

## Postoperative Complications in the Lower Jaw in Trauma Patients

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### Abstract

**Background:** Postoperative infections and wound complications are among the main complications of any surgical treatment. Knowledge of patient-specific factors in cases of wound healing disorder, which can ultimately lead to failure of fixation, would allow such complications to be counteracted.

**Methods:** A search of operation records for the period 2005 to 2010, for mandibular fractures treated by open reduction and internal fixation, identified 450 suitable patients. Patient-specific details, such as age, gender, immunosuppression status (diabetes and drug immunosuppression), smoking status (self-declaration), alcohol consumption status (self-declaration), location of the fracture (after Miloro et al.), and the circumstances of the accident, if applicable, were recorded and categorised. As postoperative complications, wound dehiscence, infections related to loosened osteosynthesis material, pseudarthrosis, and osteomyelitis were examined and documented.

**Results:** Of the total number of patients, 348 (77.3%) were male and 102 (22.7%) were female, with a median age of 34.3 years. Thirty-eight patients showed wound healing complications (8.4%). Of these, 14 presented with wound dehiscence (3.1%), 4 with osteomyelitis (0.8%), 13 with pseudarthrosis (2.8%), and 7 suffered from infections related to osteosynthesis material (1.5%). The most common fractures were in the paramedian and median region (n=259, 37%), followed by the ascending branch (n=197, 28.1%) and the angle of the mandible (n=172, 24.6%). The most common causes of injury (where they could be determined) were assaults (33.6%), followed by falls (24.9%) and traffic accidents (15.6%). Twenty-seven (6%) patients were immuno-compromised, largely due to diabetes type I or II. In addition, 152 (33.8%) patients were

smokers with a consumption of more than 5 pack-years. Regular, i.e. daily, alcohol consumption was recorded in 31 (6.9%) patients. In the treatment of wound healing disorders, three treatment modalities could be distinguished: local therapy with irrigation and close follow-up (nine cases: eight of wound dehiscence and one infection related to loosened osteosynthesis material), local wound therapy (curettage) and extension of antibiotics (seven cases: six of wound dehiscence and one of pseudarthrosis), and surgical revision with re-osteosynthesis and prolonged antibiotics (21 cases: 4 of osteomyelitis, 12 of pseudarthrosis, and 5 infections related to loosened osteosynthesis material).

**Conclusions:** In our study, only the regular consumption of alcohol was associated with a significantly increased risk of wound healing failure. In immuno-compromised patients and patients with regular nicotine consumption, a trend towards this result was observed. Although one might expect a decreased potential for healing with increasing age, we found no statistical relationship between postoperative infection and age. In our patient population, antibiotics were administered in each case for a period of 5 to 7 days.

**Keywords:** Postoperative complications; Wound complications; Wound healing disorder; Wound dehiscence; Osteosynthesis

### Introduction

The field of traumatology has undergone significant development over the past three decades, evolving from mainly conservative treatment, especially during the era of the two world wars, to the development of plate osteosynthesis and predictable and stable treatment options [1-3]. Alternative treatments in some cases still include conservative therapy, as well as different methods for treating the occlusion, without

internal or external osteosynthesis to follow [4]. Fractures of the face often result from physical altercations and traffic or sports accidents [5]. Fractures of the cheekbone and jaw, along with nasal bone fractures (which are usually underrepresented in the literature) represent the most common fractures of the face due to the exposed position of the involved structures [5]. Tension in the masticatory muscles may also lead to secondary dislocation and displacement of these fractures. Furthermore, bilateral fractures of the condylar process may lead to increased width of the dental and mandibular arch. With purely conservative repositioning and retention measures, this tendency is hard to counteract [6].

