

Significance of Microbial Analysis during Removal of Miniplates at Infected Sites in the Craniomaxillofacial Region - An Evaluative Study

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Abstract

Introduction: Open reduction and internal fixation (ORIF) can be complicated by miniplate exposure, loosening, or infection. Infected miniplates lead to exposure, extrusion, fistula formation, bony nonunion, and osteomyelitis. Whenever any posttreated cases of ORIF become infected, it is treated blindly with a high dose of antibiotics and surgical removal of infected miniplates or screws. The aim and objectives of the study were to identify the frequency and site of infection in craniomaxillofacial implants and significance of microbes isolated from the infected region. **Materials and Methods:** Removal of miniplates was being performed on 19 patients. Among them, 14 had infection or sinus opening, 3 had plate exposure, and 2 were removed asymptotically according to patient willingness. Aspirated fluid/pus was collected and sent for microbial culture and sensitivity test. Test of significance of individual microbes was done using Z-test and the value of P was calculated. **Results:** Among 14 patients associated with miniplate infection, 11 (78%) had infection in the mandible and 3 at zygoma. The bacteria isolated were mainly *Staphylococcus aureus* (7) along with coagulase-negative *Staphylococcus* (2), *Pseudomonas aeruginosa* (3), *Escherichia coli* (2), *Streptococcus salivarius* (2), and *Acinetobacter* genre (1). *S. aureus* was predominantly present in majority of the samples and statistically significant at $P = 0.023$. **Discussion:** The present study observed that in contrast to other sites in the body, there is versatility in microbial flora in the craniomaxillofacial region. It is essential for routine microbial analysis of samples and antibiotic susceptibility test for proper treatment of such cases.

Keywords: Culture, infection, maxillofacial fracture, miniplates

INTRODUCTION

Open reduction and internal fixation (ORIF) is regarded as the standard principle for the treatment of maxillofacial fractures. Miniplate osteosynthesis without interfragmentary compression is now considered the best treatment for mandibular fractures. Titanium and titanium alloys are suitable for use as permanent maxillofacial implants because their biocompatibility is superior to that of stainless steel.^[1] The choice of osteosynthesis by small plates in orofacial surgery (such as mid-face, upper face, and mandibular condyle) depends on the therapeutic orientation of the surgeon.^[2] Although postoperative infection after ORIF has been reported between 1% and 6%, there has always been uncertainty in the past about the need to remove miniplates and screws routinely following healing of jaw fractures.^[3-5] Rosenberg *et al.* removed titanium miniplates only if the

patient had symptoms or if they became infected or the wound broke down.^[6]

ORIF can be complicated by hardware exposure, hardware loosening, or hardware infection. Infected hardware is populated with bacterial colonies and leads to hardware exposure, extrusion, fistula formation, bony nonunion, and osteomyelitis. This should be managed by debridement of

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necrotic and infected tissue and antibiotic administration.^[7] Usually, such cases are treated blindly with a high dose of antibiotics and surgical removal of infected miniplates or screws. Researchers suggest that studies have been done to identify the microorganisms associated with infected implants following orthopedic surgery. *Staphylococcus* species is the most common microbe found adherent to the infected site associated with orthopedic surgery.^[8-10] Studies in the craniomaxillofacial region are very meager in literature till date. Detection of the microbes involved is necessary for the proper treatment of these cases. With the above background, the aim of the present study was to identify the frequency and site of infection in craniomaxillofacial implants in patients who had undergone ORIF. The objectives were to evaluate the various microbes involved with the infection and determine its significance associated with infected miniplates in the aforesaid region.

MATERIALS AND METHODS

This is an evaluative study conducted on patients in the age range 13–60 years attending the outpatient department of oral and maxillofacial surgery between December 2017 and March 2019. The study was commenced after the protocol had been approved from the Institutional Ethical Committee.

Inclusion criteria

Patients who had undergone ORIF and reported with infection/plate exposure/willingness to remove the hardware were included in the study.

Exclusion criteria

Patients with comorbidities or immunocompromised conditions were excluded from the study.

All the patients were selected based on a convenience sampling technique. They were explained the importance of the study and written informed consent was obtained for the same. During the study period, removal of plates was being performed on 19 patients. Among them, 14 had infection or sinus opening, 3 had plate exposure, and 2 were removed asymptotically according to patient willingness. The diagnosis was established on the basis of history, examination, and radiological findings. Radiographic investigations included orthopantomogram for the mandible and paranasal sinus view for mid-facial and upper facial regions. It was made sure that patients with infected miniplates were not under any antibiotic coverage. Antibiotics were stopped for 72 hours prior to the collection of fluid/pus.

Fluid/pus was aspirated with the help of 22 gauge 10 ml syringe from deep inside the wound and sent for culture and sensitivity to the department of microbiology of our institution. The bacteria isolated were exposed to 14 antibiotics and tested for sensitivity. The results were interpreted as follows: sensitive, intermediate, and resistant.

