the previous authors. He stated that the importance of clinical judgement could not be over-emphasized and that the only factor which influenced the principle of extraction of teeth in the line of fracture was sulphonamides and other antibiotics. The factors prompting retention of teeth in line of fracture were:

1) absence of fracture or gross injury to a tooth;

2) absence of caries or large restorations;

3) absence of periodontal disease;

4) location of tooth, including aesthetics and the possibility of arch collapse;

5) the nature of the fracture;

6) the probability of an adequate response to antimicrobial therapy.

Again, where doubt existed, the teeth had to be extracted. He added that infected or grossly carious teeth that were not in the line of fracture should also be extracted before intermaxillary fixation.

Wolujewicz (1980) felt that it was desirable to leave unerupted mesio-angular third molars in place providing that they were closely monitored. However, he advocated the removal of vertically impacted third molars as these failed to stabilize unfavourable fractures. As extraction of such teeth in line of fracture resulted in displacement of the fracture fragments, open reduction was necessary. However, in deciding whether to extract the involved third molar, factors like time after injury, tooth displacement and the presence of pre-existing pericoronal inflammation had to be taken into account. He concluded that modern antibiotic therapy has made it possible to retain such teeth in the line of fracture.

Chan et al (1984) did a study on unreliable uncompliant populations and stated that teeth in line of fracture could be retained if antibiotic cover of 3 to 4 weeks could be maintained, after which root canal treatment or extraction could be carried out with less morbidity. She also found that third molar extractions did not lead to infection. However, her sample of patients (26) was too small to make concrete recommendations. Eight patients (30 percent) had complications of soft-tissue infection, osteomyelitis, malunion and non-union.

8.3 RETENTION OF TEETH IN LINE OF FRACTURE

In 1953, Kromer investigated 690 jaw fractures treated in the Plastic and Jaw Unit from 1940-1945 under the auspices of Sir Harold Gillies. He looked at teeth in the line of mandibular fracture comparing the incidence of infection to the time of treatment. He found that fractures treated within 48 hours healed much sooner and with fewer complications, whether the teeth in line of fracture were extracted or retained, as compared to fractures which were treated between 2 and 7 days later. From the data he collected for various sites and circumstances concerning the mandibular fractures, he concluded that teeth in the fracture line which presented within 48 hours and did not present with pre-existing periapical pathology, could be retained providing that the fractures were linear and rigid intermaxillary fixation could be applied. On the other hand, he preferred that in fractures treated between 2 and 7 days after the accident, teeth be extracted as this predisposed to less infection. He added that, in times of peace, it was advisable to delay extraction and perform root canal treatment in order to conserve the teeth in line of fracture (especially anterior teeth), but did not hesitate to stress that the healing of the fracture was more essential than the prognosis of the tooth. An interesting observation made by Kromer (1953) was that exposed cementum did not retard rapid healing of the fracture if treatment was performed early enough.

He stated that the cementum was still vital and that the conditions were similar to those pertaining to tooth re-implantation. This statement by Kromer was later corroborated by a study done by Söder et al (1977) a group of Scandanavians, who extracted mature teeth from monkeys and humans and, after exposing the periodontal membrane to a dry extra-alveolar environment for 0, 30, 60, 90 and 120 minutes, transferred the cells for in-vitro culture. By means of cell counting and vital staining, they could assess cell viability and concluded that the critical period wherein cells would undergo severe damage was a dry period of 60 minutes. It was also not possible to demonstrate any cellular viability after 2 hours of drying time.

From this study it could be inferred that if saliva could be regarded as a reasonably acceptable culture medium (Andreasen & Hjorting-Hansen, 1966), the period of 48 hours stated by Kromer (1953) could be explained, as rapid reduction of fractures resulted in less exposure of cementum and periodontal ligament to the environment of the oral cavity.

In the same year of 1953, Wilkie, Decidue and Simses conducted a retrospective analysis of 250 fractured manbibles of which 190 had teeth in line of fracture. In 145 of these cases the teeth in line of fracture were retained. Eleven of these cases (7,6 percent) subsequently required open reduction, leaving a total of 134 cases (92,4 percent) to obtain good healing without operative

procedures or major complications. The 45 patients who had teeth in the line of fracture extracted required open reductions in 28 cases (62,2 percent). The incidence of infection or osteomyelitis was nil. All the patients were covered with aqueous penicillin (100,000 units 4 hourly) for the first 4 days after admission. This was followed by 300,000 units of Procaine Penicillin intramuscularly each day for the following 6 days, and from the 10th day, 300,000 units of Procaine Pen G was administered intramuscularly on a weekly basis for the remainder of the period of immobilization.

The results of this study clearly illustrated that it was perfectly safe to retain a tooth in the line of fracture if proper antibiotic therapy was administered and the patient was kept under adequate supervision. After union had occurred, these teeth could be removed or endodontically treated to prevent dento-alveolar abscess formation at some future date. From this study the authors showed the clear-cut advantage of retaining teeth in the fracture line, as they demonstrated that open reductions were used much more frequently when teeth had been sacrificed prematurely (62,2 percent) as opposed to 7,6 percent for teeth in the line of fracture that were retained.

The authors suggested the following advantages in retention of teeth in the line of fracture:

1) The teeth may be used for reduction and fixation of the bony fragments.

2) Additional trauma, displacement and compounding of the fractured bone is avoided.

3) The use of complex methods of treatment such as open reduction and external pin fixation is obviated when strategic teeth are involved in the posterior segment resulting in reduced morbidity to the patient.

4) Strategic teeth can be used as abutments for later conservative reconstruction and rehabilitation.

5) Arch integrity, aesthetics and function can be maintained.

The above study emphasized the advantages of judicious antibiotic therapy coupled with timeous reduction of the fracture. Some authors advised on antibiotic coverage either intramuscularly (Greenberg et al 1979) or orally for periods ranging from 7-14 days (Schneider and Stern, 1971) to 21-28 days (Topazian and Goldberg, 1981).

Zallen and Curry (1975) did a comparative study of 62 patients with compound mandible fractures, where 32 patients received antibiotics and 30 patients did not. In the groups receiving the antibiotics, the infection rate was 6,25 percent, compared to a complication rate of 50,33 percent where antibiotics were not administered.

Dingman and Natvig (1964) agreed with the previous authors (Kromer, 1953; Wilkie et al 1953) that teeth in line of fracture could be retained to aid in stabilization of fracture fragments, even if half of the tooth on the proximal segment were to be used to prevent dislocation of the segment. They stated that, even if a tooth was worthless, it should be retained at least until the fragments have shown evidence of clinical union. They further stated that loose teeth or teeth attached to a loose segment of alveolar bone, if retained, should be supported by ligation to adjacent teeth by using metal cap splints, interdental eyelets, arch bars,or orthodontic bands.

Ridell and Astrand (1971) studied the fate of teeth in line of fracture. They retained all 165 teeth, as was the policy of the Maxillo-facial Unit at the University of Umea, Sweden, and looked at 84 patients recalled 5 months to 11 years after the accident. The teeth were examined clinically for tenderness to percussion, apical tenderness, instability and discolouration of the crown. They also tested vitality and measured pocket depths. X-rays were taken to detect signs of apical or marginal bone destruction, root canal therapy and root resorption. Of the 165 teeth, 92 teeth were tested for viability (teeth with 2 or more roots or artificial crowns were not used), and 65 teeth responded positively. Of the remaining 27 teeth, 7 showed periapical bone

destruction and one showed apical root resorption, while the other 20 teeth showed no clinical or radiographic evidence of infection.

A total of 77 percent of retained teeth in line of fracture showed complete clinical and roentgenographic recovery. If the unsuccessful groups was treated with Endodontic and Periodontic treatment, the figure may have been increased to 80 or 90%. It is interesting that the group of patients treated within 48 hours showed 84 percent success rate, whereas cases treated later showed only 75 percent success rate. This study by Ridell and Astrand (1971) supported the findings of Kromer (1953) whose under 48 hour treatment cases were milder and required simpler fixation methods.

Roed-Pietersen and Andreasen (1970) found pulpal necrosis to be more common in teeth where the fracture had not been attended to within 48 hours. They also found pulpal necrosis to be more common when the fracture involved the apex of the tooth.
From the study of Ridell and Astrand (1971) they also added that periapical osteitis could usually be treated successfully and therefore the tooth with an apical lesion had a better prognosis than one with damage to the periodontium.

