Complications associated with open reduction using miniplate fixation of maxillofacial fractures

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Abstract

**Aims:** The aim of this retrospective study was to evaluate the postoperative complications associated with mandibular, maxillary and midface fracture treatment with open reduction using miniplate fixation.

**Material and methods:** This study is a retrospective review from January 1, 1998, through December 31, 2002, of the records of patients treated for maxillofacial fractures with open reduction using miniplate fixation at the Departments of Oral and Maxillofacial Surgery Karolinska University Hospital, Huddinge and the Central Hospital of Falun, Sweden. Postoperative complications were assessed by reviewing the patient records and radiographs. Complications were classified by infection, malocclusion and others. The total number of patients included in this study was 88.

**Results:** Infection was the most common postoperative complication affecting 19 patients. The majority of mandibular fractures associated with infection in need of revision surgery were located in the body or symphyseal area. Malocclusion was presented in twelve cases. In total 22 out of 175 miniplates were removed. Maxillary and midface fractures showed only few complications and four plates were removed from these locations.

**Conclusions:** The most frequent postoperative complication in maxillofacial trauma was infection. Infection was exclusively found in the mandible. In maxilla and midface postoperative complications were seen very seldom. Plate fracture was a very uncommon complication.

**Keywords:** open reduction, miniplate fixation, maxillofacial fractures, complications.
Introduction

The prevalence of maxillofacial fractures has been studied thoroughly (Bataineh 1998, Aksoy et al 2002, Ortakoglu et al 2004, Gomes et al 2006). Fractures of the mandible are the most prevalent and constitute about 50-70% of all maxillofacial fractures (Bataineh 1998, Ortakoglu et al 2004, Erol et al 2004, Kelley et al 2005). As regards the mandible, many studies have showed that the angle and parasympyseal regions are the predominant fracture sites (Valentino and Frederic 1994, Renton and Wiesenfeld 1996, Matthew and Frame 1999, Moreno et al 2000, Lamphier and Ziccardi 2003, King et al 2004). However, looking also at fractures that are not operated, the most prevalent mandibular fracture is the one involving the condylar neck (Heimdahl and Nordenram 1977, Ström and Hultin 1995).

In most studies the predominant cause of injury for maxillofacial fractures is interpersonal violence (Matthew and Frame 1999, Schön and Roveda 2001, Ogundare and Bonnick 2003). It has also been shown that interpersonal violence as a cause of injury has increased regarding mandibular fractures (Van Beek et al 1999). It seems to be especially true for urban settings. Traffic is another major cause of injury in the Western world (Ellis 1999, Lamphier and Ziccardi 2003, Fasola and Obiechina 2003). Studies based on Swedish patient materials (Heimdahl and Nordenram 1977, Ström and Hultin 1995, 1996) show similar findings. Hand in hand with the cause of the injury is often the socioeconomic situation of the patient (Ogundare and Bonnick 2003). Those injured by interpersonal violence may also sometimes exhibit poor compliance, unwillingness to perform appropriate home care and a high incidence of
substance abuse (Ogundare and Bonnick 2003) and inadequate nutrition. In these patients conservative treatment is often not realistic and open reduction with osteosynthesis may therefore be the only choice.

The goals of maxillofacial fracture treatment have always been restoration of the anatomical form and function with special respect of the preinjury occlusion and facial aesthetics. The treatment of maxillofacial fractures has undergone a gradual evolution and over the years many techniques have been introduced. Before the introduction of antibiotics the method of choice was mainly conservative treatment using maxillomandibular fixation (MMF). Open reduction was rarely performed and if so, limited to wire osteosynthesis (Ellis 1993). Later, miniplate and lag screw techniques were introduced (Ellis 1993) and there are now different variants of miniplate fixation. The first system for internal fixation of facial trauma was introduced by Champy and Lodde in 1976. This was a modification of the method described by Michelet et al in 1973. Later the so-called AO/ASIF (Arbeitsgemeinschaft fur Osteosynthesefragen/ Association for the Study of Internal Fixation) concept appeared. The development of the systems has meant a change in the treatment panorama.

