

Erich arch bar versus hanger plate technique for intermaxillary fixation in fracture mandible: A prospective comparative study

ABSTRACT

Introduction: Various methods have been described for intermaxillary fixation (IMF) for treatment of faciomaxillary injuries. Many studies have been described to evaluate the efficacy of different methods. Hanger plate method has not been commonly used. The aim of the present study was to compare the advantages and disadvantages of this method over Erich arch bar in mandibular fracture.

Materials and Methods: Sixty patients of only mandibular fracture presenting to trauma center requiring open reduction and internal fixation under general anesthesia were randomly allocated to Group A and Group B comprising thirty patients in each. Group A included patients who received IMF with Erich arch bar. Group B included patients who received IMF with hanger plate method. The two groups were compared for time duration of intermaxillary procedure, total duration of surgery, oral hygiene score, postoperative occlusion, and complications.

Results: The average time of intermaxillary procedure, total duration of surgery, and wire prick injuries were more in Group A. Oral hygiene score was significantly better in Group B. Postoperative occlusion was comparable between the two groups. There was screw loosening in four patients in Group B, but none had tooth root injury. The cost of material for IMF was more in Group B.

Conclusion: IMF with hanger plate method is more safe and efficacious compared to Erich arch bar in the treatment of mandibular fractures.

Keywords: Hanger plate method, intermaxillary fixation, mandibular fracture

INTRODUCTION

Intermaxillary fixation (IMF) is integral in the management of facial fractures. The methods include arch bars, dental and interdental wiring, prosthetic splints, and IMF screw.^[1] Erich arch bar has drawbacks of wire prick injury, difficult application in carious, crowded, and periodontally compromised teeth, and poor oral hygiene.^[2] The IMF screw described by Arthur and Berardo had several advantages such as quick and easy application, stable fixation, patient tolerance, better oral hygiene, and less wire prick injury.^[3,4] Hanger plate technique has been described by the Association of Osteosynthesis Craniomaxillofacial (AO-CMF). Despite the advantages of hanger plate technique, it is less commonly used. The present study compared it to Erich arch bar technique in fracture mandible.

MATERIALS AND METHODS

This prospective randomized comparative study was conducted in the department of plastic surgery on sixty patients presenting with isolated mandibular fractures to the trauma center. Patients were adequately resuscitated as per Advanced Trauma Life Support guidelines and included in study after a written informed consent.

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They were assigned to either Group A (Erich arch bar fixation IMF) or Group B (hanger plate technique for IMF) using central computer-generated randomization. A noncontrast computed tomography (NCCT) scan with three-dimensional (3D) reconstruction was done in every case for diagnosis of fracture type, number, and location [Figures 1-4].

Inclusion criteria

1. Unilateral/bilateral parasymphysis/body fractures of the mandible
2. Unilateral/bilateral fractures of angle of the mandible
3. Unilateral fracture parasymphysis with contralateral body or angle fracture.

Exclusion criteria

1. Faciomaxillary injury associated with midface fractures
2. Comminuted mandibular fractures
3. Faciomaxillary injury with dento-alveolar fracture and mandibular fractures with significant teeth loss
4. Faciomaxillary injury in a edentulous mandible
5. Fracture mandible with grievous life- and/or limb-threatening injuries
6. Fracture mandible with contraindication to IMF
7. Pathological fracture of mandible.

A team of same chief surgeons and assistant surgeon operated all patients under general anesthesia using nasal intubation or submental intubation if nasal intubation was not possible. In Group A, Erich arch bar of appropriate length was cut and contoured with hooks directed upward for upper jaw and downward for lower jaw over the buccal surface. Erich arch bar was fixed with a 15-cm long prestretched 26G stainless steel wire. The wire was passed from the mesial surface of tooth toward lingual surface and then around distal surface toward buccal surface so that arch bar is between two ends. The arch bar is fixed to the neck region of each tooth by gradually twisting two ends of the wire in clockwise direction. We achieved IMF with Erich arch bar, using prestretched 15-cm long 26G stainless steel wire secondaries passed around the corresponding hooks of the upper and lower jaws [Figure 5]. It was followed by open reduction and internal fixation of fracture using appropriate incision and titanium plates and screws.

In Group B, noncontrast CT scan with 3D reconstruction was studied to see the position of canine and premolar tooth roots. The surgical technique involved infiltration of adrenalin solution (1 in 200,000 dilutions) at premarked sites (i.e., space between canine and premolar root) for screw fixation. After 5 min, 2 to 3-hole 1.5-mm stainless steel plates were fixed at site using 6–10 mm × 1.5 mm



Figure 1: Pre-operative occlusion (Group A)



Figure 2: NCCT Scan 3-D Reconstruction head (Group A)



Figure 3: Pre-operative occlusion (Group B)

screws into a 1-mm predrilled hole in between the roots of canine and first premolar. We fixed 4–5 plates and achieved the IMF with tightening of the prestretched stainless steel wires passed through free holes of the corresponding plates

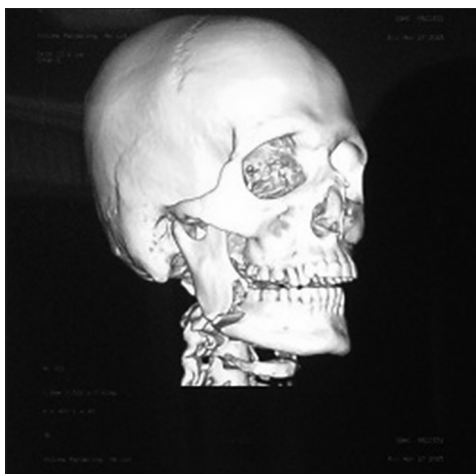


Figure 4: NCCT Scan 3-D Reconstruction head (Group B)

