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Research Article

Should wiring be replaced by miniplating of mandibular fractures even in poor developing countries?

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ABSTRACT

Background: Management of mandibular fractures has evolved significantly over the past few decades from intraosseous wiring, compression plates to miniplates. Our department started using titanium miniplates and we conducted this study to evaluate its feasibility and compare it with wire osteosynthesis.
Methods: This is a prospective randomized study conducted on 150 cases of faciomaxillary trauma due to varied etiology with mandibular fractures; 75 cases each in the wire osteosynthesis group and titanium miniplating groups respectively. The two groups were compared in terms of the postoperative complications, hospital stay, cost of hardware used and patient satisfaction.
Results: Duration of surgery for the fixation of mandibular fractures was significantly reduced in the plating group as compared to the wiring group (2.0±0.4 versus 2.8±0.7 hours). Postoperatively, wound infection was observed in 4% of cases in the plating group and 16% in the wiring group, mal-occlusion was seen in 8% of patients, all in intra-osseous wiring group. Mal-union was seen in 6 of the wiring group patients and none in the plating group. Non-union was seen in 3 patients of the wiring group and none of the plating group patients. Patient acceptability and compliance was significantly better in the titanium miniplating group as compared to the Wiring group. Although plating is costly as compared to wiring, the overall advantages outnumber the wiring group.
Conclusions: Titanium miniplating is superior to wiring though comparatively costly but cost alone shouldn't be the consideration in choosing a treatment option even in poor developing countries.

Keywords: Mandibular, Fracture, Wiring, Miniplating, Titanium, Osteosynthesis

INTRODUCTION

Maxillofacial injuries remain a serious clinical problem because of the involvement of a complex anatomical region.[1] With ever increasing traffic especially two wheelers in developing countries and poor adherence to safety measures like helmets, the incidence of maxillofacial trauma is increasing with every passing day and precious lives are lost day in and day out. Mandible being the only mobile bone of the face, it participates in basic functions such as mastication, phonation, deglutition and maintenance of occlusion.[2] The prominence, position and anatomic configuration of the mandible are such that it is one of the most frequently injured facial bones after nasal bone.[3]

The first description of mandibular fracture was as early as 1650 BC, when an Egyptian Papyrus described the examination, diagnosis and treatment of mandibular fracture. Despite the fact that it is the heaviest and strongest facial bone, mandible has several areas of weakness that are prone to fracture. The weak areas for fractures are the sub-condylar area, the angle and distal body areas, and the mental foramen.[4-6]

The goal of treatment in facial fractures is to achieve anatomic reduction and restore function while increasing patient comfort and making postoperative care easier.[7] During the past few decades, the surgical treatment of mandibular fractures has advanced significantly. Rigid internal fixation and early return to function have replaced the use of wire osteosynthesis and prolonged use of maxillomandibular fixation (MMF). Advantages include avoidance of maxillo-mandibular fixation, early mobilization of the mandible, shorter period of hospitalization, increased patient satisfaction and earlier return to the workplace.[8] Thus, the use of rigid internal fixation obviates these difficulties and it has gained widespread acceptance.[9]

The use of plates for internal fixation of facial fractures is not a new idea. Ewers and Harle quote the first description of mandibular fracture fixation using plates and screws and by Hausmann.[10] The basic concept of rigid fixation is absolute stability. MiChelet et al and Champy et al suggested that engaging a single cortex is sufficient for rigid osteosynthesis.[11] Today rigid internal fixation using plating system has gained widespread popularity. Use of tension band wiring to achieve precise reduction and stabilization of fractured segments during rigid fixation has also been described.[12]

Sher-i-Kashmir Institute of Medical Sciences (SKIMS) is one of the only two Tertiary care centers with a Plastic and Maxillofacial surgery department which caters to a population of around 10 million in our state. In our department we were using wire fixation and started miniplate mandibular fixation since 2007 and conducted this study to evaluate the feasibility of titanium miniplating of mandibular fractures and compare it with wire osteosynthesis in terms of the postoperative complications, hospital stay, cost of hardware used and patient satisfaction.

METHODS

This is a prospective study conducted in the department of plastic and reconstructive surgery, Sher-i-Kashmir Institute of Medical Sciences, Srinagar from December 2007 to December 2014. The research was conducted according to the principles of the Declaration of Helsinki.