Ideberg and Persson (1970) examined the fate of undeveloped teeth involved in the fracture line. In most cases the accident had no effect on further development of such teeth and these authors

concluded that unerupted teeth had a much better prognosis than erupted teeth, since many of the fractures did not expose the teeth to the oral environment.

In respect to the 48 hour period which appears to have only anecdotal significance, there does appear to be some evidence that injured pulp tissue can recover as suggested by Kelsey Fry and Ward (1956), Archer (1975) and others.

A study done by Kahnberg and Ridell (1979) following a similar technique as Ridell and Astrand (1971), showed that in 132 patients with 185 teeth in line of fracture, the pulp recovery rate on recall from 1 to 3 years after treatment was 59 percent based on clinical and radiological investigations. The degree of periodontal and pulpal complications were closely related to the displacement between the fragments and the severity of the fracture. 23 percent of cases which originally responded negatively to electrical stimulation showed positive sensibility at the time of re-examination. Thus they concluded that a long term observational period was necessary with regard to the final outcome of pulp damage. They emphasized the finding that conservative treatment of teeth involved in the line of mandibular fractures had a favourable prognosis especially if optimal reduction of the bony fragments was achieved.

A histological study done by Phillips and Van Wyk (1984) has cast more light on the ability of the pulp to recover. They compared the pulps of 78 teeth in the line of fracture (which were extracted between 6 hours and 97 days from the time of accident) to 118 control teeth collected from dentectomy patients.

Their results showed that the teeth in line of fracture showed a higher percentage of focal necrosis when compared to controls. The other pulp changes looked at were early changes and necrotic pulps. They described focal necrosis, a change only seen in the teeth in the line of fracture, as a localized area of necrosis of the osteoblasts found in the coronal and radical pulps. This is considered to be attributed to occlusion of the small vessels feeding the pulp and did not imply gangrene due to occlusion of the major pulp feeding vessels. These small vessel involvements led to localized ischaemia of the pulp, a condition which could be reversed with the passage of time. They therefore found that in 78 teeth in line of fracture, 9 teeth showed normal pulps as opposed to 15 for the control group, 21 teeth showed early changes of the pulp as compared to 94 for the controls, 9 showed focal necrosis as opposed to none in the control groups, and, 39 teeth showed non-vitality or generalized necrosis as opposed to 9 in the control group.

They therefore concluded that 50 percent of the teeth in line of fracture were vital at the time of extraction. They also added

that the amount of time that teeth remained in the fracture line did not have a significant effect on the vitality of the teeth. It is, however, interesting to note that pulps may recover completely or may become necrotic, depending on the severity of the haemorrhage, whether or not the apex is completely formed on the establishment of infection. In teeth with incomplete root formation, the chances of pulp regeneration are enhanced (Seltzer and Bender, 1975).

Castelli et al (1975) conducted experimental research on the histological changes of the pulp by examining the hemi-mandibles of Macaca monkeys after interruption of the Arterial Inferior Alveolar Blood Flow.

With the use of radiopaque dyes which they injected into the external carotid artery after cauterizing the inferior alveolar artery, they could determine if a collateral blood supply was reconstituted to supply the ischaemic hemi-mandible. These angiographic results after surgery revealed that, after 48 hours, very tenuous alveolodental branches were noticable only in the premolar area. The molar area was unremarkable. After 2 days, a full retrograde blood flow had been established. Anastomotic branches could be seen emanating from the mandibular branch of the sublingual artery to join with the inferior alveolar artery and its branches. The other branch of retrograde anastomosis came

from the mental branch of the inferior alveolar artery on the opposite side. After 5 days, there was good backflow through the severed inferior alveolar artery. After 9 months, a complete restoration of the well-established blood flow was observed.

The histological changes seen were that the dental pulps showed regressive changes after 12 days but that these were reversed after 21 days. The regenerative capacity of the pulp tissue was indicated by a process of cytodifferentiation which permitted repopulation of the odontoblast cells three to five weeks after surgery.

A practical consideration emanated from this study in that the preservation of the mental artery and the mandibular branch of the sublingual artery were paramount to providing prompt collateral circulation to maintain the viability of the bone in the case of severance of the inferior alveolar artery and thus accelerate the healing process. Finally, an explanation of this increased vasodilation of the regional blood vessels was put forward by Hilton (1971), who stated that when circulation to an organ was occluded, the accumulation of intermediary metabolites and the release of a large number of vasoactive substances from active metabolizing cells provoked a vasodilating effect on the regional blood vessels.

Indresano and Lundell (1982) conducted a similar study on rabbits on the blood supply to the distal fragment based on the Castelli et al (1975) approach. They confirmed the findings of Castelli et al (1975) but compared the fractured side of the mandible in 7 rabbits to the unfractured side. They used the Hydrogen "washout" method to quantify the immediate vascular responses that occurred at bone marrow sites anterior and posterior to the area in which continuity of the bone and flow of the intra-osseous vessels had been interrupted. In four animals, the unfractured side of the mandible showed no significance change in blood flow following contralateral fracture. On the opposite side, sites proximal to the fracture showed a decrease in flow of only 0,74 percent. This is what might be expected and simply indicates that normal blood flow is maintained to an area proximal to site of trauma. Anterior to the site of fracture, however, a dramatic drop in blood flow (54,5 percent) was seen because of interruption of the inferior alveolar artery and the concomitant periosteal flow.

The Hydrogen "washout" technique, which provided a direct blood flow measurement, complimented the findings of Castelli et al (1975) and showed that, within 5 minutes, the initial adjustments of retrograde flow through collateral vessels may be almost immediate. This prevents bone infarction and provides basic nutritional needs.

Schneider and Stern (1971) conducted a 3 year retrospective analysis of 157 patients in Jamaica, New York. They studied the results of retaining all 199 teeth in line of fracture. Most of their patients were treated with closed reduction (83,9 percent).

With the use of antibiotics (7-14 days from the time of trauma) and stable fixation, they managed to salvage 189 teeth, resulting in a 5 percent complication rate. The complications were infection (1 case), delayed union (6 cases) and odontalgia (2 cases).
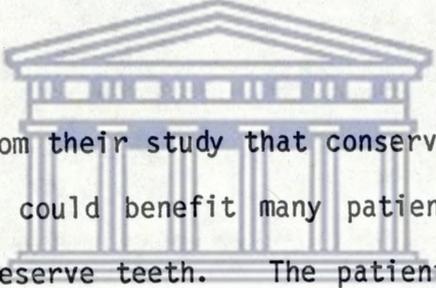
They concluded from their study that conservation of the teeth in line of fracture could benefit many patients and also simplify management and preserve teeth. The patients seen by this group had a large proportion of alcholics, impaired nutritional status, problems with homecare and incomplete dentitions. Unfortunately the latter observation could only be regarded as anecdotal as they did not provide statistical data to qualify their findings.

A very strong supporter for retaining teeth in line of fracture is Harry Archer (1975) who spoke out strongly against the "prophylactic" extraction of such teeth. He stated that even if dental pulps did not survive, antibiotic therapy usually allowed the tooth in line of fracture to remain free of infection during the time it took to heal, after which endodontic therapy could be done. He also criticised the extraction of teeth in the line of

fracture as he believed that the space left behind by the extraction could become a point of imperfection in the immobilization of the fractured segments or could produce secondary displacement.

A very interesting observation made by Archer (1975) was that although the fracture line involved one tooth, extension of the fracture line to the inner cortex of the mandible could result in involvement of neighbouring teeth. These latter teeth he said could have injuries or associated periapical lesions. In response to the protagonists of dental extraction, Archer stated that quite a few good neighbouring teeth communicating with the tooth in line of fracture would routinely suffer removal, especially in cases of comminuted jaw fractures.

In this matter, Kruger (1979) seems to make a valid point in proposing the extraction of neighbouring teeth which show pulpal or periapical involvement. If the findings of Archer are true, then this may explain why infection sometimes occurs, even if the so called "tooth in the line fracture" was extracted.

Steiner and Thompson (1977) also supported the retention of teeth in line of fracture but drew attention to the fact that, although

the modern day use of antibiotic therapy and endodontic treatment opened new vistas for previously condemned teeth, it was still up to the clinician to practice good surgical principles and warned that the availability of antibiotics did not eliminate the need for sound surgical judgement and, where doubt prevailed, the teeth in line of fracture needed to be extracted. This view was shared by Mathog (1984) who also preferred to retain teeth under antibiotic cover but had clear indications for extraction as shared by most authors.