Compared with conservative management, the most obvious advantage with open reduction using miniplate fixation is that long time MMF can be avoided postoperatively. Moreover, the rigid fixation may better resist the forces of the masticatory muscles and it has been suggested, although not proven that it should improve bony healing resulting in a more rapid return of function (Cawood 1985, Rahn 1989). The patients are also more often able to resume normal life earlier. An early recovery to masticatory function
also reduces the risk of temporomandibular joint (TMJ) ankylosis, especially in cases associated with condylar fractures. Open reduction using miniplate fixation also reduces possible side effects such as respiratory difficulties, poor oral hygiene, periodontal damage, impaired nutrition, speech difficulty and a nonaesthetic appearance of the patient. In a number of patients it has still been necessary to later remove the plates and this might be considered as a disadvantage. Routine removal of the osteosynthesis material has been debated over the years (Nakamura et al 1994, Mosbah and Oloyede 2003). The use of the highly biocompatible titanium miniplates may decrease tissue reaction. The current trend is to use more of titanium alloy miniplates instead of stainless steel and only remove them when symptoms occur (Brown and Ward-Booth 1989, Matthew and Frame 1999, Bhatt and Langford 2003, Mosbah et al 2003).

Despite the listed possible complications, osteosynthesis with miniplates is the most widely used method for treatment of maxillofacial fractures and with the exception of condylar fractures is now regarded as the “golden standard”. However, open reduction using miniplate fixation has also demonstrated complications different from those associated with conservative treatment. Such complications may be infection, nerve damage, wound dehiscence, discomfort, intolerance to cold, hypertrophic scar formation and damage to the dental roots. It has also been showed that open reduction is the only significant variable among others for increased risk of infection (Stone et al 1993).

Compared to other maxillofacial fractures, mandibular fractures are more often associated with complications, in regard to fracture healing
One reason for this may be unfavourable muscle contraction and great loading forces on the fragments. The most common fractures that become subject for miniplate osteosynthesis treatment are comminute and multiple fractures of the jaws, great instability, those showing dislocation of the bony segments and fractures associated with midface disjunction. Also fractures in edentulous jaws, are with advantage treated with miniplate fixation (Iatrou et al 1998). The occlusion in edentulous jaws can be stabilized preoperatively by using surgical guides or splints. It is also possible to achieve stable intermaxillary relation by using bone anchored fixations screws. Other indications for open reduction may be the above mentioned poor patient compliance. Some studies have been published regarding complications associated with open reduction using miniplate fixation of jaw fractures (Renton and Wiesenfeld 1996, Moreno et al 2000, Lamphier and Ziccardi 2003, Murthy and Lehman 2005, Furr et al 2006). However, no such study has emerged in Sweden. There are inherent problems with retrospective studies such as inconsistencies between different surgeons and lack of defined evaluation criteria. This study was therefore focused on infection and other sequela related to the insertion of miniplates.

The aim of this retrospective study was to evaluate the postoperative complications associated with mandibular, maxillary and midface fracture treatment with open reduction using miniplate fixation. It aimed also to give a base for future prospective trials. Postoperative complications, fracture location and cause of injury were also registered, as the frequency and type of complications.
Material and Methods

Patients

This study is a retrospective review from January 1, 1998, through December 31, 2002, of the records of patients treated for mandibular, maxillary and midface fractures with open reduction using miniplate fixation at the Departments of Oral and Maxillofacial Surgery Karolinska University Hospital, Huddinge and the Central Hospital of Falun, Sweden. The patient’s charts, operative reports and both pre- and postoperative radiographs were assessed for all patients registered and treated for fracture of mandible, maxilla and midface during the study period. All the patients treated with open reduction using miniplate fixation for maxillofacial fractures were included. None of the clinics treat patients with neurocranial trauma explaining the lack of these patients in the present material.

