

A COMPARISON OF INFECTIVE COMPLICATIONS ASSOCIATED WITH THE TWO TECHNIQUES EMPLOYED IN MINIPLATE OSTEOSYNTHESIS FOR FRACTURES OF THE MANDIBULAR ANGLE

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RESUMO

Foi efectuado um estudo piloto que avaliou uma população de 24 pacientes com fracturas do ângulo da mandíbula, tendo sido incluídos no estudo conforme se apresentaram ou foram referenciados para a Unidade de Cirurgia Maxilofacial dos Hospitais da Universidade de Londres. Trataram-se 4 pacientes do sexo feminino e 20 do sexo masculino, com idades compreendidas entre os 16 e 39 anos.

Os pacientes foram randomizados para cada um dos grupos de tratamento, ambos recorrendo ao uso de fixação intra-oral mas com abordagens cirúrgicas diferentes, ou seja, usando a técnica trans-oral ou a técnica trans-bucal; sendo duas formas de tratamento aceitáveis. O sistema de osteossíntese utilizado foi o Leibinger com recurso a miniplacas de titânio com 2 mm de espessura.

Da amostra, 14 pacientes foram tratados utilizando a técnica trans-bucal e 10 foram tratados com a técnica trans-oral.

Os pacientes foram reavaliados em cada 14 dias durante o primeiro mês, 3 meses após a cirurgia e a partir daí sempre que se justificasse.

Os exames radiológicos pós-operatórios, constituídos por ortopantomografia e raio-x lateral da face, eram efectuados imediatamente após a cirurgia e aos 3 meses de follow-up.

Foi também utilizado, um teste não-paramétrico para avaliação dos grupos e dos resultados de cada uma das suas variáveis.

Este estudo piloto levou-nos a concluir que, embora estatisticamente não seja significativo, parece verificar-se uma tendência ao aparecimento de uma menor taxa de complicações aquando da utilização da técnica trans-bucal.

ABSTRACT

This pilot-study evaluated a population of 24 patients with fractures of the mandibular angle as they present or were referred for treatment at the Maxillofacial Unit at University College London Hospitals. There were 4 females and 20 males with an age range of 16-39 years.

The patients were randomised into one of two treatment groups, these were internal fixation using either the transoral or transbuccal approaches, both of which are acceptable forms of treatment. The osteosynthesis miniplate system used was the Leibinger system which uses 2 mm titanium miniplates.

14 patients were treated via the transbuccal approach and 10 patients with the transoral approach.

Patients were reviewed at fortnightly intervals for the first month, then at 3 months following surgery and then as required.

Post-operative radiographs consisting of an orthopantomogram and postero-anterior (PA) mandible were taken immediately post-operative, and again at 3 months.

A non-parametric test to evaluate the groups for each of the outcome variables was used.

Whilst not statistically significant, there appears to be a trend, towards a lower complication rate for the transbuccal approach.

PALAVRAS-CHAVE

Fracturas ângulo mandíbula, complicações infecciosas, trans-bucal e trans-oral

KEY-WORDS

Mandibular angle fractures, infective complications, transbuccal and transoral.

INTRODUCTION

Treatise on mandible fractures appeared as early as 1650 BC, when an Egyptian papyrus described the examination, diagnosis, and treatment of mandibular fractures and other surgical ailments. Such cases were thought to be incurable and therefore were not treated, with death of the patient a common sequela.

Hippocrates described direct reapproximation of the fracture segments with the use of circumdental wires, similar to today's bridle wire. He advocated wiring of the adjacent teeth with external bandaging to immobilize the fracture. He had the insight to realize that reapproximation and immobilization are paramount in the treatment of mandibular fractures. Many authors and physicians have described the treatment of mandibular fractures. Ideas have varied, but all treatments were subtle modifications of the hippocratic concept of reapproximation and immobilization.