An interesting comparison between the extraction or retention of teeth in the line of fracture was made by Neal, Wagner and Alpert in 1978. They found no significant difference between the two groups in their sample and showed a higher complication rate (37,3 percent) in the extraction groups as compared to 29,5 percent in the retention group. They concluded that extraction of teeth in line of fracture did not minimize morbidity.

A later study by the same authors, Wagner, Neal and Alpert (1979), was conducted to look at open reductions done with the teeth in line of fracture removed or retained. They found that the infection rate was higher (28 percent) where teeth in line of fracture were removed at open reduction and internal fixation as compared to 11,8 percent where the teeth in line of fracture were

retained during the same type of operation. Also, their figures showed a higher morbidity rate (35 percent) when the teeth in line of fracture were extracted and open reduction and internal fixations were carried out. They therefore concluded that complications were more likely to occur in fractures of the angle of the mandible where the teeth in line of fracture were extracted in conjuction with open reduction and internal fixation.

Winstanley (1984) drew attention to the study of the latter authors and stated that over-treatment of fractured mandibles was not necessary. If teeth in the line of fracture could be retained, the need for open reductions and internal fixation could be reduced.

Kahnberg (1979) added another 185 teeth to this series and stated that the extraction of teeth in line of fracture could be limited to teeth with longitudinal crown-root fractures and teeth involved in longstanding infected fractures. He added that even teeth with severe periodontal or pulpal complications could be saved by adequate periodontal and endodontic therapy, a view previously expressed by Archer (1975).

Finally, a study conducted in Denmark by Larsen and Nielsen (1976) has come out very strongly in favour of retaining teeth in line of fracture. They investigated 229 patients for the period 1964-1973. Most patients were treated early and given suitable antibiotic prophylaxis. They attempted preservation of all teeth and tooth buds in the fracture line. Although they found 17 percent of unnoticed apical lesions in 118 patients and 23 percent non-viable teeth, they found that clinical infection occurred only in 0,4 percent of the patients.

It would appear from the literature that in Scandanavian countries, where treatment facilities are modern and patients enjoy a good standard of living, infection rates are extremely low. However, figures differ in areas where the populations experience less fortunate living standards and treatment modalities are not optimal. Also it is quite clear from the literature that certain traditional views are still observed in spite of recent advances in techniques and research regarding teeth in the line of fracture. Controversy still prevails regarding the principle of whether or not teeth in the line of fracture should be retained or extracted

In the wake of these interesting conflicts of opinion, it was deemed desirable to investigate the outcome of work done in our unit at Groote Schuur Hospital, Cape Town.

The purpose of this study is therefore to:

1. Conduct a retrospective investigation of our experience.

2. Investigate the incidence of infection (as a complication) when teeth in the line of fracture were either extracted or retained.

3. Investigate the incidence of infection as it relates to the age and sex of the patient, and the time interval between injury and treatment.
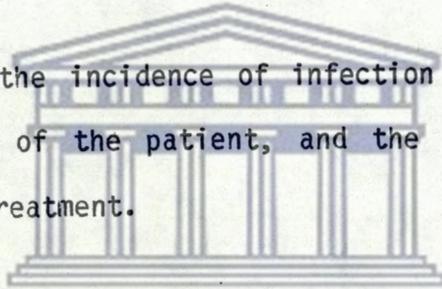
MATERIALS AND METHODS

The materials and methods for the study under consideration will be discussed under the following headings:-

9.1   The Study Sample

9.2.   Sample Selection

9.3   Criteria for Selection of Sample

9.4   Description of Sample

9.5   Criteria for Extraction of Teeth

9.6   Materials

9.7   Treatment of Mandibular Fractures

9.8   Experimental Design

9.9   Statistical Analysis
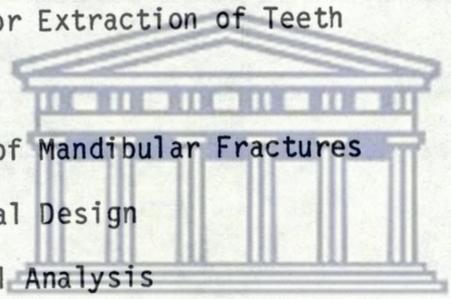
9.1 THE STUDY SAMPLE

An Ex-Post Facto Study was undertaken to determine the presence or absence of infection when teeth in the line of fracture were extracted or retained.

The data base was collected from the records of patients residing in the Western Cape and who attended for treatment of mandibular fractures for the period from June, 1983 to August, 1986 at the Maxillo-facial and Oral Surgery Clinic at Groote Schuur Hospital, Cape Town.

The cases selected for the study were only used if they complied with the requirements stated under the heading **9.3 Criteria for Selection**.
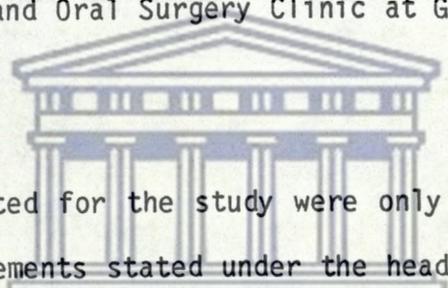
Although there were many mandibular fractures treated by the Maxillo-facial Unit, fractures with no teeth in the line of fracture, fractures in partially dentate mouths and fractured jaws where intermaxillary fixation was not used, were not selected for the study.

9.2   SAMPLE SELECTION

A total number of one hundred and fifty one (151) individuals with teeth in the line of mandibular fracture were selected for the study.

This represented two hundred and twelve (212) teeth in the fracture line.   One hundred and two (102) patients had one tooth, forty one (41) patients had two (2) teeth, five (5) had three (3) teeth, two (2) patients had four (4) teeth and one (1) patient had five (5) teeth in the fracture lines.

For statistical purposes it was necessary for observations to be independent of each other, and therefore it was decided to analyse the one hundred and fifty one patients (151) and not the two hundred and twelve (212) teeth.

The reason for the above is that teeth in the line of fracture in a single mouth cannot be regarded as being independent of each other because:

a)   The fracture line may involve more than one tooth, and infection may be transmitted from a neighbouring non-vital tooth to a vulnerable tooth in the line of fracture (Kruger 1979).

b)   Saliva is a common medium in the mouth which can therefore allow for inter-dependency between teeth.

c)   As more than one tooth is dependent on the same source of blood supply, it is expected that this can affect the vitality of one or more teeth (Castelli et al 1971).

d)   Where there is more than one fracture of the mandible in the same mouth, these fractures and their involved teeth cannot be regarded as acting independently because the individual may have a predisposition to infection or no infection, depending on local factors; for example, local bone disease (condensing osteitis) or a local gingival pathology (periodontal involvement). Although the presence of systemic disease rendered the patient unsuitable for inclusion in the study, this factor cannot be regarded as absolute, as undetected systemic factors may have an influence on healing or infection.

Of the forty nine (49) patients with more than one tooth involved in the fracture line, one tooth was chosen at random from the 2, 3, 4, or 5 teeth involved until each patient was represented by a single tooth only.

The sample was then divided into two (2) groups, namely:-

a)   Patients who had teeth in the line of fracture removed were designated Section I

b)   Patients who had teeth in line of fracture retained were designated Section II

The **Independent Variable** was represented by the two (2) separate groups.

The **Dependence Variable** related to either the presence of absence of infection.

The **Moderator Variable** was represented by the age and sex of the patients.   No attention was afforded to race as this was not regarded as being significant to the study.

The **Control Variable** was represented by the factors detailed in paragraph 9.3. (Criteria for Selection of Sample), as the treatment of mandibular fractures were not all carried out by the same operator.

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9.3 <u>CRITERIA FOR SELECTION OF SAMPLE</u>

Fractures of the mandible were selected for study if they had sufficient data regarding completion of treatment and good post-operative follow-up care. Alveolar fractures were not included in the study. The following requirements (control variable) had to be met for eligibility for the study:

1) only fractures with a tooth/teeth in line of fracture pre-operatively were used;

2) all fractures had to be compound with involvement of the periodontal ligament according to the descriptions by the following authors: (Kromer, 1953; Rowe and Killey, 1955; Walker and Bentz, 1966; Archer, 1975; Cawson, 1984; Rowe and Williams, 1975);

3) all reductions had to be clinically and radiologically optimal with sufficient teeth present in both maxilla and mandible to affect adequate immobilization. Kahnberg and Ridell (1978) stated that complications were reduced if reductions of the fracture segments were optimal. Other supporters of this condition were Roed-Pietersen and Andreasen (1971), Ridell and Astrand (1971), Kahnberg,(1979), Winstanley (1984), Rowe and Williams (1985).