The minimum follow-up period required for inclusion in the study was three months at the clinic that operated the patient. All fractures that were treated conservatively by closed reduction only, as isolated condylar neck fractures, solid fractures without dislocation or instability were excluded from this study.

A total of 88 patients met the inclusion criteria, 64 men and 24 females (ratio: 2.7 to 1). The males ranged in age from 15 to 91 years, with the mean age of 36.4 years and the females from 18 to 88 years, with the mean age of 51.8 years. There were no children and only few teenagers in our material. They were with only occasional exceptions treated conservatively. Age and sex distribution is shown in Figure 1.
The anatomical locations and total number of fractures (162) were classified in subgroups as registered in Table 1. One hundred and twenty five (77.1%) of them were located in the mandible. Seventeen were located in the maxilla (10.5%) and 20 (12.3%) in the midface area (Table 1).

**Table 1.** Anatomical distribution of all fractures registered. Figures are no. of fractures at each location (%).

<table>
<thead>
<tr>
<th>Anatomical site</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandible</td>
<td>125 (77.2)</td>
</tr>
<tr>
<td>Maxilla</td>
<td>17 (10.5)</td>
</tr>
<tr>
<td>Midface</td>
<td>20 (12.3)</td>
</tr>
<tr>
<td><strong>Fractures in total</strong></td>
<td><strong>162 (100)</strong></td>
</tr>
</tbody>
</table>

The anatomical classifications of the mandibular fractures were defined as shown in Figure 2. The most common fracture site in the mandible was the body, 43 (34.4%), followed by the angle, 34 (27.2%), the symphysis 24 (19.2%), the condylar neck 22 (17.6%) and the condyle 2 (1.6%) (Table 2).
The location of maxillary and midface fractures were defined as the specific anatomical structures involved (Table 3). Soft tissue injuries were not recorded. Fifty eight patients (65.9%) presented multiple fracture sites. Thirteen patients had no mandibular involvement. Midface fractures all involved several bones.

Figure 2. Definitions of the anatomical regions registered for mandibular fractures. The symphysis was defined as the mandibular midline.

![Diagram of mandible showing anatomical regions](image)

Table 2. Anatomical distribution of the mandibular fractures registered. Figures are no. of fractures registered at each location (%).

<table>
<thead>
<tr>
<th>Anatomical site</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body</td>
<td>43 (34.4)</td>
</tr>
<tr>
<td>Angle</td>
<td>34 (27.2)</td>
</tr>
<tr>
<td>Symphysis</td>
<td>24 (19.2)</td>
</tr>
<tr>
<td>Condylar neck</td>
<td>22 (17.6)</td>
</tr>
<tr>
<td>Condyle</td>
<td>2 (1.6)</td>
</tr>
<tr>
<td><strong>Mandibular fractures in total</strong></td>
<td><strong>125 (100)</strong></td>
</tr>
</tbody>
</table>
Table 3. Anatomical distribution of maxillary and midface fractures registered. Figures are no. of fractures registered at each location (%).

<table>
<thead>
<tr>
<th>Anatomical site</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LeFort I</td>
<td>10 (27.0)</td>
</tr>
<tr>
<td>LeFort II</td>
<td>6 (16.2)</td>
</tr>
<tr>
<td>LeFort III</td>
<td>1 (2.7)</td>
</tr>
<tr>
<td>Maxillary sinus wall</td>
<td>6 (16.2)</td>
</tr>
<tr>
<td>Zygoma</td>
<td>6 (16.2)</td>
</tr>
<tr>
<td>Infraorbital rim</td>
<td>3 (8.1)</td>
</tr>
<tr>
<td>Nose septum</td>
<td>1 (2.7)</td>
</tr>
<tr>
<td>Maxillary alveolar ridge</td>
<td>3 (8.1)</td>
</tr>
<tr>
<td>Frontozygomatic suture</td>
<td>1 (2.7)</td>
</tr>
<tr>
<td><strong>Maxillary and midface fractures in total</strong></td>
<td><strong>37 (100)</strong></td>
</tr>
</tbody>
</table>

The causes of injury were interpersonal violence 40 (45.5%), falls 21 (23.9%), traffic 18 (20.4%), sports 5 (5.7%), other 4 (4.5%) (Table 4).