It was not until 1180 that a textbook written in Salerno, Italy, described the importance of establishing a proper occlusion. In 1492, an edition of the book *Cirurgia* printed in Lyons made first mention of the use of maxillomandibular fixation in the treatment of mandible fractures. In 1795, Chopart and Desault described the effects of the elevator and depressor muscles on the mandibular fragments. Chopart was also the first to use dental prosthetic devices in an attempt to immobilize fracture segments.⁷

Through the 1800s and early 1900s, several methods were used to reduce and immobilize mandibular fractures. Although many techniques were advocated in the literature, most were variations of bandaging; extraoral and intraoral appliances; monomaxillary wiring, (including bars, monomaxillary splints, intermaxillary wiring and splints); guides or glides; and internal fixation (including wires, plates and screws).⁷

Today, as in the past the aim of mandibular fracture treatment is the restoration of anatomic form and function, with particular care to reestablish the occlusion.^{5, 10}

STATEMENT OF THE PROBLEMS

Fractures of the mandibular angle represent between 23%¹⁴ and 42%²¹ of all mandibular fractures. This site is also associated with the highest incidence of infective complications following treatment^{1, 11}. However such information is rarely categorised in a way that permits comparison of infection rates following miniplate osteosynthesis at the mandibular angle with those

at other facial fractures sites. Those figures that are discernible from the literature range from 5%-25%^{4, 20}. Following a retrospective audit of 100 consecutive facial fractures treated with miniplate osteosynthesis, our own experience demonstrated a 19% infection rate when mandibular angle fractures were examined in isolation. This complication rate is unacceptably high.

Many aetiological factors have been proposed to explain the high incidence of infection at this site. These include the retention or extraction of partially erupted third molars in or from the fracture line, a higher proportion of open injuries, and increased bone density resulting in relatively reduced vascularity.

Whilst the debate still continues as to the role of the partially erupted third molar in the genesis of infection, the other two variables are essentially beyond influence, and as such, less important. There is another factor that may influence infection rates at this site, namely the technique employed to effect miniplate osteosynthesis following fracture reduction. There are two main approaches, both of which were advocated in Champy's original paper from 1978³. The trans-oral route, in which the plate is placed on the external oblique ridge, and the trans-buccal approach, in which the plate or plates are placed more inferiorly on the buccal cortex, utilising a trochar passed through the cheek.

Retrospective analysis of Maxillofacial Unit – University College London Hospitals data suggests that there is a higher infection rate when trans-oral external oblique ridge plates are used. We are unaware of any published data that specifically investigates this putative relationship between the incidence of infection and the site of plate placement to effect osteosynthesis at the mandibular angle. Both approaches are considered appropriate techniques in the management of mandibular angle fractures. Previous studies have compared internal fixation using one or two plates without difference in outcome.⁴

AIMS OF THE STUDY

1. It is our contention that the mucosal cover afforded to plates placed on the external oblique ridge is relatively poor when miniplate osteosynthesis is used to treat fractures at the mandibular angle. We postulate that flaps heal poorly and/or breakdown when the wound margin is placed over an alloplastic surface. This results in impaired healing and a high rate of infective complications.

2. It is our contention that the better soft tissue

coverage afforded by the trans-buccal approach would reduce the rate of this particular complication in fractures of the mandibular angle.

MATERIAL AND METHODS

PATIENTS

Twenty four dentate patients (age range 16-39, mean = 27.2 years, SD = 6.92 years, F:M = 4:20) with fractures of the mandibular angle were included in this study as they presented or were referred for treatment at the Maxillofacial Unit at University College of London Hospitals.

SURGICAL TECHNIQUE

All had pre-operative radiographs consisting of an orthopantomogram and PA mandible. Each was randomly allocated to either the transbuccal or transoral treatment group. Each underwent open reduction and internal fixation, by either senior registrar or consultant maxillofacial surgeons using the Leibinger titanium 2mm osteosynthesis miniplate system. All third molars in the fracture line were left in-situ unless such teeth had sustained a root fracture, were grossly mobile, or had been affected by pericoronitis¹⁷. All patients were given our standard antibiotic prophylaxis regime:

1g amoxicillin intravenous infusion (I/V) at induction plus 500mg I/V 3 hours post-operatively. If penicillin allergy 300mg clindamycin I/V at induction plus 150mg I/V 3 hours post-operatively.

Time taken to perform the procedure was recorded. Closure was effected using interrupted 3 '0' vycril, without the placement of a wound drain.

FOLLOW-UP

Patients were reviewed at fortnightly intervals for the first month, at 3 months following surgery and then as required. Patients were informed of possible infective complications and asked to return appropriately. Post-operative radiographs consisting of an orthopantomogram and PA mandible were taken immediately post-operatively, and again at 3 months.

During this period patients were observed for clinical and radiographic signs of infection. Patients deemed to have suffered an infective complication would be those who presented with any or a combination of the following:

1 - Erythematous swelling and/or discharge of pus in the buccal sulcus or swelling overlying the

angle of the mandible appearing after the effects of the initial trauma/surgery have settled, (i.e. after 7 days).