4) All mandibular fractures had to be placed into intermaxillary fixation for a period of immobilization of approximately four to six weeks (Finnegan, 1983; Rowe and Williams, 1985; Cannell and Boyd, 1985; Bochlogyros, 1985b). Patients were recalled weekly to fortnightly in order to secure and check the quality of immobilization and attend to possible complications (including infection) for a period up to six months.

5) All patients had to receive appropriate antibiotic therapy for five to seven days from the time of commencement of treatment. Patients admitted via the Trauma Unit were given 2 mega units of Penicillin G intravenously every six hours in addition to 1 gram of Metronidazole (Flagyl) rectally every 8 hours. Out-patients were given Penicillin VK 500 milligrams orally every 6 hours in addition to 400 milligrams of Metronidazole every 8 hours. Patients were also instructed as to home care and oral hygiene practice and given Betadine (1 percent Povidone Iodine)* mouthwashes to facilitate oral health care. It has been shown that the judicious use of antibiotic therapy could reduce the incidence of infection, as discussed in preceeding pages.(Edgerton and

6) The evaluation of infection was based on clinical and radiological signs and symptoms eg. pain, swelling, suppuration and periapical radiolucency (if present) according to the criteria of Fischer-Brandies and Dielert, 1984).

*Adcock-Ingram Laboratories Ltd., Commando Road, Industria West, Johannesburg.

Hill (1952), Wilkie et al (1953), Rowe and Killey (1968), Schneider and Stern (1971), Zallen and Curry (1975), Kruger (1979), Greenberg et al,(1979), Wolujewicz (1980), Topazian and Goldberg (1981), Mathog (1984) and Rowe and Williams (1985).

Diet supplements such as Complan* and Pronutro** were routinely given to patients in intermaxillary fixation and multivitamins were added if it was deemed necessary by the clinician treating the case. As quite a large proportion of patients were from a lower socio-economic background, these dietary supplements were deemed necessary for satisfactory healing (Mathog, 1984; Rowe and Williams, 1985; Bochologyros, 1985b; Cannell and Boyd, 1985).

7) Patients were excluded from the study if they had co-existing systemic diseases as described by Bochologyros (1985b) eg. diabetes mellitus, tuberculosis etc. These have been shown to affect healing of fractures and were discussed by Cannell and Boyd (1985) and Silverman et al (1974).

8) Patients were also excluded if signs of pre-operative infection eg. Pyrexia, presence of frank suppuration with or without radiological signs of infection were present (Fischer-Brandies and Dielert, 1984).

*Complan-Glaxo (Pty) Ltd., Health Products Division, Manchester Road, Wadeville, 1401.

**Cerebos Food Company Ltd., Wadewille, 1401.

9.4 DESCRIPTION OF THE SAMPLE

The number of patients examined was one hundred and fifty one
(n = 151).

a) **Sex Distribution**

One hundred and sixteen (116) cases (76,8 percent) were male.
Thirty five (35) cases (23,2 percent) were female.

b) **Age Distribution**

See table 1.

TABLE 1 : Age Distribution of Sample Evaluated (n = 151)

Age Category (yrs)	No. of Cases	Percentage
0 - 19	22	14.6
20 - 24	41	27.1
25 - 29	35	23.2
30 - 39	43	28.5
40 - 59	10	6.6
60 +	0	0
TOTAL	151	100

MEAN AGE   27.6 years (std. dev. 8.2).

TABLE 2 : AGE DISTRIBUTION FOR EACH SEX

|	0-19 years	20-24 years	25-29 years	30-39 years	40-59 years
FEMALE	17.14%	37.14%	31.43%	11.43%	2.86%
MALE	13.79%	24.14%	20.69%	33.62%	7.76%
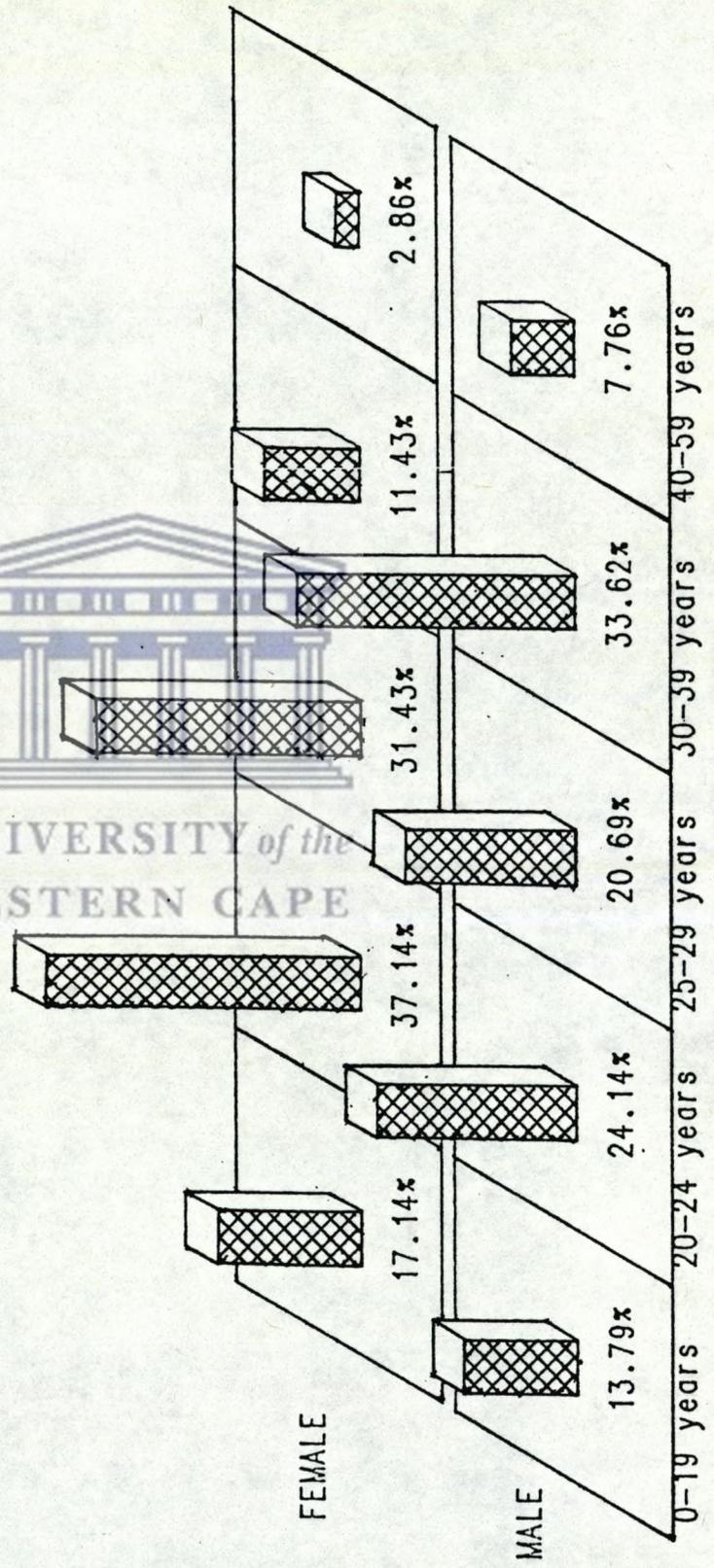
9.5 <u>CRITERIA FOR EXTRACTION OF TEETH</u>

a) Excessive tooth mobility - teeth were tested for abnormal mobility in horizontal and axial directions as recommended by Andreasen (1981). Percussion tests were of diagnostic value (a dull sound indicated possible subluxation or extrusion of the tooth).

These tests were basic to the decision on retention or extraction of the involved tooth.

b) a tooth with more than 50 percent of its cementum exposed to the oral environment (Schultz, 1977; Kahnberg, 1979; Heslop, 1985).
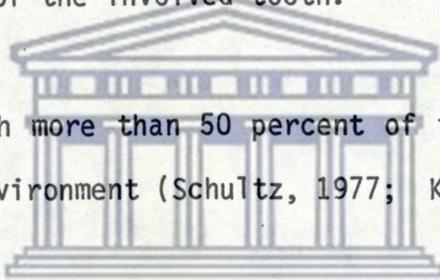
c) teeth exposed to the oral environment for more than 48 hours (Ridell and Astrand, 1971). In cases where fractures were treated after two days (48 hours) and the teeth in the line of fracture were retained, the displacement of the fracture segments had to be minimal in order to fulfil the above requirement.

d) pre-existing non-vital teeth with radiographic periapical changes.

e) teeth with fractured roots.

f) teeth with advanced periodontal involvement (Irby, 1979).

g) deeply carious teeth and those showing pulpal involvement
    (Wilkie et al, 1953; Archer, 1975; Kruger, 1979).