Interpersonal violence presented a great part of the causes to injury, especially in the male population. 21 out of these 40 cases showed angular or condylar neck fracture on one side and simultaneous body fracture on the same or opposite side. The distribution of the fracture location after interpersonal violence is shown in Figure 3.
Table 4. The distribution of gender and the cause of fractures registered. Figures are no. of patients in each category (%).

<table>
<thead>
<tr>
<th>Cause</th>
<th>No. of males (%)</th>
<th>No. of females (%)</th>
<th>Total no. of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpersonal violence</td>
<td>38 (59.3)</td>
<td>2 (8.3)</td>
<td>40 (45.5)</td>
</tr>
<tr>
<td>Falls</td>
<td>11 (17.2)</td>
<td>10 (41.7)</td>
<td>21 (23.9)</td>
</tr>
<tr>
<td>Motor vehicle accidents</td>
<td>3 (4.7)</td>
<td>6 (25)</td>
<td>9 (10.2)</td>
</tr>
<tr>
<td>Bicycle related injuries</td>
<td>6 (9.4)</td>
<td>3 (12.5)</td>
<td>9 (10.2)</td>
</tr>
<tr>
<td>Sports injuries</td>
<td>4 (6.3)</td>
<td>1 (4.2)</td>
<td>5 (5.7)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (3.2)</td>
<td>2 (8.3)</td>
<td>4 (4.5)</td>
</tr>
<tr>
<td>Total for column</td>
<td>64 (100)</td>
<td>24 (100)</td>
<td>88 (100)</td>
</tr>
<tr>
<td>Overall ratio</td>
<td>64/88</td>
<td>24/88</td>
<td>88 (100)</td>
</tr>
</tbody>
</table>

Figure 3. The distribution of fracture sites in cases of interpersonal violence. Total no. of patients is 40.
Fracture fixation

Fracture treatment was done under general anaesthesia in all cases. The mean time elapsed from injury to operation for the whole material was 3.3 days. The premorbid occlusion and MMF was achieved through application of arch bars or eye-lets (Fordyce et al 1999). Edentulous patients were treated without the use of surgical guides or splints. An intraoral approach for fracture exposure was used in all cases. After use of local anaesthesia the incision was made and the periosteum was then elevated, exposing the fracture sites. After repositioning and fracture closure noncompression miniplates were inserted and secured with monocortical self-tapping screws. In total, 175 osteosynthesis miniplates were inserted. The MMF was then released and both the occlusion and the stability of the fracture were rechecked. Primarily, no MMF was used postoperatively. However, some patients with e.g. simultaneous condylar neck fracture, required closed reduction and postoperative MMF. Some patients required postoperative occlusal guidance with elastics to achieve good occlusion.

All patients received prophylactic antibiotics with intravenous injection of 3g bensylpenicillium in a single dose before the start of operation. If infection occurred preoperatively it was treated with intravenous injection of bensylpenicillium 3g three times a day or clindamycin 600mg three times a day. Postoperative infections were treated with oral V-penicillium 1g three times a day or oral clindamycin 150mg three times a day for 7-10 days. All patients were instructed to maintain a soft diet for 30-45 days. If a revision surgery was necessary to remove osteosynthesis material, it was, in the most
cases done in local anaesthesia. If the revision surgery was necessary because of mal-union or non-union it was done under general anaesthesia. All the patients were treated by oral and maxillofacial surgeons or residents in training supervised by a consultant.

*Evaluation of postoperative complications*

The postoperative complications were classified as follows: infection, malocclusion and others. Complications as plate fractures, palpable plates and screws, plates interfering with subsequent treatment and plate removals of patients request were included in the group “others”. Needs of revision surgery and removal of the osteosynthesis material were also evaluated. These parameters were defined as follows: if clinical and/or radiological signs of infection were present, if the occlusion did not fit properly and if the surgical wound did not close. Clinical and/or radiological signs of non-union or mal-union, if the patients had revision surgery and registration of removal of osteosynthesis material during revision surgery were registered. The number of times the patient met to check-up the treatment performed was also registered.