2 - Intra-oral wound dehiscence with plate exposure.

3 - Radiographic evidence of loosening of screws, osteomyelitis, fracture non-union.

4 - Persistent infection requiring plate removal.

SCORING SYSTEM FOR INTRAORAL WOUND INFECTIONS

We used the following scoring system, and overt infection was defined as a score of 8 or more.

Scoring system for intraoral wound infections		
Swelling ¹	0 - 3	
Pain ²	0 - 4	
Erythema ³	0 or 5	
Purulent exudate	0 or 10	
Isolation of pathogenic bacteria from the wound ⁴	0 or 10	
Temperature ⁵	0 or 10	
Wound dehiscence	0 or 10	
Total		

¹Swelling: visual assessment will be used;

- 0: no swelling
- 1: minor swelling
- 2: moderate swelling
- 3: great swelling

²Pain: verbal analogue scale will be used;

- 0: absent
- 1: mild
- 2: moderate
- 3: severe
- 4: excruciating pain

³Erythema: 5 given for the presence of extraoral erythema.

⁴Swabs taken only when there is pus and pathogenic bacterial refers to significant growth.

⁵Temperature: 10 is given when the temperature is 37.5C° or more (measured orally).

Information was recorded on an individual patient proforma. On completion, data was analysed and subjected to non-parametric statistical analysis.

Patients presenting with infective complications were managed initially with antibiotics, and if necessary plate removal and wound debridement.

INCLUSION CRITERIA

All patients presenting with one or more facial fractures which included a displaced fracture of the mandibular angle. Diabetic patients were included, but noted.

EXCLUSION CRITERIA

Patients who at presentation had clinical evidence of pre-existing infection at the fracture site.

Patients undergoing immuno-suppressive therapy.

Patients requiring re-operation for post-operative malocclusion.

STATISTICAL ANALYSIS

Non-parametric tests are sometimes known as assumption-free tests because they make no assumptions about the type of data on which they can be used. Most of these tests work on the principle of ranking the data, that is, finding the lowest score and giving it a rank of 1, then finding the next highest score and giving it a rank of 2, and so on. This process results in high scores being represented by large ranks, and low scores being represented by small ranks. The analysis is then carried out on the ranks rather than the actual data. This process in an ingenious way around the problem of using data that breaks the parametric assumptions. However, this ingenuity comes at a price: by ranking the data we lose some information about the magnitude of difference between scores and because of this non-parametric tests are less powerful than the parametric counterparts.⁶

The Mann-Whitney test is used for testing differences between means when there are two conditions and different subjects have been used in each condition.

The Mann-Whitney test works by looking at differences in the ranked positions of scores in different groups. Therefore, the first part of the output summarizes the data after it has been ranked. The Mann-Whitney test relies on scores being ranked from lowest to highest: therefore, the group with the lowest mean rank is the group with the greatest number of lower scores in it. Similarly, the group that has the highest mean rank should have a greater number of high scores within it. Therefore, this initial table can be used to ascertain which group had the highest scores, which is useful in case we need to interpret a significant result.⁶

There are many variations on the Mann-Whitney test; in fact, Mann, Whitney and Wilcoxon all came up with statistically comparable techniques for analysing ranked data. The form of the test commonly taught is that of the Mann-Whitney test. However, Wilcoxon developed a different procedure, which can be converted into

a z-score and, therefore, can be compared against critical values of the normal distribution.

Statistical Package for the Social Sciences (SPSS) provides both statistics and the z-score for the Wilcoxon statistic and is the statistical package used to analyse the results in this study.

SPSS has a column for each variable and in each column there is the value of Mann-Whitney's U statistic, the value of Wilcoxon's statistic and the associated z approximation. The important part of the table is the significance value of the test, which gives the two-tailed probability that the magnitude of the test statistic is a chance result. This significance value can be used as it is when no prediction has been made about which group will differ from which. However, if a prediction has been made then we need to calculate the one-tailed probability.⁶

In this study, age and time of surgery were sufficiently normally distributed to allow the t-test to be used for comparison between infection and non-infection groups.

RESULTS

Twenty four dentate patients with fractures of the mandibular angle were included in this study.

Age showed borderline significance at the 10% level ($\rho = 0.11$), where as time of the surgery had no significant relationship with infection ($\rho = 0.62$).

