

Comparison of Titanium bone plates and screws vs. stainless steel bone plates and screws in the management of mandibular fractures – A long term clinical study

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Abstract

Objectives:

The objectives were to study the versatile nature and the biocompatibility of the titanium material and to determine the usefulness of titanium mini plates over the stainless steel plates in the management of fractures of mandible.

Materials and methods:

The present study comprised of thirty four subjects with fractures of mandible at various anatomical sites. All patients included in this study were found to be of good health without any evidence of clinical infections. The procedure was done under general anesthesia. The fractures were exposed through appropriate incisions. Sixteen of the patients were treated with titanium bone plating system and eighteen with stainless steel plating system. The plates and screws used were of standard design, size and calibration. The patients were recalled for follow-up at 3 weeks, 3 months and 6 months and the data was recorded.

Results: In a total of 34 patients the T-test revealed a significant difference in the average time taken for adaptation and plating of the 2 system of plates. The average time taken for stainless steel plate was 6.82min and for that of titanium was 3.64 min. The test for comparison of infection rate showed that 20% of the patient treated with stainless steel plates and screws had local infection while the success rate for titanium plates was 100%. 20% of cases treated with titanium system encountered the complication of shearing and fracture of the titanium screw head while fitting the screw. Wound dehiscence in case of stainless steel bone plates was noted in one out of ten patients (10%) while in the group treated with titanium plates it was 0%.

Conclusion: In this study of short duration, titanium plates were found to be very ideal in the management of mandibular fractures. Titanium plates were more biocompatible when compared to stainless steel plates as evidenced by the rate of infection. In all cases the plates were found to be rigid, stable and satisfactory for use in the facial skeleton. Titanium plates being more malleable were easily adapted to the varying contours of the mandible which clinically translated into reduced time required for plating.

KEYWORDS: Titanium bone plate systems, stainless steel plate systems, fractures of mandible

Introduction

In the past inter-maxillary fixation has been the traditional method for supporting bone ends in close apposition to allow undisturbed bone healing of the fractures of mandible^{10,41}. The advancement in the maxillofacial surgical techniques has made it possible to almost immobilize and orient any part of the facial skeleton^{15,22}. Since reduction and immobilization is the basic principle of fracture treatment, the key to success in traumatology is a reliable method of osseous fixation⁸. The most recent as well as versatile method is the miniplate fixation, which uses the principle of

monocortical osteosynthesis^{5,8,41}. It is a simple osteosynthesis technique that would guarantee fracture healing without intermaxillary fixation and without compression^{8,41}.

The technical advantages of miniplates are that they are small and easily adapted, are applied monocortically, approach is intra-oral and they provide functional stability since the system is biomechanically balanced⁸. But one the most significant drawbacks was the phenomenon of "stress shielding atrophy" of the bone under the rigid plates which make the bone vulnerable to refracture once the plates were removed^{9,10,25,26,28,34,38}.

Several metals have been tried since 1920's. Although gold, silver, copper and its alloys, lead and aluminium and its alloys were used and tested, stainless steel emerged through the era as the new corrosion resistant material^{14,17,18,19,24,30,35}. At about the same time or later on other metals or alloys like titanium were introduced with claims of lots of advantages over the classic stainless steel^{20,21,24,28,31,37,40}.

Titanium was first used in 1940's and was shown to be not only biocompatible but had a tendency for osseointegration and had excellent corrosion resistance. It also has excellent ductility and tensile strengths and totally non-toxic^{24,25 30,31,32,35}.

These observations prompt a study to compare titanium bone plates and screws with stainless steel bone plates and screws used in the treatment of the facial skeleton^{1,11,14,19,21,23,26,31,35,40}.

OBJECTIVES

The objectives of the present study were:

1. To study the versatile nature of the titanium plate.
2. To study the biocompatibility of the material.
3. To determine the usefulness of titanium mini plates over the stainless steel plates in the management of mandibular fractures.

Materials and Methods:

The present study comprised of thirty four subjects with fractures of the mandible at various anatomical sites. Sixteen patients were treated with titanium bone plating system and eighteen with stainless steel plating system. The plates and screws used were of standard design, size and calibration. (**Figure 1 & Figure 2**)

The patients were diagnosed both clinically and radiographically with standard radiographs and were posted for surgery under general anesthesia following routine investigations, physicians fitness and pre-anesthetic evaluation. Patients with diabetes, on steroidal drugs and smokers were excluded from the study. All patients included in this study were found to be of good health without any evidence of clinical infections.

Surgical technique:

The procedure was done under general anesthesia and the patients were intubated with a nasal

endotracheal tube. The jaws were placed into IMF before exposing the fracture site.

The fractures were exposed through appropriate incisions. Once exposed the fracture segments were aligned, reduced and reconfirmed by checking the occlusion.

Fixation and Osteosynthesis

The technique for osteosynthesis was similar for all the cases. Time recording was done starting with the start of adaptation of the plate to the completion of plating. After the selection of a suitable plate, it was adapted accordingly to conform to the contour of the bone surface. This was achieved with the use of a plate bending plier. Compensatory bending was done while operating on the mandibular fractures.