The complications registered were divided in two subgroups; minor and major complications. All complications related to infections and later removals of osteosynthesis material were classified as major. Also need of extensive malocclusion treatment and plate fractures were classified as major. Infections treated by oral antibiotics only and less extensive malocclusions as well as plate removals because of subjective reasons were classified as minor complications.
The patients were divided in subgroups dependent on the complications and the number of times of postoperative check-ups was registered for each subgroup (Table 5).

**Table 5.** Patients were divided by postoperative complications and the number of times of postoperative check-ups were registered for each subgroup.

<table>
<thead>
<tr>
<th>Kind of complication</th>
<th>Mean (no.)</th>
<th>Range (no.)</th>
<th>Patients (no.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infections treated with antibiotics only</td>
<td>7.3</td>
<td>3-13</td>
<td>n=6</td>
</tr>
<tr>
<td>Infections resulting in plate removal</td>
<td>9.8</td>
<td>4-17</td>
<td>n=13</td>
</tr>
<tr>
<td>Plate removals of other reasons</td>
<td>7.1</td>
<td>3-16</td>
<td>n=9</td>
</tr>
<tr>
<td>Malocclusions</td>
<td>7.8</td>
<td>3-17</td>
<td>n=12</td>
</tr>
<tr>
<td>No complications at all</td>
<td>5.3</td>
<td>1-12</td>
<td>n=51</td>
</tr>
<tr>
<td><em>Overall</em></td>
<td>6.1</td>
<td>1-17</td>
<td></td>
</tr>
</tbody>
</table>
Results

In total 41 complications were registered in 37 patients. All the complications manifested in this study were summarized in Table 6. Most of the complications were found in the mandible, while maxillary and midface fractures showed only few minor complications. Age distribution and kind of complications is summarized in Figure 4.

Table 6. All the complications manifested in this study. The total number of patients with complications were 37. Note that a patient can exhibit more than one complication. Figures are no. of patients.

<table>
<thead>
<tr>
<th>Complications</th>
<th>Fracture site</th>
<th>Mandible</th>
<th>Maxilla</th>
<th>Midface</th>
<th>Total no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Malocclusion</td>
<td>12*</td>
<td>1*</td>
<td>0</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>37*</td>
<td>4*</td>
<td>1</td>
<td>41</td>
<td></td>
</tr>
</tbody>
</table>

* In one case with bimaxillary fractures, it was not possible to determine the origin to malocclusion.

Figure 4. Complications summarized by age distribution. Figures are no. of patients.
**Infection**

Infection was the most common complication affecting 19 patients and was exclusively associated with mandibular fractures (*Table 6*). All the infected patients were treated by oral antibiotics, mostly with 1g oral V-penicillium three times per day, but 13 patients also needed a revision surgery with removal of osteosynthesis material. Nine out of these 13 infected cases were caused of interpersonal violence. The majority of mandibular fractures associated with infection that needed reoperation were located in the body or symphyseal area (*Figure 5*).

![Figure 5](image)

**Figure 5.** Fracture site correlated to postoperative infection that needed revision surgery (total no. 13).

Four of the infected fractures showed no fracture healing at the revision surgery. In one case a second revision surgery was necessary because there was no bony healing. Wound dehiscence with plate exposure was seen in one case. No clinical signs of infection were present in this case but it was anyhow considered as an infection. After removal of the plate the wound closed.
In one case infection occurred after a new trauma and the miniplate was removed five months after insertion. One plate was removed because of plate fracture and infection.

The mean time elapsed between injury and operation for the subgroup that showed postoperative infection that needed a revision surgery was 2.8 days while it was 3.3 days in the group without postoperative infections.