The patients of craniofacial trauma (aged 16 years and more), admitted in the department of accident and emergency of this institute were evaluated for mandibular fractures. A total of 150 cases of mandibular fractures were studied. A detailed history with general physical and systemic examination and a thorough local examination was carried out in all patients.

Routine investigations were carried out, besides mandibular x-rays, orthopantomogram (OPG), CT scan of head with facial cuts in all patients. Radiographs of other parts of the body or special investigations were done wherever indicated.

All the patients who needed open reduction to manage their mandibular fractures were included in this study. Informed consent was obtained and treatment was assigned by random allocation (by computer generated numbers) to either titanium miniplate osteosynthesis (group I, n = 75) or wire osteosynthesis (group II, n = 75).

All patients were operated under general anaesthesia. Premorbid occlusion was reestablished with manual or instrumental manipulation. Maxillomandibular fixation was then achieved through the application of Erich arch bars, Ivy loops or screw MMF.

In case of titanium miniplate fixation group, two miniplates (2.0 mm 4-hole or 6-hole) were placed across each fracture (Figure 1 a, b, c). At least two screws were placed on either side of the fracture line in each plate. Maxillomandibular fixation was released; both occlusion and stability of the fracture line were rechecked. The incision site was closed in layers. In those patients who had associated condylar/subcondylar fractures, maxillomandibuar fixation was continued for 10-14 days followed by elastics.

Figure 1: (a) Fracture exposed by intraoral approach and marking of drill hole sites done.

In case of trans-osseous wiring, after the exposure of the fracture site, periosteum was elevated from both the cortices. This was followed by fixation with stainless steel wire 26G, either as figure-of-eight or double wire after MMF in occlusion (Figure 2 a, b, c).

After fixation, occlusion was re-evaluated, and maxillomandibular fixation was continued for 6 weeks. In patients having associated condylar/subcondylar fractures, MMF was kept for two weeks followed by elastics. Wound was closed back in layers. All patients were given advice regarding the maintenance of oral hygiene and diet.

Figure 1: (b) CT scan 3D reconstruction showing right parasymphyseal fracture mandible.

Figure 1: (c) Fracture fixed with two titanium miniplates (2 mm 4 hole).

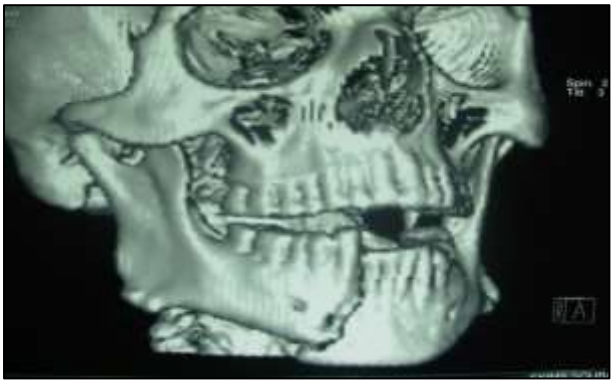

Figure 2: (a) CT scan 3D reconstruction showing right parasymphyseal fracture mandible.

Figure 2: (b) Fracture exposed by intraoral approach and marking of drill hole sites done.

Figure 2: (c) Fracture fixed with two interosseous wires.

Follow up examinations were made initially at weekly intervals and then after every month for at least 1 year. Outcome of the treatment in both groups was recorded in terms of the duration of maxillomandibular fixation, length of hospital stay, postoperative complications, patient comfort and acceptability and cost difference between the two groups - all were assessed and compared. Finally whole data were subjected to statistical analysis.

Statistical analysis

The whole data was expressed as mean, standard deviation and percentages. The difference between the treatments groups was observed by Yates corrected - Chi square test and Mann-Whitney U-test. P value was set at ≤ 0.05. Data was analyzed by using SPSS for Windows

(version 11.5; SPSS Inc., Chicago, Illinois) statistical software package.

RESULTS

The age of patients ranged from 16 to 58 years with a mean age of 30.2 years in the Plating group, and 18 to 63 years with a mean age of 31.1 years in the wiring group. Maximum cases (44%) were in the age group of 16 to 25 years with 74% (about three-fourths) in the age group of 16 to 35 years.

Eighty four percent patients were males and 16% females in the Plating group with a male to female ratio of 5.25:1. In the Wiring group, 88% were males and 12% females with a male to female ratio of 7.33:1. Overall, 86% were males and 14% were females with a male to female ratio of 6.14:1. Forty percent cases presented during summer followed by autumn and spring and least (8%) in winter.