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9.6 <u>MATERIALS</u>

<u>Radiographic Apparatus</u>

Two types of diagnostic radiographs were routinely taken on admission of the patients to either the Trauma Unit or the Maxillo-facial and Oral Surgery Clinic.   These were:-

a) Orthopantomograms with the use of a Panelipse machine*.   This method was not standardized.

b) Postero-Anterior Views of the Mandible with the use of a Elema Schonander Skull Unit.**   This method was not standardized.

The radiographs mentioned in (a) and (b) were repeated twenty-four to forty eight hours post-operatively and in regular follow-up re-examinations carried out on an Out-patient basis.

c) A Viewing Box*** was used to interpret the radiographs without magnification.   No intra-oral pictures were used as the above radiographs were sufficient.   The presence of sequestra and non-union were included in infection.

Below are examples of the types of radiographs used in the study.

*General Electric Company, Dental Systems, P O Box 414,Milwaukee

**Siemens, Siemens House, 80 Roeland Street, Cape Town

***Phillips City Electrical Company (Pty) Ltd., Cobern Street,

Cape Town.

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Fig. 1: Showing an orthopantomographic view of a bilateral fractured mandible (pre-operative)

a) Red arrow shows a compound fracture of the left angle of the mandible with tooth 38 in line of fracture embedded in the proximal segment.

b) Blue arrow shows a compound fracture of the right body of the mandible with tooth 44 in the line of fracture.

Fig 2: Shows a postero-anterior view of the same case seen in
Fig. 1

a) Red arrow shows the fracture at the left angle of the mandible
with the tooth 38 embedded within the proximal segment.

b) Blue arrow shows the fracture at the right body of the
mandible involving tooth 44.

Fig. 3: Shows a post-operative orthopantomographic view in which the teeth in line of mandibular fracture were extracted

a) Red arrow shows inter-osseous and circumferential wiring affecting an optimal reduction of the left angle fracture.

b) Blue arrow shows the fracture of the right body reduced via closed reduction. Also seen in the picture are interdental eyelet wires and wires used for intermaxillary fixation (immobilization).

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Fig. 4: Shows a postero-anterior view of the same case shown in Fig. 3

a) The red arrow shows the optimal reduction affected by the inter-osseous and circumferential wiring at the left angle.

b) The blue arrow shows the fracture at the right body reduced via closed reduction.

Fig. 5: Showing an orthopantomographic view of a bilateral fractured mandible (pre-operative)

a) Red arrow shows a compound fracture at the left body of the mandible involving tooth 34 and possibly tooth 35.

b) Blue arrow shows a compound fracture at the right body of the mandible involving tooth 46 and possibly tooth 45.

Fig. 6: Shows a postero-anterior view of the same case described in Fig. 5

a) The red arrow shows the fracture at the left body of the mandible

b) The blue arrow shows the fracture at the right body of the mandible.

Fig. 7: Shows a post-operative orthopantomographic view of the same case shown in Fig. 5 treated via closed reduction

a) The red arrow shows teeth 34 and 35 **retained** in the line of fracture, at the left body of the mandible. An Erich Arch Bar*was applied to the lower teeth from teeth 46 to 37.

b) The blue arrow shows the fracture at the right body of the mandible in which both teeth in the line of fracture namely, teeth 46 and 45 were **retained** . (continued)

*Rocky Mountain Orthodontics, P O Box 17085, Denver, Colorado, U.S.A.

The Erich Arch Bar was again used for fixation of the teeth and intermaxillary fixation (immobilisation) was affected with upper inter-dental eyelet wiring and tie-wires.

Also seen are the extraction sockets of teeth 32, 31 and 44 which were removed due to abnormal mobility.

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Fig. 8: Shows a postero-anterior view of the bilateral fractures of the mandible where the teeth in the line of fracture were retained.

a) The red arrows shows the fracture at the right body of the mandible with optimal reduction.

b) The blue arrow shows the fracture at the left body of the mandible. This view also shows an optimal reduction.

9.7 <u>TREATMENT OF MANDIBULAR FRACTURES</u>

The principles of treatment have already been discussed in preceeding pages, and therefore the methods only will be described.

Early fracture treatment was intended whenever possible, particularly if soft tissue lesions were also present and some facial fractures, being compound, required earlier attention. Antibiotic prophylaxis was instituted in all compound fractures including those fractures communicating with tooth buds as recommended by Lenstrup (1955). Antibiotics were also given prophylactically as a routine procedure. At operation the skin and oral cavity was prepared with 1 percent Povidone-Iodine solution (Betadine). None of the cases under treatment required extraoral open reduction procedures. Most cases of closed reduction were performed under local anaesthesia using 2 percent Xylotox*block and infiltration injections with Adrenaline as vasoconstrictor. Cases requiring open reduction and internal fixation were treated under general anaesthesia.

Laceration of the soft tissues were primarily treated by cleansing and the necessary hemostasis. Tissue flaps were placed in

*Adcock-Ingrams Laboratories Ltd., Commando Road, Industria West, Johannesburg.

anatomically correct positions and, if necessary, supported by loosely placed sutures. Usually fracture treatment would be carried out first.

Most fractures were stabilized by interdental eyelet wiring and intermaxillary fixation. Interdental arch bars, mainly of the Erich design, were used in cases where additional stability was needed to support loose fragments, and in cases where post-operative intermaxillary fixation had to be deferred until the mental or respiratory state or general condition of the patient allowed intermaxillary fixation. This period varied from 24 hours to several days.

The Erich Arch Bars were moulded pre-operatively in the mouth of the patient and fixed to the teeth using 0,16 and 0,18 **Rocky Mountain*** soft stainless steel wire placed gingivally off the prominent line of the teeth (Dingman and Natvig, 1964). The same type of wire was used for inter-maxillary fixation and 0,20 **Rocky Mountain Wire** was used in cases where suspension was needed.

In cases where the occlusion could not be optimized intra-operatively, elastic traction was used for approximately 12 to 24

*Rocky Mountain Orthodontics, P O Box 17085, Denver, Colorado, U.S.A.

hours after which there was usually maximum intercuspation of teeth allowing for optimal intermaxillary fixation.

Circumferential wires were used in association with arch bars in cases where comminuted fractures were closed and did not warrant open reduction.

Where there was an inadequate number of teeth, open reduction and internal fixation was done. Transosseous wiring was carried out intra-orally. Transosseous wiring of the mandible was only used if satisfactory re-positioning and fracture stability could not be obtained by intermaxillary fixation alone.

Increased stability requirements were present with concomitant mid-facial fractures where the mandible was used as a stabilising splint. In acute trauma cases, most teeth in the line of fracture were retained, as they were required to aid in supporting displaced fractures, and also obviate the need for open reduction. Impacted wisdom teeth often hindered displacement of the fracture segments and were therefore preserved as recommended by Rowe and Williams (1985) and Wolujewicz (1980).

Neither compression plates, nor metal cap splints, or Gunning splints were used to provide immobilisation of a dentate lower jaw against an edentulous upper jaw. A single case was treated with a Sherman*plate where reduction could not be affected by the conventional interosseous wire. Cases which did not require

*Down Bros. & Mayer & Phelps, Mitcham, Surrey, England.

intermaxillary fixation for the treatment of partially dentate mandibles which were well-stabilized by arch bars and internal fixation were not included in the study. Firm internal fixation in edentulous patients was usually carried out without the use of Gunning Splints or intermaxillary fixation and these cases showed good healing.

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9.8 <u>EXPERIMENTAL DESIGN</u>

The investigations were conducted under the headings of **Section 1** and **Section II** (vide appendix 1 for pro-forma) and divided into Parts A, B and C respectively.

PART A

Time lapse between the occurrence of the accident (trauma) and the commencement of active treatment. This was recorded as Groups:

GROUP 1 : Treated within 24 hours

GROUP 2 : Treated between 25 to 48 hours

GROUP 3 : Treated between 49 and 96 hours

GROUP 4 : Treated between 4 to 7 days

GROUP 5 : Treated after 7 days.

