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Original Research Paper

Otorinolaryngology

COMPLICATIONS ASSOCIATED WITH SURGICAL TREATMENT OF FACIAL FRACTURES

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ABSTRACT

Introduction: Compared to other maxillofacial fractures, mandibular fractures are more commonly associated with complications. Among them, open reduction is the only significant variable due to increased risk of infection.

Objective: The aim of this prospective study was to evaluate the postoperative complications associated with mandibular, maxillary and midface fracture treatment in patients treated with open reduction using miniplate fixation.

Method: In this prospective study, 104 patients with mandibular, maxillary and zygomatic bone fracture were treated with plate osteosynthesis. Postoperative complications were monitored.

Results: In 31 patients (29.8%) out of the 104 patients with facial fracture,infection was the most common postoperative complication affecting 12 patients (11.5%),actually 38.7% compared to the total number of complications. Infections only occurred after the mandibular operation, but no maxillary or zygomatic fractures became infected. Removal of plates was performed in 8 patients (7.7%), for reasons other than infection. Occlusion problems occurred with 7 patients (6.7%) and maltreated fractures with 4 patients (3.9%). The overall percentage of complications was higher than expected, but still the same as in other studies.

Conclusion: The most frequent postoperative complications of facial bone fractures were infections. Infections occurred with the mandible, while no zygomatic bones and maxilla became infected. The interval between the occurrence of the injury and surgical fixation is not associated with the development of complications in fractures.

KEYWORDS : facial bone fractures, complications, operative healing

INTRODUCTION

Considering the clinical aspects of the trauma, the high rate of facial fractures are obviously related to the prominent position of these anatomical structures and their greater exposure to the external trauma.

Fractures of the facial bones make up 8-10% of all head injuries, they are more frequent and their treatment is complex. Fractures of the mandible are the most prevalent and constitute about 50-70 % of all maxillofacial fractures (***Ortakoglu et al 2004, Erol et at al 2004, Kelley et al 2005***). As regards the mandible, many studies have showed that the angle and parasymphyseal regions are the predominant fracture sites ***(Lamphier and Ziccardi 2003, King et al 2004***). Their significance is functional and aesthetic.

The main causes of maxillofacial fractures are violence and traffic accident (***Allareddy et al. 2011 , Ravindran and Ravindran Nair 2011***). These days traffic accidents present most common causes of injury, from 15 to 75% all around the world. Violence is the second most common cause of maxillofacial fractures as the result of a fist and leg striking, hitting with dull objects and rarely with sharp objects. The rate of interpersonal violence as a cause of injury especially in mandibular and zigomatic fractures increases. Among the fractures caused by traffic trauma and violence , after nasal bones ,mandibular a zygomatic bone are the most frequently fractured bones of the face.

These injuries are most common in the third decade of life (***Ravindran and Ravindran Nair 2011***). The test of proportion for males and females shows that there was a statistically significantly higher proportion of males involved in accident and injuries. Male to female ratio is 3:1, both for total maxillofacial traumatology and for fractures of individual facial bones.

Investigations in traumatology of facial bones are mainly devoted to their frequency and not to other factors that have an impact on the success of the treatment. There is insufficient work on the presence of complications, as well as on the general health and integrity of the injured person. Diagnosis and treatment of fractures of individual facial bones are still not fully defined.

Early and accurate diagnosis is the key in this situation. Type of surgical procedure depends on various factors: type of injury, surgeon affinity, the possible complications as well as the the general condition of the patient. Blood circulation should be good, proper position and immobilization of the bone fragments should be performed. The choice of treatment is also influenced by comorbidity, general condition, but also site of fracture, dislocation and functional impairment. Apart from the lack of recognition, delayed treatment of maxillofacial fractures has unfortunately contributed to the generally accepted attitude that maxillofacial fracture is not urgent and that its treatment can be delayed with no consequences .