Road traffic accident was the leading cause (60% of cases) followed by fall from height (24% of cases). A peculiar cause of 6% of cases in our study was bear maul (Table 1.)

Table 1: distribution of patients as per aetiology (N = 75 in each group).

Cause	Plating group		Wiring group		Total	
	No.	%	No.	%	No.	%
Road traffic accidents	45	60.0	45	60.0	90	60.0
Fall from height	15	20.0	21	28.0	36	24.0
Bear maul injury	6	8.0	3	4.0	9	6.0
Blast injury	3	4.0	3	4.0	6	4.0
Firearm injury	3	4.0	-	-	3	2.0
Assault	3	4.0	-	-	3	2.0
Work-related injury	-	-	3	4.0	3	2.0
Total	**75**	**100.0**	**75**	**100.0**	**150**	**100.0**

$\chi 2 = 3.7$, p= 0.722 (NS).

Table 2: Distribution of patients as per the local signs.

Signs	Plating group		Wiring group		Total		P value
	No.	%	No.	%	No.	%	
Malocclusion	63	84.0	45	60.0	108	72.0	0.115 (NS)
Open bite	27	36.0	3	4.0	30	20.0	0.013 (Sig)
Cross bite	12	16.0	6	8.0	18	12.0	0.663 (NS)
Restricted mouth opening	24	32.0	18	24.0	42	28.0	0.753 (NS)
Trismus	18	24.0	15	20.0	33	22.0	1.000 (NS)
Step deformity mandible	18	24.0	6	8.0	24	16.0	0.247 (NS)
Crepitus	24	32.0	18	24.0	42	28.0	0.753 (NS)
Exposed mandible							
Internally	15	20.0	9	12	24	16.0	0.059 (NS)
Externally	12	16.0	11	15	23	21.0	0.118 (NS)
Anaesthesia in the distribution of inferior alveolar nerve	12	16.0	9	12.0	21	14.0	1.000 (NS)

Local signs and fracture sites are recorded in Table 2 and 3. Comparative cost of hardware used for fixation is depicted in Table 4.

Postoperatively, wound infection was observed in 4% of cases in the plating group and 16% in the wiring group, while mal-occlusion was seen in 8% of patients, all in intra-osseous wiring group. Mal-union was seen in 6 of the wiring group patients and none in the plating group patients. Non-union was seen in none of the plating group patients, but was seen in 3 patients of the wiring group. Plate exposure occurred in 3 patients and plate prominence was observed in none. Seventh nerve (marginal mandibular nerve) palsy was seen in 3 patients (2%), while as inferior alveolar nerve injury was observed in 3 patients of the wiring group.

Duration of surgery for the fixation of mandibular fractures was 2.0±0.4 hours in the plating group and 2.8±0.7 hours in the wiring group.

In the titanium miniplating group, 24% patients were discharged on the first day, 56% between 2-3 days and 20% between 4-7 days. In the Wiring group, 36% of the patients were discharged between 2-3 days, 40% between 4-7 days and 24% after the first week. Cost of the hardware is compared in Table 5.

Patient acceptability and compliance are shown in Table 5.

Table 3: Distribution of the patients as per the fracture site (anatomical region).

Site	Plating group		Wiring group		Total	
	No.	%	No.	%	No.	%
Symphyseal	9	7.5	6	5.5	15	6.6
Parasymphyseal	57	47.5	51	47.2	108	47.4
Body	12	10.0	15	13.9	27	11.8
Angle	18	15.0	12	11.1	30	13.2
Ramus	3	2.5	3	2.8	6	2.6
Subcondylar	9	7.5	12	11.1	21	9.2
Condyle	12	10.0	9	8.3	21	9.2
Total	**120**	**100.0**	**108**	**100.0**	**228**	**100.0**

$\chi 2 = 0.9$, p= 0.988 (NS).

Table 4: Cost of fixation (hardware).

	Plating group	Wiring group
Total no. of cases	75	75
Total no. of fractures fixed	99	87
Total no. plates used	198	-
Total no. of screws used	376	-
Total no. of wires used	-	87
Cost of fixation of one fracture	3500	300
Total cost of plates and screws/wires (rupees)	**346500**	**26100**

One Dollar = 67 Indian rupees.

Table 5: Patient acceptability/satisfaction (using a scale from 0 - 10).