Once the plates were adapted and held in place with an instrument, the pilot holes were tapped with appropriate drill bits under copious saline irrigation. After the first screw was seated firmly the orientation of the plate was confirmed and then the remaining holes were drilled and the screws placed while maintaining the compression between the segments.

Once the fixation was complete, the surgical site was well irrigated with betadine and saline. After achieving good hemostasis the incisions were closed in layers^{10,22}.

Post-operative complications such as pain, erythema, infection, wound dehiscence, exposure of plates, palpability of plates and occlusal discrepancies were noted and recorded on a daily basis during the hospital stay of the patient^{2,3,29}. (**Figure 3 and Figure 4**)

The patients were recalled for followup at 3 weeks, 3 months and 6 months and the data was recorded. Immediate post-operative radiograph was taken on the 1st post operative day. Two follow up radiographs on the 3rd and 6th post operative months were taken. The radiographic appearance of the fracture site and the two system of plates were compared.

RESULTS

This study was an attempt to compare the efficacy of titanium bone plates and screws with stainless steel bone plates and screws in the treatment of mandibular fractures^{20,21,24,28,31,37,40}.

The study involved thirty four patients with fractures of mandible selected by random sampling and were divided broadly into two groups.

Group 1- those who were treated using stainless steel bone plates and screws.

Group 2- those who were treated using titanium bone plates and screws.

For statistical convenience the etiology of fractures were divided into 3 groups

1. Road traffic accidents
2. Falls
3. Assaults

The patients who were treated were divided into 5 age groups .

1. <20 years
2. 21-30 years



Fig 1. Armamentarium



Fig 2. Armamentarium (Stainless Steel & Titanium Bone Plates & Screws)