Complications of treatment of these fractures may occur before, during and after treatment. Complications are influenced by numerous factors such as age, type and location of the fracture, patient condition, medication, condition before injury, treatment choice, degree of correction and fixation of the fragments, as well as the competence of the surgeon and the patient's cooperation

(***Olate S et al***). This highlights the importance of studying some factors of facial fracture treatment.
Fracture site, degree of dislocation and functional impairment are directly correlated with the need for surgical intervention, results and degree of complications. Both fractures and joint fractures correlate with the results of the treatment and degree of complications.

Compared with conservative management, the most obvious advantage with open reduction using miniplate fixation is that long time maxilla-mandibular fixation 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 5 also reduces the risk of temporomandibular joint 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 reduce tissue reaction. The current trend is to use more of titanium alloy miniplates instead of stainless steel and only remove them when symptoms occur (***Bhatt and Langford 2003, Mosbah et al 2003***).

Despite the 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(***Mosbah and Oloyede 2003***). 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 comminuted 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 (***Lamphier and Ziccardi 2003, Murthy and Lehman 2005, Furr et al 2006***). However,these studies are rare. This study was therefore focused on infection and other sequela related to the insertion of miniplates.The goals of maxillofacial fracture treatment have always been restoration of the anatomical form and function with special attention on the occlusion and facial aesthetics.

Goal:
The aim of this prospective study was to evaluate the postoperative complications associated with mandibular, maxillary and midface fracture treatment with open reduction using miniplate fixation. It is aimed also to evaluate the frequency and type of complications, fracture location and cause of injury, as well as the time of the intervention and the hygiene of the mouth.

Method:
In this prospective study, 104 patients were treated operatively due to facial fractures at the Clinic for Otorhinolaryngology and Maxillofacial Surgery, Clinical Center of Montenegro. A total of 104 patients were followed and treated surgically with open reduction using miniplate fixation. The minimum follow-up period was three months at the clinic that operated the patient.

From the all number of patients with facial bone fractures (mandibular, maxillary and midface except the nose)patients who were treated conservatively(patients with incomplete fracture, isolated condylar neck fractures, solid fractures without dislocation) were excluded from this study.

Patients were ages 16 to 89 years. Except for male and female, patients were also divided into age groups. Depending on the bones of broken faces, we divided the patients into groups:

1. Patients with fracture of the mandible;
2. Patients with a maxilla fracture;
3. Patients with a fracture of the zygomatic bone;
4. Patients with fracture of maxilla and zygomatic bones.

Patients of the first group, depending on the fracture location, are further divided into fractures: body, symphysis, angle, condylum and subcondylar fractures.

In these patients beside the fracture locations and causes, frequency and type of postoperative complications are recorded too. Fracture treatment was done under general anaesthesia .

We performed preoperatively and postoperatively radiographs for patients. All patients in this study were operatively treated by open reduction using miniplates fixation and screws. Some patients required maxilla-mandibular fixation.

In some patients, occlusion was preoperatively stabilized by mandibular maxillary immobilization, and with edentulous jaws we fixed the jaws with the screws to obtain a stable intermaxillary relation. For setting maxillomandibular fixation, we used the 0.8 mm diameter wire and the Erich rail.

It has been reported that surgery was performed the day after the fracture occurred.

This study focuses on the occurrence of complications, such as infections and other consequences associated with using miniplates.

The complications that we have followed are: infections, poor occlusion, unsteadiness, bad healing of of fragments, hypertrophic scarring. We noted patients who needed osteosyntactic plates to be removed due to infections, as well as cases where miniplates had to be removed for some other reason. Patients who had to re-operate due to poor scarring were identified. In addition to the clinical examination, these patients also performed radiographs. Complications were divided into major and minor complications.

In major complications, we classified infections requiring surgical treatment followed by antibiotics, removal of osteosynthetic plates as a result of infection, poor occlusion requiring re-treatment, bad healing of bones.