Depending on the external force applied and particular characteristics of the region on which it acts, different types of wound can be distinguished. Mechanical wounds are caused by direct or indirect external trauma. Chemical wounds arise due to the action of (usually) liquid, and sometimes gaseous, substances contacting the skin or mucous membranes. Wound bleeding, soreness, and inflammation are commonly seen in wound healing. Intact soft tissue is a prerequisite for successful fracture healing and therefore is directly associated with the acting injurious agent. The sequence of events in wound healing is modified by a variety of factors that, depending on the circumstances, may be therapeutically influenced and include the type of wound, size of the defect, extent of tissue damage, contamination level, inflammatory condition, circulatory conditions and, particularly, the part of the body affected (as well as general factors, such as health and nutritional status, age, hormonal influences, and chronic treatment with certain medications (including corticosteroids, cytostatics, and immune-suppressants) [7].

Postoperative infections and wound complications, such as haematoma, seroma, necrosis of the edge of the wound, and unacceptable scarring, are the main risks associated with any surgical treatment [8]. The causes of these complications can be both general (age, anaemia, metabolic disorders, lack of substrate, and effects of drugs) and local (foreign substance, suture stress, infection, and radiotherapy). Nevertheless, with adequate wound and post-treatment care, a high proportion of undisturbed wound healing outcomes may be expected [7]. Knowledge of patient-specific factors in cases of wound healing disorder, which can ultimately lead to failure of fixation, would allow the above problems to be counteracted.

## Material and Methods

The operation records of the Department of Oral and Maxillofacial Surgery of University Hospital Zurich, for the period 2005 to 2010, were searched for cases of mandibular fracture that had been treated by reduction and internal fixation.

To allow further processing, the results were entered into an Excel spreadsheet (Microsoft Corp., Redmond, WA, USA). The guidelines of the Declaration of Helsinki were adhered to for all data collection procedures.

The resulting patient and surgical data were then compared with the original operation protocols and verified. Data relating to pre- and postoperative treatment were augmented by

processing of the electronic health records (KISIM; Cistec AG, Zurich, Switzerland and VITODENT) and extraction of patient-specific details.

The following criterion was used to decide whether a patient should be included in the wound healing disorder patient group: history of complications in the medical records, e.g. wound dehiscence, infection due to loosened osteosynthesis material, pseudarthrosis, or osteomyelitis.

A total of seven variables with potential effects on wound healing were defined, as follows: age, gender, immune-compromisation status (based on diabetes and drug immunosuppression status), smoking (>5 pack-years), daily alcohol consumption, localisation of fractures (after Miloro et al.) [4] and multifragmentary fractures (two or three fractures). Likewise, patients were classified into subgroups according to the cause of injury.

Comminuted fractures and fractures with defect zones were treated with reconstruction plates in accordance to the load-bearing principle. Fractures of the mandibular angle were fixed with a Champy plate in cases with fracture lines running from upward posterior to downward anterior and appropriate apposition surface of the fragments. In all other cases of not comminuted and missing defect zone, one plate was placed in the crestal region and one in the basal region of the mandible. Two systems were applied, namely the Synthes mandible system and/or recon system (Synthes, Zurich, Switzerland) and the medartis system (Medartis, Basel, Switzerland).

Statistical analysis was performed using the SPSS software package (ver. 21.0; IBM Corp., Armonk, NY, USA). Cross tables were and descriptive statistics were generated. Statistical significance was defined as a p-value  $\leq 0.05$  based on the chi-squared test according to Fisher. A p-value  $\leq 0.1$  was interpreted as indicating a trend towards significance. Patient data were completely encrypted for the purposes of the statistical analysis.

## Results

Between 2005 and 2010, we found that 450 patients had been treated for mandibular fractures by open reduction and internal fixation (ORIF). Of these, 348 (77.3%) were male and 102 (22.7%) were female. The median patient age was 34.3 years, with the oldest and youngest patient being 90.5 and 13.3 years of age, respectively. Of the 450 patients, 38 (8.4%) had a wound healing disorder. Fourteen patients had a wound dehiscence (3.1%), four presented with osteomyelitis (0.8%), thirteen presented with pseudarthrosis (2.8%), and seven suffered from infections related to osteosynthesis material (1.5%). These patients were slightly older, with a median age of 38.6 years. Of these patients, 81.6% were male and 18.4% were female. Table 1 details the locations of the mandibular fractures.