	Plating group		Wiring group		Total	
	No.	%	No.	%	No.	%
Excellent	30	40.0	-	-	30	20.0
Good	36	48.0	6	8.0	42	28.0
Fair	9	12.0	6	8.0	15	10.0
Poor	-	-	63	84.0	63	42.0
Total	**75**	**100.0**	**75**	**100.0**	**150**	**100.0**

$\chi 2 = 38.3$, p = 0.000 (Sig).

DISCUSSION

Majority of our patients (44%) were in the age group of 16 to 25 years with 74% of our patients (about three-fourths) in the age group of 16 to 35 years. This is in agreement with Patrocinio et al, Kellman et al, Zachariades et al and Ozgenel et al who observed a peak occurrence in young adults aged 20 to 29 years.[2,13-15] This predominance is due to the fact that this age group is more prone to road traffic accidents and violence.

Most of our patients (86%) were males with a male to female ratio of 6.1:1. This male predominance is in agreement with most of the authors.[2,4,9,11,13-23]

Road traffic accidents were the major cause (60%) of mandibular fractures in our study followed by fall from height (24%). A unique cause of mandibular fractures in our study was bear maul injuries accounting for 6% of cases. Differences between populations regarding the causes of maxillofacial fractures have been reported to be due to socioeconomic, geographic and cultural

differences. In our study, road traffic accidents were responsible for the majority of mandibular fractures which is consistent with the findings in many developing countries where road traffic accident remains the commonest cause of maxillofacial fractures.[2,22] This is at variance with reports from developed countries where assaults are now becoming the commonest cause of injury.[11,16,23]

Motorcyclists who sustained facial fractures had not worn helmets during the accident. Similarly, majority of accident victims were not using seat belts at the time of injury, emphasizing the need for their mandatory use.

Maximum number of injuries (40%) occurred during summer followed by autumn and spring and least (8%) in winter which again is in agreement with Malara et al who reported majority of cases occurring in spring and summer with least cases in winter.[1] In addition, in our state, environmental conditions are such that during winter people like to remain indoors and overall traffic movement is less, especially motorbike plying comes to a virtual halt. As a result, incidence of road traffic accidents decline during winter. In addition, fall from height being the second leading cause in our study; fall from walnut trees is peculiar in our valley during the last month of summer, and early autumn (harvesting season), leading to increased incidence of cases during these months.

Majority of our patients (47.4%) had parasymphyseal fracture followed by angle (13.2%), body (11.8%), condyle and subcondyle (9.2% each), symphysis (6.6%) and ramus (2.6%). This is in accordance with Kellman et al, Theriot et al, Abbas et al, Ozgenel et al who also observed parasymphyesal fracture as most common fracture followed by angle, body, condyle-subcondyle, symphysis and ramus.[11,13,15,21] This is in contrast to the observations made by Iizuka et al and Adeyemo et al who noted angle and body as the most common sites of fracture followed by parasymphysis, condyle and symphysis.[18,23]

Operative time was reduced in the titanium miniplating osteosynthesis group as compared to the wire osteosynthesis group which was statistically significant, inspite of the fact that most of the patients with complex associated injuries were managed with titanium miniplate fixation. Reason for this is that wiring requires more dissection, exposure of two surfaces (buccal as well as lingual), wider exposure, and wires are tedious to apply. This is in contrast to what had been reported by Leach et al that plate fixation was associated with slightly longer than average hospital stay and a significantly longer operative time.[24]

Twenty four percent of plating group patients was discharged on the 1st postoperative day while 80% were discharged by the 3rd day. Only 16% of wiring group patients were discharged within 3 days and 24% of patients were discharged during the 2nd week. Patrocinio et al reported that the time until discharge ranged a lot, depending on patient's condition and severity of associated injuries ranging from the same day to 82 days.[2] Our findings are in agreement with those of Renton et al who showed significantly shorter hospital stay in plating group.[16] Contrary to ours, Leach et al and Hoffman et al reported that plate fixation was associated with longer than average hospital stay.[17,24]

In our study, the overall incidence of wound infection was 10%, with 4% of infection rate in the plating group and 16% in the wiring group. This is in agreement with the published literature, reporting the infection rate with plates to be between 3% and 23%. On the other hand, the reported rate of infection of mandibular fractures treated with conventional methods is between 4.4% and 17%.[14] Sindet-Pedersen et al reported that titanium miniplate fixation is associated with a low complication rate and reduced morbidity as compared to the conventional treatment.[25] Likewise, Renton et al reported a significantly reduced complication rate in plating group compared with trans-osseous wiring group.[16] The low infection rate with plates is related to low mobility of the fragments. In addition, metal plates can be used in the presence of infection because they provide mechanical immobility which is the principal factor for success in treating infected fractures.[14] Theriot et al and Leach et al reported that the number of infections was higher with plates than with wires.[11,24] Hoffman et al reported a comparable infection rate in the two groups.[17]