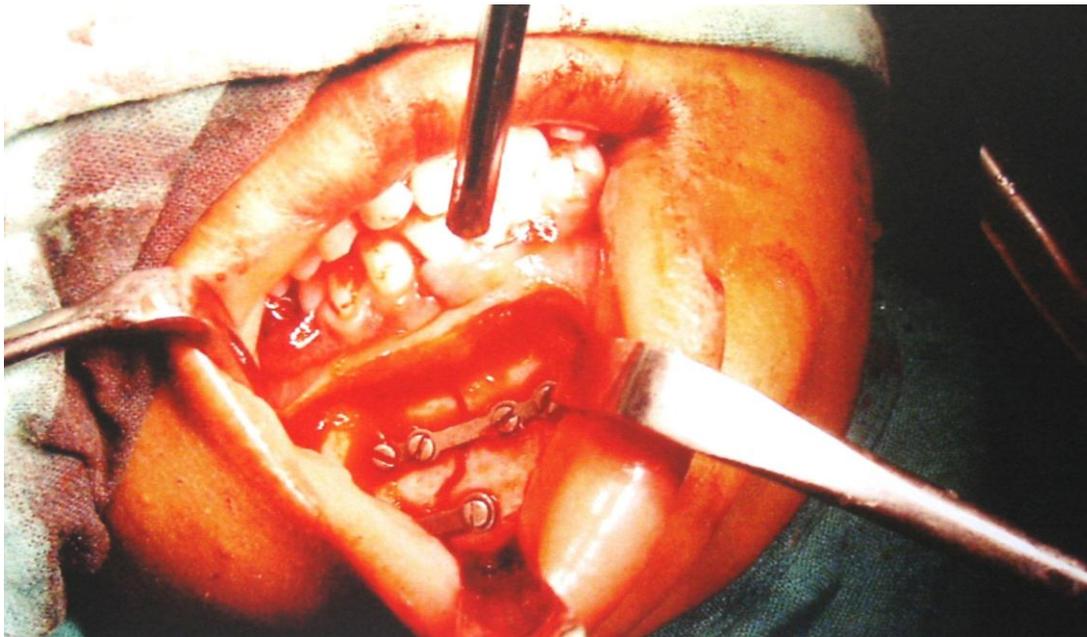


Fig 3. Fixation of Stainless Steel bone plating system

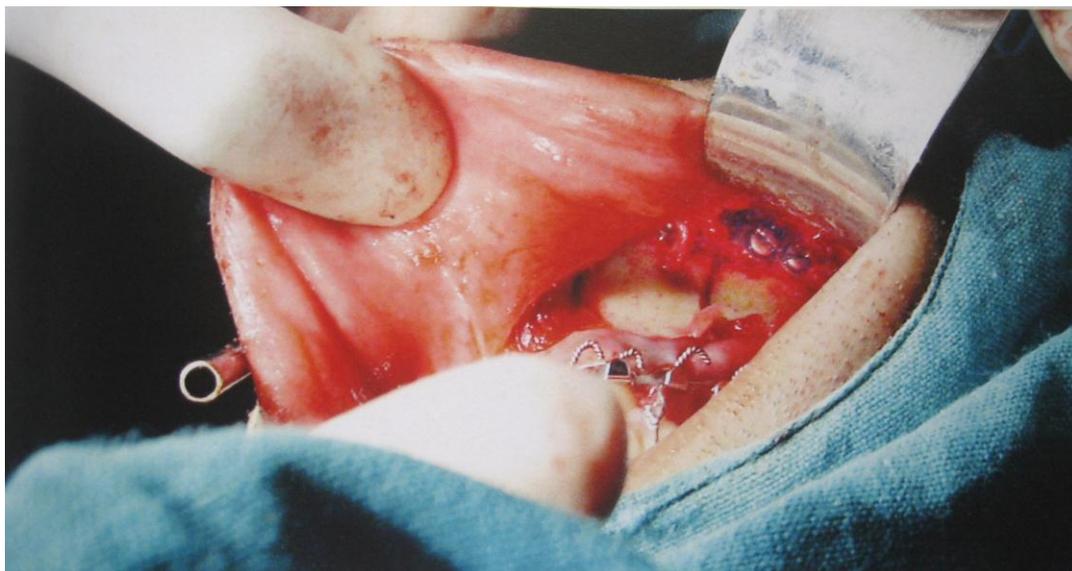


Fig 4. Fixation With Titanium Bone Plates And Screws

3. 31-40 years

4. 41-50 years

5. >50 years

Time was recorded right from the beginning of adaptation of to the completion of plating in both group1 and group 2 patients^{9,11,13,17,23}.

The local infection rate was calculated for both the groups.

The other parameters of erythema, pain, wound dehiscence, exposure of plates, palpability of plates over the soft tissues and radiographic appearance of the plates were noted^{2,3,29}.

The T-test revealed a significant difference in the average time taken for adaptation and plating of the 2 system of plates. The average time taken for stainless steel plate was 6.82min and for that of titanium was 3.64 min.

The test for comparison of infection rate showed that 20% of the patient treated with stainless steel plates and screws had local infection while the success rate for titanium plates was 100%.

The complication encountered in the group was the shearing and fracture of the titanium screw head while fiving the screw. This accounted for 20% of cases treated with the titanium system.

Wound dehiscence in case of stainless steel bone plates was noted in one out of ten patients (10%) while in the group treated with titanium plates it was 0%.

The other parameters of erythema, pain, wound dehiscence, exposure of plates, palpability of plates over the soft tissues and radiographic appearance of the plates had very insignificant results.

DISCUSSION

Orofacial trauma surgery is the foundation from which the speciality of maxillofacial surgery arose and has significantly expanded and developed over the last 50 years²².

Developments in biomaterials over the last decade have contributed to the dramatic advances in the overall therapeutic armamentarium of the oral and maxillofacial region^{1,9,14,18,19,21,24,25,30}.

Titanium has been the material of choice for facial osteosynthesis^{20,21,24,28,31,37,40}. The biotechnological advances and the inherent advantages of this material in the recent past has seen it become the traditional choice for craniomaxillofacial reconstruction, implantology, traumatology, cosmetic osseous surgeries etc^{28,30,33}.

Titanium is considered a highly biocompatible and a corrosion resistant material with excellent osseointegration and its pliability is an added advantage for better adaptability^{24,25 30,3132,35}.

In the present study twenty cases of fractures of the mandible were selected for comparison of open reduction with titanium and stainless steel bone plates and screws.

The use of titanium bone plates have been described and appreciated by several authors. The advantages of this metal have been discussed at

length^{1,11,14,19,21,23,26,31,35,40}. However, complications can arise. In the present study, the only complication that was encountered was that the screw shaft sheered and fractured during the placement of the screws^{9,10,25,26,28,34,38}. This happened in two of the five cases that were treated with titanium bone plates and screws.

In the present study the time taken for adaptation of the plates was noted. According to the data it is evident that the average time taken for adaptation of the titanium plates was lesser than that taken for stainless steel plates^{9,11,13,17,23}. This has been attributed to the pliability of material.

In this study the infection rate was calculated for both stainless steel and titanium systems. Patients treated with titanium bone plates and screws had no local infection while one out of five patients with stainless steel had local infection in the plated site during the second and third post operative weeks^{2,3,29}. This could be due to delay in seeking treatment.

Wound dehiscence in case of stainless steel bone plates was noted in one out of five patients (20%) while in the group treated with titanium plates it was 0%.

The other parameters of erythema, pain, wound dehiscence, exposure of plates, palpability of plates over the soft tissues and radiographic appearance of the plates showed insignificant difference.

Summary and Conclusions

In the present study comparing titanium miniplates with stainless steel miniplates the following inferences were drawn.

1. Titanium plates being more malleable were easily adapted to the varying contours of the facial skeleton which clinically translated into reduced time required for plating.
2. Titanium plates were more biocompatible when compared to stainless steel plates as evidenced by the rate of infection.
3. In all cases the plates were found to be rigid, stable and satisfactory for use in the facial skeleton.

In this study of short duration, titanium plates were found to be very ideal for use in the middle third of the facial skeleton where the requirement for contour is maximum. It is an alternative miniplating system when used judiciously in clinically controlled cases and serves as an excellent biomaterial for use in the facial skeleton.

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