Infections treated with oral antibiotics with no need for surgical intervention were classified into minor complications, as well as removal of the plates as a result of the small wound dehiscence and different position of the plates following the patient distress.

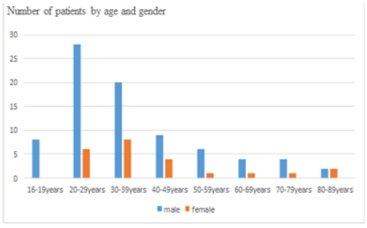
All patients were preoperatively and postoperatively treated with

clindamycin of 600mg, 3 times a day or Ceftriaxone 2 g parenteral dose and postoperatively. All patients were instructed to maintain a soft diet for a month, in some cases up to two months.We've presented the data in tables and graphically.

The results

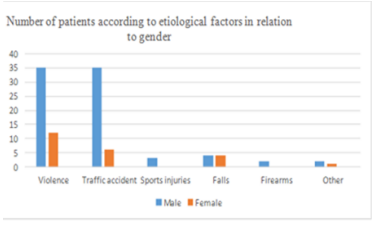
Out of a total of 104 patients with facial fractures, 81 were males and 23 female patients. The ratio of male and female patients was 3,5: 1. The age and gender distribution is shown in ***Figure 1***. Cause of fracture distribution based on gender is shown in ***graph 2***.

Figure 1. The distribution patients with fractures of facial bones by age and gender



When etiologic factors are concerned, women are more frequently injured in violence (>50%), men are equally injured in violence and traffic trauma, while other etiologic factors are less frequently represented, as can be seen in ***graph 2***.

Figure 2. The distribution of etiological factors, as the cause of bone fracture in relation to the gender



In sports injuries and gunshot injuries only men were involved, while in injuries like falls, males and females were equally involved. Table 1 shows site (location) of facial fractures distribution in patients. Fractures of the mandible and zygoma constituted the foremost locations of fractures with a significant higher difference than other locations. Isolated manibula fractures are most commonly observed in (44,1%) of patients ,while fracture of the zygoma is most frequently isolated fracture of the maxillofacial region (29,4%) or combined with fracture of maxille (21,6%). Maxilla fractures stand for 26,5 % while as an isolated bone fractures are observed only 4,9 %.

Table 1.Anatomical distribution fractures of facial bones

Anatomical site	No	(%)
Mandible	45	(44,1)
Maxilla	5	(4,9)
Zygomatic bone	22	(21,6)
Zygomatic et facial bones	30	(29,4)
Total	102	(100)

Anatomical distribution of the mandibular fractures is also registered. ***Table 1.*** shows fractures registered at each location (%).(***Table 2***).

Table 2. Distribution of patients depending on the site of mandibular fracture

Fractura part of the mandible	No	(%)
Body	17	(37,8)
Symphysis	4	(8,9)
Angle	16	(35,5)
Condyle	3	(6,7)
Subcondylary fracture	5	(11,1)
Total	45	(100)

The most common fracture site in the mandible was the body (17%), followed by the angle (16%). The subcondylar region was fractured 11.1%, while the other parts stand for less than 10%. The patients were operated three days after the fractures.

Table 3. Distribution of complications in patients with facial fracture

Comlications	N	%
Infections without surgical interventions	7	6,7
Infections with surgical interventions	5	4,8
Removing the mini plates for another reason	8	7,7
Malocclusion	7	6,7
Malunion bone	4	3,9
Without complications	73	70,2
Total	104	100%

Depending on the occurrence of complications postoperatively, the patients are divided into groups, as in ***Table 3***.

Out of 104 patients with facial fracture, 31 patients (29.8%) developed complications.

Infection was the most common complication affecting 12 patients (11.5%). 7(6.7%) infected patients were treated by oral antibiotics, but 5 (4.8%) patients also needed a revision surgery with removal of osteosynthesis material. In 8 patients (7.7%), plates were removed due to wound dehiscence, displacement of the osteosynthetic material or a scar formation which was fixed to the osteosynthetic material. Malocclusion was registered in 7 patients (6.7%) and malunion in 4 patients (3.9%).