PART B

In each of the groups represented in part A, the fracture sites were divided into the following:

Angle

Body

Symphysis Region

This was indicated by recording the actual teeth namely, First Molar, First Premolar etc. It was accepted that Incisors and Canines constituted the symphysis and parasymphyseal regions

respectively, and the Premolars to the second Permanent Molar constituted the body of the mandible; the third molar was included at the angle of the mandible (after Ellis <u>et al</u> 1985).

PART C

In each of the groups represented in part A, the age of the patient was categorized as:-

Category 1 : Under 20 years
Category 2 : 20 to 39 years
Category 3 : 40 to 59 years
Category 4 : 60 years and over
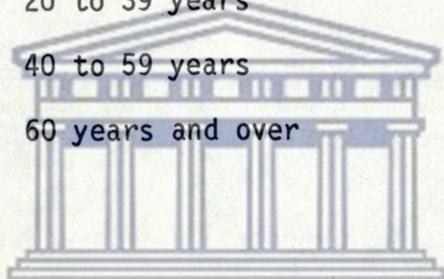
9.9 STATISTICAL ANALYSIS

a) Data tables were used to illustrate the type of teeth involved in the fracture line and the time interval between injury and treatment. Descriptive statistics (mean, standard deviation) were calculated from the observed values.

b) Individual groups designated as Sections I and II respectively were compared with regard to sex distribution. The findings were analysed using the chi-square* test to determine significance at the 99 percent and 95 percent levels.

c) The association between the type of procedure used, namely extraction versus retention of the teeth in the line of fracture, with regard to the time elapsed between injury and treatment was calculated using the chi-square test at the 99 percent and 95 percent levels of significance.

d) The difference in age between the groups ie. Section I and II was calculated for significance using the student "t"** test at the 99 percent and 95 percent levels.

*Siegel, S (1956) pp 197-200

**Siegel, S (1956) pp 19- 20

e) The Fisher's exact*** test was used to determine the association between procedure and infection where the rate of infection was too low for the chi-square test to be used.

f) An inter-examiner variability test was not considered necessary as the study was conducted Ex-Post Facto and the **Intervening Variable** was corroborated by the **Control Variable.**

***Siegel, S (1956) pp 96-104.

RESULTS

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10.1 THE DISTRIBUTION OF TEETH INVOLVED IN THE LINE OF MANDIBULAR FRACTURE

TABLE 3: n = 151

Teeth Involved	Number	Percentage
Central Incisor	12	7.9
Lateral Incisor	12	7.9
Canine	15	9.9
1st Premolar	11	7.3
2nd Premolar	23	15.2
1st Molar	2	1.3
2nd Molar	16	10.6
3rd Molar	60	39.7
TOTAL	151	100

The results in table 2 show that the tooth most commonly involved in the mandibular fracture line was the third molar with a frequency of 40 percent. The second most common involved tooth was the second premolar. The distribution for all other teeth was relatively even except for the first molar which appeared to be rarely affected (1 percent).

10.2 DISTRIBUTION OF CASES EXTRACTED AND RETAINED

TABLE 4:   n = 151

	Number	Percentage
Cases extracted	66	43.7
Cases retained	85	56.3
TOTAL	151	100

Table 4 shows that there were more teeth retained in the line of fracture (56 percent) than those extracted (44 percent).

10.3 <u>DISTRIBUTION OF TIMING OF TREATMENT AFTER INJURY</u>

TABLE 5:   n = 151

Time Interval	Number of Cases	Percentage
0 - 24 hrs	43	28.5
25 - 48 hrs	21	13.9
49 - 96 hrs	22	14.6
4 - 7 days	29	19.2
> 7 days	36	23.8
TOTAL	151	100

From table 5 it can be seen that most cases were treated within 24 hours. However, the second most common timing of treatment was after seven days. This will be discussed in Chapter 11.

10.4 SEX DISTRIBUTION OF EXTRACTION VERSUS RETENTION OF TEETH IN SAMPLE

TABLE 6:   n = 151

Section I = Extracted

Section II = Retained

Frequency (Cases) Row Percentage (%) Column Percentage (%)	Male	Female	TOTAL
I Teeth Extracted	53 80.30 45.69	13 19.70 37.14	66 cases 43.71%
II Teeth Retained	63 74.12 54.31	22 25.88 62.86	85 cases 56.29%
TOTAL	116 76.82	35 23.18	151 cases 100.00%

DF = 1 chi value 0.798

From Table 6 it can be seen that 46 percent of males in the sample had their teeth extracted from the line of fracture compared to 54 percent who had their teeth retained.   The difference is however not statistically significant.

(chi-square   p-value = 0,372)

Similarly 37 percent of females had their teeth extracted compared to 63 percent who had their teeth retained.   However, when comparing males to females, it can be seen that 80 percent of males had their teeth extracted compared to 20 percent of females.   In addition, 74 percent of teeth retained occured in males as compared to 26 percent of teeth retained in females.
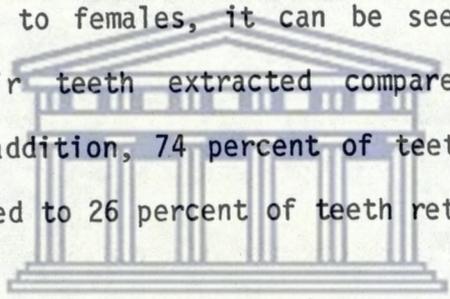
10.5 THE ASSOCIATION BETWEEN THE PROCEDURE (extraction or retention) AND THE TIMING OF TREATMENT

TABLE 7:   n = 151

Frequency (Cases) Row Percentage (%) Column Percentage (%)	0 - 24hrs	25 - 48hrs	49 - 96hrs	4 - 7 days	> 7 days	TOTAL
I Teeth Extracted	10 15.15 23.26	10 15.15 47.62	9 13.64 40.91	12 18.18 41.38	25 37.88 69.44	66 cases 43.71%
II Teeth Retained	33 38.82 76.74	11 12.94 52.38	13 15.29 59.09	17 20.00 58.62	11 12.94 30.56	85 cases 59.29%
TOTAL	43 28.48	21 13.91	22 14.57	29 19.21	36 23.84	151 cases 100.00%

chi - square   Value 17.266   DF 4 $p = 0.002$*

*Significant at 95 percent level.

There is a significant association between the procedure used (namely extraction versus retention of teeth in the line of fracture) and the time interval between injury and treatment.

Most of the patients who had their teeth retained (39 percent) were treated within 24 hours. Of the 43 patients treated within 24 hours, only 10 cases (23 percent) had their teeth extracted compared to 33 cases (77 percent) who had their teeth retained; whereas of the 36 patients who were treated after 7 days, 25 cases (69 percent) had their teeth extracted compared to 11 cases (31 percent) who had their teeth retained. Of the middle group (1 - 7 days), 43 percent had their teeth extracted and 48 percent had their teeth retained.

From the table it is also clear that 38 percent of the 66 patients who had their teeth extracted were treated after 7 days, whereas only 13 percent of the 85 patients who had their teeth retained were treated after 7 days.

10.6 THE ASSOCIATION BETWEEN THE AGE CATEGORY AND THE MODALITY OF TREATMENT (ie. extraction versus retention of teeth)

TABLE 8: n = 151

Frequency (Cases) Row Percentage (%) Column Percentage (%)	0 - 19yrs	20 - 24yrs	25 - 29yrs	30 - 39yrs	40 - 49yrs	TOTAL
I Teeth Extracted	8 12.12 36.36	10 15.15 24.39	14 21.21 40.00	26 39.39 60.47	8 12.12 80.00	66 cases 43.71%
II Teeth Retained	14 16.47 63.64	31 36.47 75.61	21 24.71 60.00	17 20.00 39.53	2 2.35 20.00	85 cases 56.29%
TOTAL	22 14.57	41 27.15	35 23.18	43 28.48	10 6.62	151 100.00%

Teeth extracted : mean age 30.3 years (std. dev. 8.9).

Teeth retained : mean age 25.6 years (std. dev. 6.9).

students "t"- test   p = 0.0004*

*Significant at 95 % level.

The difference in age between the group of patients who had teeth extracted and the group who had teeth retained is statistically significant using the students "t" test.

In the 0-19 year age group, 36 percent of the 22 cases had their teeth extracted compared to 64 percent who had their teeth retained. In the 20-24 year age group, 24 percent of the 41 patients had their teeth extracted compared to 76 percent who had their teeth retained.