In our study, malocclusion was seen in 8% of patients, all in intraosseous wiring group. Ozgenel et al and Fox and Kellman, both reporting malocclusion rate of 5.9%.[8,15] Mal-union was seen in six of the wiring group patients and none in the plating group, while the reported mal-union rate for current plating procedures range from 0.5% to 1.9%.[19] Non-union was seen in none of the plating patients, as is also reported by Fox and Kellman and Bolourian et al.[8,9] However, non-union was seen in three patients of the wiring group.

In our study, plate exposure occurred in 3 patients and plate prominence was observed in none. This is in agreement with Rubin et al who after reviewing the literature reported that the average incidence of the implant becoming exposed is 2% with plate prominence reported in none.[26]

The use of miniplates is a standard technique in the treatment of facial fractures. Miniplates aim to fix the bone ends solely in the reduced position without compression. Because the plates are very thin, they achieve good aesthetics and are scarcely palpable. It has been advocated that engaging a single cortex (monocortical screws) is adequate.[27] Reviews of large series of patients have consistently found relatively lower infection rates and improved overall results when plate fixation has been utilized. The advantages of plate

fixation include absolute immobilization of the fracture site. Also the ideal treatment for comminuted fractures of the mandible is by means of ORIF with titanium miniplates. In fractures with extensive displacements, by exposing the fracture, one is able to reduce all these comminuted fragments to a pre-traumatic anatomic position. 28 Though inter-osseous wiring is simple and inexpensive, it needs more exposure than rigid fixation techniques. It fixes the fracture none rigidly and tends to loosen because of the pressure on thin wire. Even the best inter-maxillary fixation and wire fixation allows some motion, which contributes to both non-union and infection. Threading the wire through both fragments can be difficult and must be repeated if the wire is broken during tightening.[14]

A major advantage of titanium miniplate osteosynthesis is the avoidance or reduction of inter-maxillary fixation duration leading to an overall general improved postoperative function including respiratory function. Inter-maxillary fixation is fraught with dangers such as vomiting and aspiration even in otherwise healthy patient. Maintenance of weight and mouth opening are also better.[16] There is better patient compliance and improved nutrition during the healing period. There is both clinical and experimental evidence that prolonged inter-maxillary fixation results in muscular atrophy and stiffness of temporomandibular joint.[17] Furthermore, it is safer in the neurologically damaged patient, particularly in the presence of seizure disorder; it may also eliminate the need for tracheostomy. Certain brain injured patients actually do not tolerate inter-maxillary fixation, and may often break and dislodge appliance, and avoidance of inter-maxillary fixation will improve the likelihood of success. In addition, it can save people in certain profession (e.g. sales) from loss of livelihood.[13]

The limitation of these plates is the cost. Reported results from several studies focusing on economic analysis have been inconsistent. Investigators including Hoffman et al, Thaller et al, Brown et al and Dodson and Pfeffle have argued that ORIF may be the more cost-effective approach for treating mandible fractures if the costs of treating potential complications are considered. In contrast, El-Degwi and Mathog, Schmidt et al and Shetty et al suggest that the use of MMF offers considerable cost-savings over ORIF. Our study results are consistent with the findings of other investigators (Schmidt et al, Abubaker and Lynam), that the cost of ORIF is nearly threefold higher than conventional MMF and wiring.[29]

CONCLUSION

A major advantage of the Titanium miniplate osteosynthesis is the altogether avoidance or reduction of the period of inter-maxillary fixation. This is of critical importance in the patients with head injuries and patients needing multiple surgical procedures. The ideal treatment for comminuted fractures of the mandible is by means of open reduction and internal fixation with Titanium miniplates.

Operating time and hospital stay are significantly reduced in the titanium miniplate group as compared to wiring group. There is higher incidence of infection and occlusion-related complications in the wiring group as compared to the titanium miniplate group.

Miniplating is more costly as compared to wiring, though the advantages are far more and there is a better patient compliance and acceptability with the titanium miniplate fixation. Although cost implications are important however it should be just one factor in making a decision regarding the best treatment for each patient even in developing countries.

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