The most commonly affected areas were the paramedian and median region (37%), followed by the ascending branch (28.1%) and the angle of the mandible (24.6%). A total of 700 fractures were counted in 450 patients.

Overall, 215 (47.7%) patients suffered simple fractures, 220 (48.8%) had a double fracture, and 15 (3.3%) had three

fractures. Analysis of wound healing per number of fractures showed the following rates: 7.9% success rate (17/215) for single fractures, 9.1% success rate (20/220) for double fractures, and 6.7% success rate (1/15) for three fractures.

**Table 1:** Number of mandibular fractures by location.

Location	Frequency	Percentage
Socket and joint head	45	6.4
Collum, ascending branch and processus coronoideus	197	28.1
Mandibular angle	172	24.6
Corpus	27	3.9
Paramedian und Median	259	37
Total	700	100

The most common causes of injury in this study were assaults (33.6%) and falls (24.9%), followed by traffic accidents (15.6%). Twenty-seven (6%) patients were defined as immune-compromised due to the presence of diabetes mellitus type I or II, and one patient was in receipt of immunosuppressive medication. One-hundred-and-fifty-two patients, (33.8%) were smokers with a cumulative consumption of at least 5 pack-years. Daily alcohol consumption was determined *via* interview or from the medical records of 31 patients (6.9%).

The data presented in Table 2 show that the only factor significantly associated with wound healing outcome was alcohol consumption, while there were trends towards an association with immune-compromisation and smoking status.

Three treatment modalities for wound healing disorders were distinguished: local therapy with irrigation and close follow-up (nine cases: eight of wound dehiscence and one infection related to loosened osteosynthesis material), local wound treatment and extension of the antibiotics (eight cases: one of wound dehiscence, one of pseudarthrosis, and six of swelling), and surgical revision by curettage with re-osteosynthesis and continuation of antibiotic therapy (21 cases: 4 of osteomyelitis, 12 of pseudarthrosis, 3 infections related to osteosynthesis material, and 2 cases of swelling). Antibiotic therapy was administered for a period of 5 to 7 days in all patients. In most cases, this was a combination of amoxicillin and clavulanic acid (Augmentin®; CH). Alternatively, when penicillin allergy or intolerance was noted, clindamycin (Dalacin®; CH) was administered over a period of 5 to 7 days.

In the four cases of osteomyelitis, intermaxillary fixation (IMF) using IMF screws or circumdental wiring was applied, after which revision of the fracture-line was performed (in one case including wider decortication) together with removal of previously implanted plates and screws. Re-osteosynthesis was performed after thorough cleaning of the region. Antibiotics and

analgesics were administered in conjunction with the surgical treatment.

**Table 2:** The p-values for associations between all included variables and occurrence of wound healing disorder (significant= $p>0.05$ ).

	Wound healing disorder
Age	0.564
Sex	0.686
Immunosuppression status	0.058
Smoking status	0.074
Alcohol status	0.010
Two fractures	0.707
Three fractures	0.823

In cases of pseudarthrosis (13 cases), granulation tissue was removed and re-osteosynthesis performed, after IMF using IMF screws or circumdental wiring in conjunction with antibiotics for 1 to 3 weeks (Figures 1-4).



**Figure 1:** Pseudarthrosis 6 months after open reduction and internal fixation. Note retention of the wisdom tooth during initial surgery and use of short plates.



**Figure 2:** Spongy bone harvested from the iliac crest.

Seven cases were associated with infections related to loosened osteosynthesis material, of which four had classic infections, two were due to a plate fracture, and one was due to a swab that had been left in place intraoperatively. The treatment was IMF using IMF screws or circumdental wiring, removal of the old plates and screws, and re-osteosynthesis in conjunction with antibiotics for 1 week.



**Figure 3:** Surgical revision of pseudarthrosis with spongy bone and placement of new load bearing plates. Wisdom tooth was removed.



**Figure 4:** Stable patient free from signs of infection at 8 months after plate removal.

We found no statistically significant differences between the two plate systems and no differences between two or one plate in mandibular angle fractures.