In the 25-29 year age group, 40 percent of the 35 patients had their teeth extracted compared to 60 percent who had their teeth retained.

In the 30-30 year age group, 60 percent of the 43 cases had their teeth extracted compared to 40 percent who had their teeth retained.

In the 40-49 year age group, 80 percent of the 8 cases had their teeth extracted compared to 20 percent who had their teeth retained. A progression can be seen in table 8 that the tendency for extraction increases as the patient age category gets older.

It can also be seen from table 8 that 60 percent (row percentage) of the 85 patients who had their teeth retained were in the age range from 20-29 years (mean age 25.6 years ± 6,9).

In addition, 60 percent (row percentage)of the 66 patients who had their teeth extracted from the fracture line were in the age range from 25-39 years (mean age 30.3 years ± 8.9).

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10.7 THE INCIDENCE OF POST-OPERATIVE INFECTION WHEN TEETH WERE EXTRACTED OR RETAINED (BY NUMBERS)

TABLE 9:   n = 151

Five of the one hundred and fifty one cases (151) had post-operative infection.
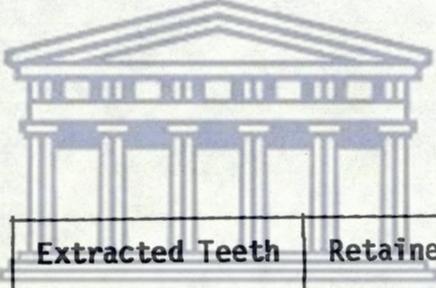
	Extracted Teeth	Retained Teeth	Total
Infection	3	2	5
No Infection	63	83	146
TOTAL	66	85	151

The rate of infection in the extracted cases is 4.55% (95 percent confidence interval of 0,95% - 12.71%).

The rate of infection in the retained cases is 2.35 percent (95 percent confidence interval of 0.29% - 8,24%).

Because of the low rate of infection relating to both modalities of treatment, namely extraction and retention, the infected frequency in two of the cells in the two-way table is less than 5. The chi-square test is therefore not appropriate and the Fisher's exact test was used instead.

The Fisher's exact test p-value is 0,654,* suggesting that there is no significant association between procedure and infection rate.
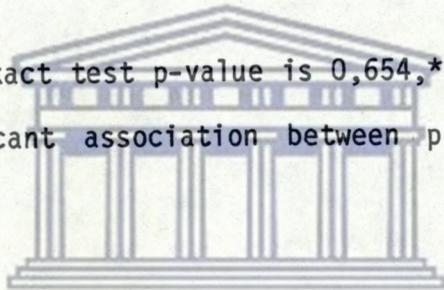
*Result not significant at 95% level.

DISCUSSION

This study was initiated through anectdotal discussion between clinicians involved in the treatment of mandibular fractures at the Maxillo-facial and Oral Surgery Clinic at Groote Schuur Hospital, Cape Town.

In view of the paucity of information available as regards the assessment and treatment of teeth in the line of mandibular fracture in southern Africa, statistical values could not be used to predict the outcome of treatment if teeth in the line of fracture had to be extracted or retained. Although the incidence of infection was found to be very low in the Western Cape sample, the results will be more meaningful once the descriptive statistics have been analysed.

1. AGE INCIDENCE

TABLE 1 AND 2:

Fifty percent of the sample was between the ages of 20 and 29 years, while 29 percent of the cases was between 30 to 39 years and 15 percent of the cases between 0 and 19 years.   In comparison to a study conducted by Melmed and Koonin (1975) on a similar Western Cape Sample, but looking at mandibular fractures per se, Melmed found figures of 35 percent for his 20 to 29 year groups; 22 percent for 30 to 39 year group and 22 percent for his

0 to 19 year groups. It can therefore be seen that a higher percentage of patients from the present sample were between the ages 20 to 39 years as compared to the previous study conducted by Melmed from 1968 - 1973.

Sixty eight percent of the female sample was within the 20 to 29 year age group compared to 45 percent of the male sample for the same age group. The majority of males occurred within the older 30 to 39 year age group.

Berstein and McClurg (1977) and Olson et al (1982) found a similar age distribution where mandibular fractures were concerned ie. the greatest incidence being between 21 to 30 years

2. SEX DISTRIBUTION

TABLE 6:

Seventy seven percent (77%) of the sample was male and 23 percent female. This constitutes a ratio of 3.3:1 and compares favourably with studies conducted by Bochlogyros (1985a) who examined 1,521 cases and Olson et al (1982) who reviewed 580 cases.

Of the 116 male patients, 54 percent had their teeth retained while 46 percent had their teeth extracted. Of the the 35 female patients, 63 percent had their teeth retained compared to 37 percent who had their teeth extracted. However, when one looks

at the male to female ratio regarding extraction, then 80 percent of the male sample was subjected to extraction but if the male group was compared with regard to extraction versus retention, then 46 percent of teeth were extracted and 54 percent were retained. Although these figures seem to show that extraction of teeth was more common in males, the ratio of male to female (3:1) has to be borne in mind and statistical analysis (chi-square p = 0,372) show this relationship to be insignificant.

Thus one can obviously conclude that more teeth (56 percent) were retained than extracted (44 percent).

3. SITE DISTRIBUTION OF TEETH IN LINE OF MANDIBULAR FRACTURE

TABLE 3:

The most commonly involved tooth was the third molar (40 percent of cases) followed by the second premolar (15 percent of cases). From this could be inferred that most fractures occurred at the angle and body of the mandible. Again, this does not differ much from the Melmed and Koonin (1975) study where they found a 31 percent incidence of Angle fractures and 40 percent incidence of Body fractures.

It is interesting that although Irby (1979) stated that the third molar area was most prone to infection as a result of debris

collection and haematoma contamination, the results of this study do not support Irby's contention.

4. COMPARISON BETWEEN THE INTERVAL BETWEEN INJURY AND TREATMENT AND MODALITY OF TREATMENT

TABLE 7:

a) Most patients (39 percent) who had their teeth retained were treated within the first 24 hours. This type of practice seems to emanate from the premise that early treatment of fractures results in less post-operative complications. According to Kromer (1953), a tooth in the fracture line delays healing if it is not extracted within 48 hours. However, recent studies have been done to show that early reduction of fractures reduced post-operative infection rates (Edgerton and Hill, 1952; Dingman and Natvig, 1964; Roed-Pietersen and Andreasen, 1970; Archer, 1975; Ridell and Astrand, 1971; Larsen and Nielsen, 1976; Kahnberg and Ridell, 1979; Kahnberg, 1979; Wolujewicz, 1980; Mathog, 1984; Winstanley, 1984; Rowe and Williams, 1985).

The findings of the present study correspond to the recommendations of the latter clinicians as 77 percent of the cases treated within 24 hours had their teeth retained. It is interesting to note that only 29 percent of the patients in Melmed's study (Melmed and Koonin, 1975) were treated within 24 hours.

b) In the cases treated after 7 days, 69 percent of cases were subjected to extraction of teeth in the line of fracture. These patients who appeared after 7 days were mostly referred cases from rural areas, cases from outlying satellite hospitals and patients from poor educational and socio-economic background.

In the group treated between 1 and 7 days, the ratio between extraction and retention of teeth in the line of fracture was about even. A low percentage of cases (13 percent) had their teeth in line of fracture retained after 7 days as compared to 38 percent of cases which, when seen after 7 days, were treated with extraction.
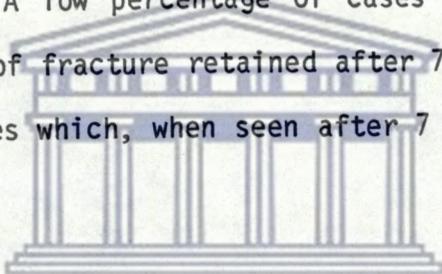
5. **THE RELATIONSHIP BETWEEN AGE AND THE TYPE OF TREATMENT (EXTRACTION VERSUS RETENTION)**

TABLE 8:

In the younger age group (0 to 19 years) most teeth in the line of fracture were retained (64 percent). This figure was even higher in the 20 to 24 year group, namely 76 percent of teeth were retained. In the group aged 25 - 29 years, 60 percent of cases had their teeth retained. It can therefore be seen that there was a great tendency for teeth to be retained in young people as 60 percent of the 85 patients who had their teeth retained were between the ages of 20 to 29 years with a mean age of 25.6 years (standard deviation 6,9 years).