From ***Table 4*** it can be seen that in 12 patients an infection was recorded, which is 38.7% compared to the total number of complications.

Table 4. Distribution of complications in relation to the facial bone that is broken

Comlications	mandible	maxilla	zygomatic bone	Total
Infections without surgical interventions	7	-	-	7 (22,6%)
Infections with surgical interventions	5	-	-	5(16,1%)
Removing the mini plates for another reason	3	3	2	8(25,8%)
Malocclusion	6	1	-	7(22,6%)
Malunion bone	3	-	1	4(12,9%)
Total	24 (77,4%)	4 (12,9%)	3 (9,7%)	31(100%)

Infections only occured after the mandibular operation, and they did not registered in the maxilla and zygomatic fractures. Removal of the plates for some other reasons was present at 25.8% and it occurred after the mandibular, zygomatic and maxilla surgery. Malocclusion as a complication presented 22.6% of all complications, and in most cases it was after the mandibular fracture (6 patients), and only one patient with maxillary fracture. Poor fracture healing was recorded on the mandible fractures (3 patients) and the zygomatic fractures (1 patient), representing 12.9% of the overall complications.

Figure 3. The frequency of complications in relation to the age of the patient

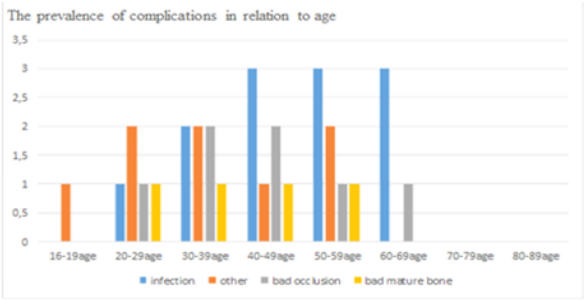


Figure 3 shows the distribution of complications based on age group of the patients. Complications occurred in the age of 16-69 years. Infections were recorded in the age group of 20 to 69, but were more common in the fifth, sixth and seventh decades of life. Patients who got plates removal for other reason (on the chart labeled as second) were in 20 to 60 years age category, more common in the third, fourth and sixth decades of life. Poor occlusion occurred with patients from the third to seventh decades of life, most commonly in the fourth and fifth decades. Nonunion of fractures occured in patients from the third to sixth decades of life, with equal distribution in these age groups. Considering that the most complications occurred after operative treatment of the mandibular fracture (77.4% of all complications), ***Table 5*** shows the frequency of complications in relation to the site of the mandibular fracture.

Table 5. The frequency of complications compared to the localization of mandibular fractures

Complications	Body	Symphysis	Angle	Condylar frakture	Subcondylar frakture	Total
Infection	5 (20,8%)	6 (25%)	1 (4,2%)	0	0	12 (50%)
Removing the plates for another reason	2 (8,3%)	1 (4,2%)	0	0	0	3 (12,5%)
Malocclusion	2 (8,3%)	1 (4,2%)	1 (4,2%)	1(4,2%)	1(4,2%)	6 (25%)
Malunion bone	0	0	2 (8,3%)	0	1(4,2%)	3 (12,5%)
Total	9(37,5%)	8(33,3%)	4(16,7%)	1(8,3%)	2(8,3%)	24

In the mandibular fracture, the most complications were found in the body area (37.5% of the total number of complications on the mandible), followed by symphyseal area (33.3%), angulation at 16.7%, subcondylar region 8.3% and condyle 4.2%. Out of the total number of complications on the mandible, 50% were infections, and the other complications were considerably less frequent.