**Malocclusion**

Twelve patients showed a postoperative malocclusion (*Table 6*). Seven needed minor occlusal equilibration only and four were treated with postoperative occlusal guidance with elastics. Only one was classified to have a major complication and was treated with orthodontic appliance. This was an 18-year old woman injured in a horse accident were she gained a complex mandibular body and angle fracture on the opposite side.

One patient with malocclusion showed bimaxillary fractures. In this case, the maxillary fracture was treated by open reduction using miniplate fixation, while the not displaced mandibular fracture was treated conservatively. This malocclusion case was resolved with occlusal equilibration. The rest of malocclusion cases showed only mandibular involvement.

**Others**

Ten complications were related to other causes than infection and malocclusion. Except the 13 miniplates removed caused by infection additionally nine plates were removed by other reasons. Five of these were
removed from the mandible and four from the maxilla. Four miniplates were removed of patients request, three interfered with subsequent treatment and two were removed of unclear reasons. Another plate fractured but since the patient did not exhibit any symptoms it was left untreated.
Discussion

In this study 51 (58.0%) patients had no postoperative complications. This means that as many as 37 (42.0%) patients had some kind of complication. The overall complication rates were higher than expected but if the minor sequelae were excluded the complication rates were similar to comparative studies (Passeri and Ellis 1993, Renton and Wiesenfeld 1996, Moreno et al 2000, Lamphier and Ziccardi 2003, Murthy and Lehman 2005, Furr et al 2006). Fourteen (15.9%) patients showed major complications, which still may be regarded as a fairly high figure.

Infection was the most common complication, affecting 19 (21.6%) patients. Thirteen (14.8%) patients with infection needed revision surgery. In seven of these reoperated cases the infection was caused by reasons related to the fracture. Six cases were caused by plate and screw related complications.

In this study in total 2 out of 175 miniplates fractured (1.1%). The first in an elderly edentulous woman with a solid posterior mandibular body fracture, this plate fracture might be related to an insufficient fixation as only a single plate was used. The second plate fracture was seen in a 24-year-old man also with a solid body fracture. In this case the cause of the plate fracture was unclear.

The cause of injury showed the same pattern as previous reports in western countries (Ellis and Walker 1994, Schön and Roveda 2001, Ogundare and Bonnick 2003, Feller et al 2003, King et al 2004). Interpersonal violence was highly associated with fractures in the mandible.
Other causes of injury were associated with both mandibular and midface fractures. In males interpersonal violence was the most common cause to injury, while in women fall was most common. Also this concurs with other studies (Schön and Roveda 2001, Feller et al 2003). There were some clear differences between the two centres regarding the cause of injury. Only three patients were injured in traffic related accidents in Huddinge. Thirty-one out of 40 cases of interpersonal violence were seen in Huddinge. That is explained by differences in population structure and that traffic related accidents are mainly treated at another hospital in Stockholm. The incidence of fall accidents was high in this study. Most of these patients were old, females slightly older than males. Many falls were caused by accidental falls by elderly persons, other causes were fall from a ladder or a roof or fall in connection with an epileptic fit. It may be possible that at least a small part of the fall accidents could in fact have been caused by interpersonal violence. Nevertheless, it is clear that interpersonal violence is more related to young adults whereas falls are more common in the elderly. Nine of the infected fractures reoperated were caused by interpersonal violence. As mentioned persons injured by interpersonal violence may sometimes exhibit poor compliance, unwillingness to perform appropriate home care, a high incidence of substance abuse (Ogundare and Bonnick 2003) and inadequate nutrition which can explain the high frequency of infection complications.