1. Sensitive – the bacteria cannot grow if the drug is present and antibiotic is effective against them
2. Intermediate – a higher dose of the antibiotic is needed to prevent the growth of the bacteria

3. Resistance – the bacteria can grow even if the drug is present. This is a sign of an ineffective antibiotic.

All the patients were further prescribed oral clindamycin 300 mg ter die sumendum (3 times a day) while the culture sensitivity report was awaited. Infected plate removal was done under local anesthesia in aseptic conditions. Antibiotics were prescribed according to culture sensitivity test for 5 days, and follow-up was done at weekly intervals for 4 weeks till the patients became asymptomatic.

All the data obtained were recorded in a predesigned pro forma and subjected to statistical analysis using the Statistical Package for the Social Sciences version 16.01 software (IBM, Endicott, New York, USA). Categorical variables such as the site of infection, cause of removal of miniplates (primary variables), and microbes present (secondary variable) were represented in terms of frequency (in percentage). Test of significance of individual microbes was done using Z-test to obtain a Z-score and the value of *P* was calculated. Significance was considered at *P* < 0.05.

RESULTS

A total of 19 patients (17 males and 2 females) underwent removal of miniplates in a 16-month duration. The mean age of the patients was 24.4 years. Among them, 14 (73.7%) patients had infection associated with implants, 3 (15.8%) had exposed plates, and 2 (10.5%) were asymptomatic moreover concerned with the presence of metal inside the body [Figure 1].

Sixteen patients underwent ORIF earlier in our institute, whereas the remaining three were treated elsewhere. The hardware used in the majority of patients (17) was titanium and other 2 had implants made of stainless steel. The duration of plate removal was 3 months to 2 years and 11 months after ORIF, with a mean of 11.9 months.

The different sites involved with miniplate infection were mandible 11 (78%), subcategorized as parasymphysis (7), symphysis (2), mandibular angle (2) and 3 (22%) zygoma, subcategorized as fronto-zygomatic region (2), infra-orbital rim (1) [Figures 2 and 3]. The bacteria isolated were mainly *Staphylococcus aureus* – 7 (50%) along with coagulase-negative *Staphylococcus* – 2 (14.3%), *Pseudomonas aeruginosa* – 3 (21.4%), *Escherichia coli* – 2 (14.3%), *Streptococcus salivarius* – 2 (14.3%), and *Acinetobacter* genre – 2 (14.3%). Table 1 represents the distribution of site and microbes associated with the miniplates.

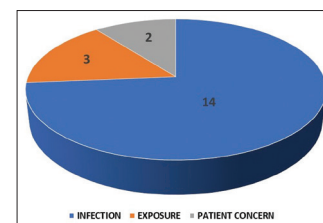


Figure 1: Graph showing incidence of plate removal

Test of significance for the presence of individual microbes was calculated using Z-test. *S. aureus* was predominantly present in most of the samples (50%) and found to be statistically significant at $P = 0.023$. The presence of other microbes was statistically nonsignificant ($P > 0.05$) [Table 2].

DISCUSSION

Infection and sinus tract formation are the most common cause of miniplate removal at craniomaxillofacial site, followed by plate exposure. Other causes include persistent anesthesia due to close proximity of nerve, thermal conductivity, late removal of tooth from the site of fracture before insertion of endosseous implants, tenderness on palpation over implants, and patient concern over the presence of implant.^[11,12]

With the growing use of titanium, the incidence of infection following ORIF has greatly reduced. However, infections do occur due to improper implant placement, loosened

screws, hospital-acquired infection, and improper hygiene maintenance by the patient. Removal of stainless steel plates is relatively easy in contrast to titanium and its alloys due to its osteointegration properties. Even though multiple implants are placed at a single fractured site such as superior and inferior plates at the mandibular symphysis and parasymphysis regions, it is often a single or double screw which gets infected. In case of titanium implants, it is often wise to surgically expose the infected site and remove only infected plate or screws instead of removal of all the plates if the choice of surgery is associated with infection.^[13,14]

Mandibular parasymphysis was the most common site of infection (43%) in our study. Bhatt *et al.* also found that 34% of infected miniplates were in relation to the parasymphysis region.^[11] It was also noted that the inferior border plate was most commonly infected compared to the superior border plate (ratio of 5:1). Zygoma was the second most common site for the removal of miniplates. The zygomaticofrontal junction and infraorbital rim have thin skin and subdermal layer, so miniplates and screws in these regions become visible, especially in lean patients.^[15] Francel *et al.* and Islamoglu *et al.* claimed that the close approximation of zygomaticomaxillary buttress region to the anterior wall of the antrum may lead to screw loosening, bone resorption, granulation tissue formation, and even inflammation. The presence of maxillary sinusitis or close vicinity of the zygomaticomaxillary buttress plate to infected maxillary posterior teeth could further complicate the situation leading to infection of miniplate. The plate might also dehiscence owing to severe comminution of the underlying fractured bone.^[15,16]

Infection on implants is mostly due to bacterial communities growing in protected biofilms on the foreign material and in necrotic bone tissue. These localized grouped bacteria are often metabolically quiescent, which makes them difficult to identify and culture. Cultures taken from an open wound at the time of initial fracture fixation do not correlate with an eventual later infection.^[17] As biofilms are formed over the implants, it is difficult for the drugs to enter it and clear the microbes. Hence, simple surgical drainage and nonstandardized antibiotic therapy are of little use in case of infection associated with osteosynthesis implants.^[11,18,19] Malanchuk and Kopchak