The other variables were also subject to statistical analysis in relation to infection.

Gender (ρ value = 0.337; exact ρ value = 0.575), past medical history (ρ value = 0.418; exact ρ value = 0.620), 3rd molar (ρ value = 0.448; exact ρ value = 0.653), smoking (ρ value = 0.169; exact ρ value = 0.383), substance abuse (ρ value = 0.655; exact ρ value = 0.833) and fracture site (ρ value = 0.858; exact ρ value = 0.910) showed no statistical relationship to infection.

Alcohol showed borderline significance in relation to infection (ρ value = 0.032; exact ρ value = 0.178). This is at odds with previously reported data (Renton *et al.*, 1996). This probably reflects the small sample size.

From the 24 patients treated in this study 4 (16.6%) developed infection.

Of the 14 patients treated via transbuccal approach only one had infection, a rate of 4.2% of all the patients treated and 7.1% of the transbuccal cohort.

Of the 10 patients treated via transoral approach 3 presented infection, a rate of 12.5% of all the patients treated and 30% of the transoral cohort.



Fig. 1 - Transoral Approach; 4 hole miniplate placed in the external oblique ridge

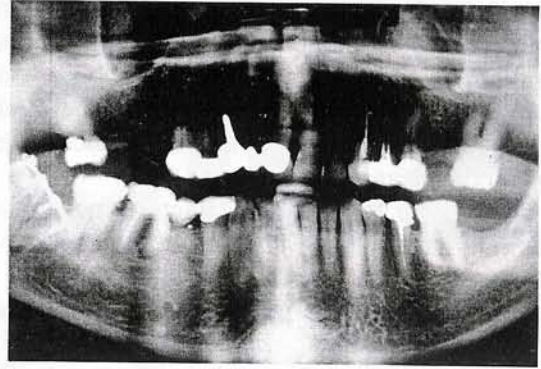


Fig. 2 - Transoral Approach; X-ray



Fig. 3 - Transbuccal Approach; 4 hole miniplate placed in the buccal cortex

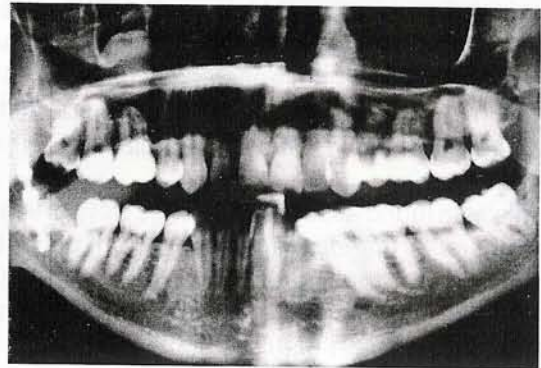


Fig. 4 - Transbuccal Approach; Final X-ray

DISCUSSION

Fractures of the mandibular angle represent between 23% and 42% of all mandibular fractures^{14,21}. This site is also associated with the highest incidence of infective complications following treatment.

In this study age showed a trend toward a significant relationship with infection, the 24 patients had an age range between 16-39 years, M:F ratio (20-4). This demonstrates that the study comprises a cohort primarily composed of young males. This merely representing the demography of this particular condition, rather than an association *per se* between age/sex and infection.

The presence of the 3rd molar in the line of fracture showed no significant impact on infection rates. A third of the cases in this study requiring third molar removal. According to our protocol all third molars in the fracture line were left in-situ unless such teeth had sustained a root fracture, were grossly mobile, or were previously affected by pericoronitis.

Gender, past medical history and smoking showed no significant impact on infection rate.

Although 16 of the 24 patients were smokers (66.6%). The lack of relationship between infection and smoking found there is odds with previous reports of the literature². This again probably reflects the relatively small sample size.

In this study we have defined alcohol abuse as a consumption of alcohol exceeding 21 units/week for females and 28 units/week for males (as per National Governmental Guidelines).

In this study 10 males and 2 females exceeded this limits. However we were unable to demonstrate a statistically significant relationship between excessive alcohol consumption and infective complications. This is not consistent with the findings of other authors, and again represents the small sample size.

Ellis and Walker⁴ described that approximately 60% of patients with mandibular fractures gave a history of chronic alcohol consumption, nonintravenous, and/or intravenous drug abuse.