All patients with infection were treated with Clindamycin 600x3 parenterally or per 7-10 days or with dual antibiotic therapy: Ceftriaxone 2 g twice daily for 7-10 days and Metronidasol 400 mg tablet 3 times for 5 days. Five out of twelve patients with infection needed revision surgery, the removal of osteosynthesis materials and curettage, which was in the body and symphysis area. Three cases were infections caused by plate and screw related complications. In these cases, we removed mini plates and screws in the body and symphysis area, not as a consequence of the infection, but due to wound dehiscence, causing them to be in contact with the saliva and they bothered the patient. Plates were removed 4 months after surgery.

In all patients with infection in the mandible, the injury was the result of interpersonal violence. In 10 patients with fracture of the mandible, with infection as a complication, the oral hygiene was poor. Removal of plates for other reasons (except for infections) on maxilla was in 3 patients and in 2 patients on zygomatic bone as can be seen in ***Table 4***.

Malocclusion as a complication occurred in 6 patients with mandibular fracture (25%) in 2 patients with fractures located in the body area and one patient in the other mandibular parts, as can be seen in ***Table 5.***

The poor fracture healing occurred with 3 patients with the fracture of the mandible and in one patient with the fracture of the zygomatic bone.

DISCUSSION

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***). In our study, patients with bone fractures were between 20 and 90 years of age, with the highest incidence of fractures between 20 and 40 years of life. Such results are consistent with results in other studies (***Kontio et al. 2005***). The male-female ratio was 3,5: 1,and was comparable to previous studies of other authors (***Kontio et al 2005***) but somewhat lower than in other international reports (***Ogundare and Bonnick 2003***).

The most common etiologic factor in female patients is violence (> 50%), while other etiologic factors are significantly less represented. These results are considerably higher than in other studies (***Ogundare and Bonnick 2003***) where violence is more pronounced as a dominant etiological factor related to male patients. This is due to the rise in violence against women, which is poorly regulated in our country. Of the etiologic factors in male patients, interpersonal violence and traffic trauma are equally represented and make up 82.9% of the total cause of injury in these patients. Other etiologic factors are represented at a much lower percentage. For the distribution of etiologic factors, opinions are divided, in some research interpersonal violence is reported as the most common cause of injury (***Ogundare and Bonnick 2003***), especially in fractures of the mandible, as well as in our research. This is particularly represented in urban environments. In the western part of Europe and in the US, traffic trauma is referred to as the dominant cause of injury (***Lamphier and Ziccardi 2003, Fasola and Obiechina 2003***).

The most common broken bone of the maxillofacial region was the zygomatic bone as a single broken bone (29.4%) or combined with the maxillary fracture (21.6%). Immediately the fracture of the mandible (44.1%) was reduced, while the fractures were much smaller (single 4.9%, and 21.6% in combination with the zygomatic bone). These results slightly deviate from the usual ones, where the most common lower jaw is the most commonly injured bone of the maxillofacial region (60-70%), while the upper jaw (15-24%) and the zygomatic bone (9.5-20%) are not so common but with constant the tendency of growth. Punching as a dominant way of interpersonal violence (which is in our country increasing) can lead to fractures of the bones or mandibles, but very rarely to the fractures of the maxilla. That is why it is quite understandable that the traffic accident in the etiology of the fracture of the maxilla occupies a dominant position.

When it comes to mandibles, as frequently fractured bone, the most common broken areas are body area (37.8%) and angulus (35.5%), while the other parts were significantly less broken. These results are consistent with the results of other studies (***Lamphier and Ziccardi 2003, King et al 2004***). However, there are also other reports showing the opposite with more fractures of the angle (***Ogundare and Bonnick 2003***).

In this study, 104 patients with fracture of the bones 31 had some complications, representing 29.8% of the total number of injuries. The overall percentage of complications was higher than expected but similar to other studies (***Lamphier and Ziccardi 2003, Murthy and Lehman 2005, Furr et al 2006***).