It can also be seen from the results of the study that 60 percent of the teeth were extracted in the age group 30 to 39 years and 80 percent of the teeth were extracted in the 40 to 49 year age group. It is therefore quite clear that older patients were more prone to have their teeth extracted, as the majority of these (60 percent of 66 cases) were between 25 to 39 years with a mean age of 30.3 years (standard deviation 8.9 years).

6. THE RELATIONSHIP BETWEEN THE EXTRACTION AND RETENTION OF TEETH WITH REGARD TO THE INCIDENCE OF INFECTION

TABLE 9:

The results of this study show a very low infection rate in a Western Cape Sample where the problems of poor nutrition, poor oral health care, poor educational standards, indulgence in alcohol and poor compliance prevail. Yet a figure of 2,35 percent* infection rate is comparable to German and Scandinavian studies where the former conditions do not prevail in the same proportion. In the cases where the teeth in the line of fracture were extracted, the infection rate was 4,55 percent**. This figure almost doubles the figure for infection where the teeth were retained and corroborates the study by Neil et al (1978),

*95 percent confidence interval 0.29% to 8.24%

**95 percent confidence interval 0,95% to 12.71%

although both studies are not statistically significant. In essence, it could be said that the extraction of teeth from the fracture line does not reduce morbidity (Neil et al 1978) and that the act of extraction delivers a traumatic (Kahnberg and Ridell, 1979) insult to bone and is often technically difficult. Extraction of teeth also facilitates the displacement of fracture segments and introduces another dimension, namely, open reduction.

Wagner et al (1979) studied the effects of 100 consecutive cases of open reductions. When teeth were extracted from the angle of the mandible and the fractures reduced with internal fixation, the infection rate was 35 percent whereas a complication rate of only 11,8 percent was found where teeth in the line of fracture were retained.

The results of the present study seem to contradict, in rather strong terms, previous clinicians advocating the removal of teeth in the line of fracture; for example, Thoma (1969) felt that the need for closed reduction was unnecessary if facilities for open reduction are available. It can clearly be seen from this study, as well as studies by Wagner et al (1979) and also a strong appeal made by Winstanley (1984) that the viewpoint held by Thoma (1969) is now outmoded.

Sturgis and Holland (1946) recommended the prophylactic extraction of teeth in the line of fracture even if they were of strategic importance. Similarly, Lewis and Perutsea (1959) stated that because teeth in the line of fracture could not be regarded as a centre of ossification, it was advisable not to wait until infection had occurred.

Bradley (1965) and Clark (1965) regarded teeth in the line of fracture as foreign bodies and Clark (1965) stated that there was no justification for the use of antibiotics to suppress infection.

In answer to these statements, it can clearly be seen that the retention of teeth in the line of fracture has few disadvantages.

Greenberg et al (1979), Schneider and Stern (1971) and Zallen and Curry (1975) have all shown the advantages of using antibiotic therapy prudently and this has also been the practice in the present study. The protocol of our antibiotic regime has already been outlined in the Materials and Methods section.

It can also been seen that the preservation of the tooth in the line of fracture does not appear to increase the risk of infection or delay the healing process (Ridell and Astrand, 1971) and therefore a conservative approach to such teeth is recommended.

Archer (1975) encouraged this practice with good justification and Wilkie et al (1953) outlined the advantages of retaining teeth during times when the outcry against such practice was still very strong. With the passage of time, more studies came to the fore and augmented the conservative lobby.

Interestingly, even though the cases selected for our study did not include cases with overt systemic diseases (which, according to Bochlogyros (1985b), could affect the healing process) it is nevertheless difficult to screen for undetectable systemic conditions which could manifest later, just as determining the alcohol consumption of known or prospective alcoholics would have required detailed serum analyses (liver enzymes) for undetectable liver disease. It is still quite encouraging to find such a low infection rate in a population sample where diversity of life style and behavioural characteristics and nutrition vary considerably.

Finally, it is also evident from the results of this study that adequate primary care (antibiotic cover, mouthcare and rehydration of patients) as recommended by Fischer-Brandies and Dielert (1984), played a supportive role in the outcome of the treatment and that optimal reduction and fixation made the retention of teeth in the line of fracture a predictable exercise (Finnegan, 1983; Kahnberg and Ridell, 1979; Kahnberg, 1979).

It can also be seen, as illustrated in table 10, that the results
of treatment in our study compared most favourably with studies
conducted in other parts of the world.

TABLE 10:- STUDIES OF TEETH IN THE LINE OF MANDIBULAR FRACTURE

	Number of Patients	TILOF***	TILOF Extracted	Infection Percentage	TILOF Retained	Infection Percentage
KROMER 1953	164	164	82	-	82	32
RIDELL 1971	84	165	-	-	165	4
ZALLEN 1975	62	62	-	-	62	50%* 6%**
NIELSEN 1976	118	244	-	Nil	244	0,4
WILKIE 1979	250	190	45	-	145	8
KAHNBERG 1979	132	185	-	-	185	8
NEIL 1979	113	207	132	37	75	30
CHUONG 1983	227	202	50	14	152	11
CHAN 1984	26	26	-	-	8	30
HENDRICKS 1986	151	151	66	5	85	2

*Without antibiotics
**With antibiotics
***TILOF : Teeth in the line of fractures

CONCLUSION

Based on the findings of this study it may be concluded that:-

1) Most teeth in the line of mandibular fracture involved the 3rd molar and therefore occured at the angle of the mandible. In spite of location, the probability for infection was small.

2) More teeth in the line of fracture were **retained** rather than extracted.

3) Males had more teeth in the line of fracture **retained,** as the male to female ratio was 3:1.

4) Most patients treated within the first 24 hours had their teeth in the line of fracture **retained.**

5) Most patients seen after 7 days were treated by **extraction** of the teeth in the line of fracture.

6) Teeth in the line of fracture were **retained** in the **younger** age group.

7) More teeth in the line of fracture were **extracted** in the **older** age group.

8) The overall infection rate was very low in comparison to other studies.

9) The infection rate was lower when teeth in the line of fracture were **retained**.

10) In view of the low infection rate and the fact that there was no significant difference between the extraction and retention of teeth in the line of fracture, all teeth should therefore be **retained** unless the specific criteria for extraction are met.

11) **Retention** of teeth in the line of fracture reduces the need for open reduction and therefore reduces the cost of treatment and post-operative morbidity.

12) If the tooth in the line of fracture is given the benefit of the doubt more often, it can only be to the patient's advantage and the tooth can always be extracted whereas the opposite does not apply.

APPENDICES

APPENDIX I

THE PRO-FORMA USED FOR COLLECTION OF THE DATA.

P R O F O R M A

SEPSIS WHEN TEETH IN LINE OF FRACTURE WERE EXTRACTED OR RETAINED

Date of injury

1 □ □ □ □ □ □ 6

Date of treatment

7 □ □ □ □ □ □ 12

Case Number

13 □ □ □ 15

Hosp. No: ....

Sex: M=1 F=2 □ 16

Classification: Sec.I □

Sec.II □ 18

PART A: Timing of Treatment

Treated within 24 hours.......... Group 1 □ 19

Treated between 25 and 48 hours.. Group 2 □

Treated between 49 and 96 hours.. Group 3 □

Treated between 4 and 7 days..... Group 4 □

Treated after 7 days............. Group 5 □ 23

PART B: Type of tooth involved in fracture line

Central Incisor ☐ 24

Lateral Incisor ☐

Canine ☐

1st Premolar ☐

2nd Premolar ☐

1st Molar ☐

2nd Molar ☐

3rd Molar ☐ 31

PART C: Age of Patient

Category: 1 : 0 - 19yrs ☐ 32

2 : 20 - 39yrs ☐

3 : 40 - 59yrs ☐

4 : 60 + ☐ 35

Presence/Absence of infection post-operatively

Infection ☐ 36

No Infection ☐ 37

APPENDIX II

LIST OF TABLES

APPENDIX III

LIST OF FIGURES

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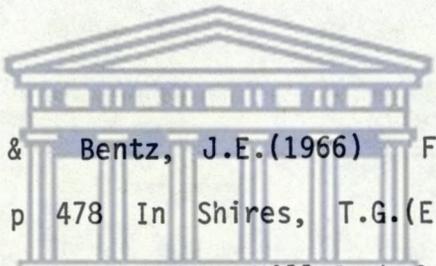
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