Four infected fractures did not show bone healing at the time of revision surgery and healed adequately after this revision. The anatomical distribution of the mandibular fractures concurred with many other studies (Moreno et al 2000, Lamphier and Ziccardi 2003, King et al 2004).
However, there are also other reports showing the opposite with more fractures of the angle (Valentino and Frederic 1994, Renton and Wiesenfeld 1996, Ogundare and Bonnick 2003). Similar to King et al (2004) symphyseal/parasymphyseal fractures were most frequently associated with fractures at other sites of the mandible, fractures of the opposite mandibular body being the most common. The location of infections in this study leading to revision surgery differs from previous reports (Lamphier and Ziccardi 2003) where the mandibular angle has been found to have most complications (Ellis and Walker 1994, Anderson and Alpert 1994). In this study only 5.9% of the angle fractures became infected. Anyhow these findings agree with what has been found by Fox and Kellman (2003). Instead, the body and symphysis/parasympysis were the most common locations for infection in this material. Lamphier and Ziccardi (2003) reported wound dehiscence as a common complication but in this study it was seen in only one patient. It might be possible that some wound dehiscence had been unattended and later developed into infections.

The reason for removal of additional nine plates was in four cases of patients request without any sign of infection. The reason for these requests was palpable plates. Three plates interfered with subsequent implant insertion or bone grafting and were therefore removed in connection to this treatment. In two cases the cause to plate removal was unclear.

The number of plates removed was totally 22 out of 175 (12.6%). This is a higher figure than a previous report by Fox and Kellman (2003) but similar to that reported by Mosbah et al (2003).
The appearance of post surgical malocclusion depends of several independent factors as the number of fractures and their displacement, the reduction achieved, number of plates used and their placement but also of the patient’s pre surgical occlusion and dental condition. This study did not analyze these factors but a combination of fractures in the angle and symphyseal/ parasymphyseal regions were unfavourable and represented eight out of twelve of the cases that showed malocclusion. The 18-year old woman, who needed postoperative orthodontic treatment for her malocclusion, had several persisting primary molars and an unstable premorbid occlusion.

The male: female ratio was comparable to previous studies in Nordic countries (Heimdahl and Nordenram 1977, Ström and Nordenram 1991, Ström and Hultin 1995, 1996, Kontio et al 2005) but somewhat lower than in other international reports (Ellis and Walker 1994, Schön and Roveda 2001, Ogundare and Bonnick 2003). In the males the most fractures occurred before the fourth decade, whereas in females most fractures occurred after the age of forty. The age distribution is similar to other studies done on the mandibular and midface trauma (Feller et al 2003, Cabrini Gabrielli et al 2003, Kelley et al 2005, Kontio et al 2005, Zimmermann et al 2005). In this study complications divided by age accords well with the age distribution for the whole material.

This study does not report on alcohol or drug abuse. It has been shown in other studies that these habits are more common among patients involved in interpersonal violence (Heimdahl and Nordenram 1977, Ogundare and Bonnick 2003) and that these patients comply poorly postoperatively. It was
also the impression in this study that abuse was present in most of the cases with interpersonal violence. Because of this study was conducted as a retrospective review of the patient’s records, there was no control group or treatment procedure to compare the material with. It would have been interesting to compare the frequency and type of complications with conservative fracture treatment, at least in those cases where such treatment also is possible.

This study showed that the time delay between injury and operation did not affect the frequency of complications. This is in agreement with results in previous studies (Stone et al 1993, Edwards 1994, Peled et al 1997) where only to the severity of the fracture could be correlated to the rate of complications. In this retrospective study with lack of defined evaluation criteria for the severity of the fracture we refrained from any conclusions regarding this correlation.

Since the complications demands additional treatment in terms of surgical exposure with plate removal under general anesthesia, additional sick leave for the patient etc., it would be interesting to study this from a health economic point of view. It is our intention to do so in a subsequent prospective study.
Conclusions

The most frequent postoperative complication of maxillofacial fractures was infection presenting 46.3% followed by malocclusion presenting 29.3% of the complications. The infections were exclusively found in the mandible. In maxilla and midface postoperative complications were seen very seldom. Plate fracture was a very uncommon complication affecting 1.1% of the plates inserted.

Acknowledgement

For his support and guidance in performing this study, I would like to thank my mentor and supervisor Dr. Anders Holmlund, Professor, Department of Oral and Maxillofacial Surgery, Institution of Odontology Karolinska University Hospital, Huddinge, Sweden.

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