In 24 patients, there were complications on the mandible, representing 77.4% of the total number of complications, in most cases in the treatment of mandibular intraoral access, in the treatment of corpus fractures and symphysis, rarely angulus.

Such results are different from those of some other authors, which indicate angulus as the most common site of complications in the mandibular fracture (***Lamphier and Ziccardi 2003***). However, our results are consistent with the results obtained in ***Fox and Kellman (2003).*** It is teeth region so the oral hygiene of the patient must be taken into consideration. Having in mind that it is the only movable bone of the face where the muscular force plays the dominant role in fracture and dislocation of fragments, the muscle traction influence on osteosynthetic plates set to provide adequate healing of bone fragments can not be neglected.

The most frequent postoperative complication of maxillofacial fractures was infection, while other complications were less represented. Infection as the most common complication was present in 12 patients (11.5%), representing 38.7% of the total number of complications .The infections were exclusively found in the mandible. In all patients with infection, poor oral hygiene was noted. Inadequate nutrition in these patients may also explain the high incidence of infection as a complication.

All osteosynthetic plates were placed intraoralally, transmucosal, because they were body and symphysis fractures, and only one patient had osteosynthetic plates set in an angular area. Out of this number, only 5 patients (4.8%) were with severe complications, and besides providing adequate antibiotic therapy, surgery had to be performed. In these patients, the plates were placed in the body and symphysis area and the infection occurred as a result of the reaction to the osteosynthetic material that had to be surgically removed. In these cases, it is possible that dehiscence of the wound had occurred earlier so the patient did not notice it at the time or did not consider it relevant and didn't go to the surgeon when needed. It is precisely for this reason that infection can occur due to exposure to bacterial flora from the mouth cavity and due to the poor oral hygiene.

In 3 of 5 of these patients, during re-surgery and removal of the plates, it was found that the bone was not completely healed but after the surgery the analyses showed that condition was significantly improved showing complete healing of the bones and infection cure.Infections as the most common complication did not occur after the operation of the fracture of zygomatic and maxilla bone.

Malocclusion as a complication occurred with all patients in a small degree, followed by dental and orthodontic corrections on the teeth. Malocclusion appeared only in one case of maxilla fracture, in other cases it was in the fracture of the mandible (6 patients). 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. We did not analyze all of these factors in this study because there were small complications that were corrected by routine dental work.

The malunion fracture (fracture- *mala sanata*) occurred in 3 patients with the mandible fracture and in one patient with the fracture of the zygomatic bone. The patient with this complication on the zygomatic bone claimed that he started playing basketball after only one month of surgery. In the patients with mandibles fracture, two cases were patients who were not disciplined and did not obey the dietary advice while one patient during the healing period fell from bed while sleeping but that was not relevant to the case.

We consider that this study may provide a significant insight into the occurrence of complications after facial bone fractures treated with osteosyntactic plates. Having in mind the fact that this is a prospective study, we have noted all the complications that occur, and in this way even more emphasized their significance and the possibility of treating as well as preventing them. Furthermore, we will work on the complications of these fractures by comparing them with conservative treatment of patients where possible, as well as by comparing different ways of treatment.

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, Peled et al 1997***) where only to the severity of the fracture could be correlated to the rate of complications.

The appearance of complications sometimes requires additional treatments in terms of surgery, which is certainly not desirable. This study showed the significance of the early and accurate diagnosis and therapy that could provide better results aiming to reduce the number of complication or even better to eliminate them.

CONCLUSIONS

Complications after operative treatment of facial bone fractures are very significant because they can affect the patient aesthetically and functionally. The most common postoperative complications in facial fracture were infections, which represented 38.7% of the complications, followed by malocclusion with 22.6%. Infections only occurred after operative treatment of the mandibular fracture.

Complications after open reduction and osteosynthesis of titanium plates were very rare on maxilla and zygomatic bone. It is difficult to detect significant variables that can affect the occurrence of complications. This study showed that the time delay between injury and operation did not affect the frequency of complications.

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