Table 1: Distribution and microbial analysis of infected miniplates

Case number	Site of infection	Duration after ORIF	Bacteria isolated
1	Parasymphysis	2 years 2 months	Coagulase negative staphylococcus
2	Parasymphysis	11 months	<i>S. aureus</i> <i>S. salivarius</i>
3	Parasymphysis	4 months	<i>Acinetobacter</i> spp.
4	Parasymphysis	7 months	<i>P. aeruginosa</i> <i>Acinetobacter</i> spp.
5	Ramus	3 months	<i>E. coli</i>
6	Infraorbital	3 months	<i>E. coli</i>
7	Frontozygomatic suture	2 years 11 months	<i>S. aureus</i>
8	Symphysis	4 months	<i>P. aeruginosa</i>
9	Infra-orbital rim	6 months	<i>S. aureus</i>
10	Parasymphysis	2 years 5 months	<i>S. aureus</i>
11	Right angle	8 months	<i>S. aureus</i>
12	Parasymphysis	1 year 3 months	Coagulase negative staphylococcus
13	Symphysis	11 months	<i>S. aureus</i> <i>S. salivarius</i>
14	Parasymphysis	5 months	<i>S. aureus</i> <i>P. aeruginosa</i>

S. aureus=*Staphylococcus aureus*, *S. salivarius*=*Streptococcus salivarius*,
P. aeruginosa=*Pseudomonas aeruginosa*, *E. coli*=*Escherichia coli*,
ORIF=Open reduction and internal fixation



Figure 2: Infected miniplate at mandibular symphysis



Figure 3: Infected miniplate at frontozygomatic suture

Table 2: Test of significance of the various microbe present

Microbes	Frequency (%)	Z score	P
<i>S. aureus</i>	7 (50)	2	0.023**
<i>P. aeruginosa</i>	3 (21.5)	0	0.5
Coagulase negative <i>staphylococcus</i>	2 (14.3)	-0.5	0.692
<i>S. salivarius</i>	2 (14.3)	-0.5	0.692
<i>Acinetobacter</i> spp.	2 (14.3)	-0.5	0.692
<i>E. coli</i>	2 (14.3)	-0.5	0.692

**Significant P value. *S. aureus*=*Staphylococcus aureus*,
S. salivarius=*Streptococcus salivarius*, *P. aeruginosa*=*Pseudomonas aeruginosa*, *E. coli*=*Escherichia coli*

reported that the type of antibiotic used can influence the risk of infection in cases of mandibular fractures. They described a lower infection rate associated with the use of lincosamides, which are known to accumulate in bone tissues.^[20] Spacers with local antibiotics are often a good additive treatment if there is a suspicion of infection during surgery. Antibiotic loaded nonresorbable polymethylmethacrylate bone cement is applied, which can be introduced as beads on a string or simultaneously be used for mechanical stabilization as a rod or for temporary filling of large bone defects.^[17]

Isolated bacteria in most of the studies associated with infected implants in orthopedic surgeries have shown presence of *S. aureus* and *Staphylococcus epidermidis* (coagulase-negative *Staphylococcus*) accounting for two of three infection isolates.^[13] Similarly, in our study, 75% of bacteria were found to be these two species. *E. coli* was isolated from two cases and *Pseudomonas* spp. from two which is more prominent in bone tissue infection. *Acinetobacter* spp. which is reported sporadically in orthopedic implants was also present in two cases.^[14] Test of significance was performed in our study using Z-test to determine the vital role of individual microbes. *S. aureus* isolated in majority of the patients was found to be statistically significant with $P = 0.023$. The present study also observed that there is versatility in microbial flora in the craniomaxillofacial region.

In our center, we exclusively use titanium implants for the treatment of craniomaxillofacial surgeries, so we attended majority of the plate removal cases of titanium and only few of stainless steel. Maxillomandibular implants due to close proximity from the oral cavity can get contaminated by oral fluids, which were proven with the presence of *S. salivarius* in association with *S. aureus* in two of the cases of mandibular fracture. It was noted that patients who had infection within 3 months of ORIF had a greater chance of *E. coli* susceptibility. Marta Ribeiro et al. observed that pseudomonas species and *E. coli* were found in association with osteomyelitis and bone infection.^[13]

As wide flora of microbes is associated with infected implants in the craniomaxillofacial region, it is essential to perform routine microbial analysis of samples and their antibiotic susceptibility test for proper treatment of such cases. In our study, all the cases responded well to the antibiotic regime

prescribed after culture and sensitivity test and were found asymptomatic after 4 weeks of follow-up.

CONCLUSION

Surgical site infection associated with miniplates is not uncommon at the craniomaxillofacial region. This remains the most important factor for the removal of hardware in postoperative ORIF cases. *S. aureus* was isolated in majority (50%) of the cases. Furthermore, studies should be done on a larger scale to evaluate the microbes involved at infected sites to achieve a definitive conclusion.

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Conflicts of interest

There are no conflicts of interest.

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