Substance abuse showed no significance impact on the infection in this study, but this variable should always be considered. The results of a study done by Passeri *et al.*¹⁵ show that intravenous drug users had a 30% rate of complication

(including infection, malunion, malocclusion and neurosensory dysfunction), and chronic non-intravenous drug users and alcoholics had complication rates of 19% and 15.5% respectively. Those individuals who did not abuse substances had a complication rate of only 6%.

Surprisingly, the number of fractures per patient was not associated with risk of postoperative infection as found by previous authors.¹⁹

The mechanism of injury in this study was predominantly assault, represented in 16 of the patients, (66.6%). According to the British Association of Oral and Maxillofacial Surgeons Survey of Facial injuries study⁹ the aetiological profile reveals falls (40%), assaults (24%), other accidents/sports injury (21%), road traffic accident (5%) as the cause of facial trauma. Therefore our figure for assault as the aetiological factor of 66% is much higher than the aforementioned study; but again this may reflect the relatively small sample size.

We also found associated injuries were present in 41.6% of all mandibular angle fracture patients, the majority of these were involved in vehicular accidents, similar figures have been previously reported by Fridrich *et al.*,⁸ Smith,¹⁸ and Fedok *et al.*,⁵

No cases of malunion, non-union or facial deformity occurred. However a number of patients had a relatively small duration of follow-up, range (3-4 months), it may be too early to discount such complication in this group. Koury *et al.*,¹³ and Kearns *et al.*,¹² reported a series with follow-up of 26 months and found a complication rate of 11.5%.

In our study timing of surgery showed no significant impact on infection rate, however several authors have recommended that fractures are reduced and stabilized within 48 hours. To reduce the chance of infection tracking into the fracture^{2, 16}. Naturally, earlier surgery also limits the discomfort to the patient. Late treatment, when the healing process has begun, is associated with poor outcome as it is increasingly difficult to reduce the fracture properly². In general most mandibular fractures in the dentate area should be operated on within 48 hours. This particularly applies if the oral mucosa is lacerated.

Internal semi-rigid fixation affords patients early postoperative movement and a return to function. Early function without maxillomandibular fixation permits better oral hygiene and nutritional intake; access to an oral airway which is of paramount importance in a frequently polytraumatized patient population; reduced prevalence of temporomandibular joint ankylosis associated with long-

term maxillomandibular fixation; and better patient communication⁵. Plate placement in a biplanar orientation is superior to monoplane plate placement when applied to either a monocortical or a bicortical plating technique.⁵

Of the 24 patients treated in this study 4 developed infection, ie an infection rate of 16.6%. If we compare this figure with the previous one from the Maxillofacial Unit Audit of 19%, this is a decrease of 2.4%.

Of 14 patients treated via the transbuccal approach only one developed infection, representing an infection rate of 4.1% of all the patients treated and 7.1% of the transbuccal cohort.

Of the 10 patients treated via the transoral approach 3 presented infection, representing an infection rate of 12.5% of all the patients treated and 30% of all the transoral cohort.

In this study there are trends towards better results with the transbuccal approach versus transoral approach, which may result from a better placement of the plate, better soft tissue cover for the plate, and better bone stock, permitting more secure plate fixation, and therefore immobilisation.

We are aware of not other research that specifically relates the position of plates placement in miniplate osteosynthesis for mandibular angle fractures. From the above results we are confident that with larger numbers we will be able to demonstrate a significantly lower complication rate when the transbuccal approach is adopted over the transoral approach.

CONCLUSION

In this study we have shown that the key to success are: fixation of the plate in the region of optimal stress; good mucosal coverage; suppression of infection related to the presence of the mandibular third molar; and systematic prescription of antibiotics.

The results in relation to demographic variables were consistent with other authors findings. The small number of patients included in this study, don't allow us to draw hard and fast conclusions from them.

We found a post-operative and three month orthopantomogram and PA mandible a useful manoeuvre to adequately assess the healing process, quality of bone and position of the plates.

A three month follow-up was adopted in this study. However it may be more reasonable to follow these patients for 1 year to detect later

complications ie non-union, malocclusion and facial deformity. However we appreciate the difficulties that can arise from long term follow-up in this patient group. However study had an unusual follow-up profile, with 100% return rate to the outpatient appointments.

The protocol used for the extraction of third molar in the fracture line seems to be reasonable and should be considered in the surgical approach to this kind of fracture.

In this study there were trends towards better results with the transbuccal approach versus transoral approach, using one four hole 2 mm titanium miniplate.

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