## Discussion

The average age of our patients was 34.5 years. This accords with previous publications for non-selectively analysed patient population [9]. The main causes of facial fracture in younger patients are violent incidents and traffic accidents [10]. In general, such fractures are more prevalent in patients aged between 20 and 30 years [11,12]. Although decreased healing potential might be expected with increasing age, we were unable to find a statistical relationship between the postoperative infection rate and age of the patients [13].

The ratio of male to female patients with surgically treated mandibular fractures in the current study was about 4:1 (77.3:22.7%). In comparison, Kyrgidis et al. [12] reported that 81% of their cases were male.

In our group of immunocompromised patients, a trend towards an association between compromised immunity and infection was detected ( $p > 0.058$ ). In a study of liver transplant patients with immunosuppression and subsequent dental implants, all implants were still present and in good periodontal condition after 3 years. This indicates that there is a functioning defence system protecting soft tissue from microbial stressors, even under conditions of immunosuppression [14]. In this group of patients, proper oral hygiene is essential. In the future, it might be useful to extend the analysis to a larger cohort to increase the statistical validity of our results.

Although nicotine consumption by inhalation showed a trend towards an association with wound healing failure, no statistical significance was detected. The effects of nicotine inhalation occur *via* microcirculatory disturbances [15]. In other studies, smoking was considered a significant risk factor for postoperative wound healing complications [16].

With a  $p$ -value  $< 0.01$ , daily alcohol consumption was the only factor in our study associated with a statistically significant increased risk of wound healing failure. This association was also found in other studies [16,17]. The mechanism of action may involve suppression of angiogenesis, which leads to various stress situations within the wound, thus compromising the proliferative phase of wound healing. Smokers are four times more likely to be alcohol-dependent than non-smokers, which shows the strong association between these two types of substance abuse [18].

Of the total number of who had a double fracture experienced wound healing complications, while for those with triple fractures the incidence rate was 6.7%. This result is in contrast to Cabalag et al. who reported that 13.8% of their cases with postoperative complications had a significantly ( $p < 0.001$ ) increased probability of multiple fractures leading to postoperative infection [19].

In the present study, fractures were divided into three types: socket to the ascending branch (34.1%), mandibular angle (23.1%), and body to symphysis (42.8%). This distribution corresponds to the usual proportions for a Western country. Whether or not the fracture was located in the tooth-bearing part of the mandible was not associated with the rate of infection in our study, although this has been described in other studies [20].

In our cohort, assaults were the most common cause of mandibular fractures, accounting for 33.6% of all the fractures; this was followed by falls (24.9%), traffic accidents (15.6%), and sports accidents (8.4%). However, the cause, of injury *i.e.*, (assault, fall, or traffic accident), was not associated with the rate of wound healing complications [21].

Prolonged prophylactic antibiotic treatment was administered in each case of ORIF; consequently, the postoperative infection rate, of 8.2%, was relatively low. In other studies, however, no difference was detected in the rate of infection between patients with and without prophylactic antibiotic treatment [22,23]. The rate of wound healing complications in our study is comparable to that of Deprich et al. who reported a complication rate of 8.9% (and where infections were the most common complication) [24]. Cabalag et al. reported among all the facial fracture cases in their study, the lower jaw was the region that developed an infection most frequently during the postoperative period [19]. This lends credence to our study, since it deals exclusively with the most common localisation of wound healing complications.

In our study, only alcohol consumption was significantly associated with postoperative infection, although there was a trend towards an association for immune-compromisation and nicotine consumption. However, no association was found

between the thickness of the applied plate and postoperative infection.

Further examination of the significance of the factors discussed in this study for wound healing outcome would be of interest. Multi-centre collaborations should be performed to access larger databases.

## Conclusion

This study shows that among all of the tested factors, only regular alcohol consumption was associated with a significantly increased risk of wound healing complications, although there was a trend towards an association with immune-compromisation and regular nicotine consumers. Although decreased healing potential with increasing age might be expected, we found no statistical relationship between postoperative infection rate and age. Among our patient population, antibiotics were administered for all each cases.

## Conflict of Interest

All authors declare that they have no financial or personal relationships with other people or organisations that could inappropriately influence (bias) this work.

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