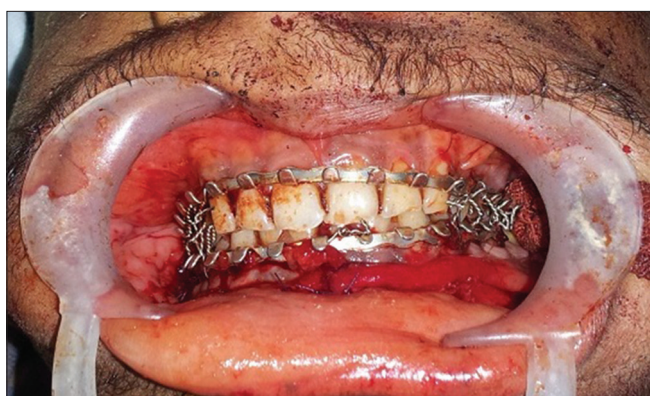


Figure 5: Occlusion after Intermaxillary fixation (Group A)



Figure 6: Occlusion after Intermaxillary fixation (Group B)

on both jaws [Figure 6]. It was followed by open reduction and internal fixation of fracture using appropriate incision and titanium plates and screws. The IMF device was removed 7 days postsurgery. Subsequently, the patients were assessed at 2 weeks, 1 month, and 3 months postoperatively. The parameters evaluated in both groups included time duration to achieve IMF and total duration of surgery,

incidence of wire prick injury, and stability of fixation device at the time of surgery. Postoperatively, we evaluated for loosening/dislodgement of screw, teeth root injury, and oral hygiene status using specially designed index to assess mucositis with fixation device *in situ*. It was modified from Oral Hygiene Index-Simplified described by Greene and Vermillion (1964). The new oral hygiene index was under the headings of debris index, bleeding enlargement, and gingival enlargement. Scores were allotted as mentioned below:

Debris score

The Debris score and criteria are as follows:

- 0 – No debris or stain
- 1 – Soft debris covering not more than one-third of the tooth surface
- 2 – Soft debris covering more than one-third but not more than two-third of the tooth surface
- 3 – Soft debris covering more than two-third of the exposed tooth surface.

Bleeding component

The Bleeding component score and criteria are as follows

- 0 – No bleeding on provocation
- 1 – Light bleeding on provocation
- 2 – Moderate bleeding on provocation
- 3 – Spontaneous bleeding.

Gingival enlargement score

The Gingival enlargement score and criteria are as follows

- 0 – No gingival enlargement
- 1 – Enlargement present but not covering the implant/arch bar
- 2 – Enlargement covering implant/arch bars.

The above criteria were evaluated for teeth numbers 11, 14, 24, 31, 34, and 44 for each patient at 1 week postoperatively before removal of IMF. The scores at all the teeth region were summated to obtain a grand total. The grand total was divided by the number of teeth evaluated (6) to get an oral hygiene score. A score of 0–1.6 was considered good, 1.7–4.8 as fair, and 4.9–8 as bad.

After follow-up till 3 months, the assessment of occlusion was recorded as poor, fair, or good as per the patient by a blinded observer from the department of plastic surgery [Figures 7 and 8]. The statistical analysis of the observations was done using *t*-test, Fisher's exact test, and Chi-square test using SPSS 22.0 2013 Version IBM, USA. $P < 0.05$ with 95% confidence interval was considered statistically significant [Table 1].

RESULTS

In our study, the mean age of patients in Group A was 31.43 ± 9.47 years and 31.27 ± 11.41 years in Group B ($P = 0.951$). In our study, the predominant gender constituted males in both groups. Group A had 25 (83.3%) male and 5 female patients (16.7%), whereas Group B had 28 males (93.3%) and 2 females (6.7%) ($P = 0.424$). The two groups were comparable for age and sex statistically ($P = 0.951$ and $P = 0.424$, respectively).

The average duration of time to achieve IMF in Group A was 81 min, whereas it was 21.20 min in Group B ($P = 0.0001$). The total operating time was 173 min in Group A and 93 min in Group B ($P = 0.0001$). It showed that the new technique is quick and significantly reduces the operation time. There were 11 prick injuries verified by glove perforation in Group A and Group B had only 2 prick injuries ($P = 0.011$).

New oral hygiene score was calculated by adding debris index, bleeding score, and gingival hypertrophy score. The mean debris score was 1.84 ± 0.445 in Group A as compared to 1.002 ± 0.19 in Group B ($P = 0.001$). The mean bleeding score was 1.06 ± 0.520 and 0.396 ± 0.255 in Group A and Group B, respectively ($P = 0.001$). The mean gingival hypertrophy score was 0.968 ± 0.487 in Group A as compared to 0.335 ± 0.178 in Group B ($P = 0.001$). The overall mean oral hygiene score was 3.88 ± 1.27 for Group A and 1.73 ± 0.51 for Group B ($P = 0.001$). There were four cases (13.3%) where one screw loosening was recorded in Group B and none had dislodgement. None of the patients had tooth root injury.

The postoperative occlusion was graded as fair by two patients (6.7%) in both the groups ($P = 1.00$). Five patients (16.7%) in Group A and 4 (13.3%) patients in Group B

were graded as fair occlusion by blinded observer ($P = 1.00$). In our study, the average cost of the materials required for IMF in the Group A was Rs. 550 (cost of Erich arch bar, 26G stainless steel wire) and it was Rs. 1250 (cost of 10-hole 1.5-mm stainless steel plate and 6–10 mm \times 1.5 mm four screws) for Group B [Tables 1 and 2].

Table 1: Statistical analysis

Parameter evaluated	Test used	P	Mean	SD
Total time for intermaxillary fixation (min)	Unpaired t-test	0.0001	Group A: 81 Group B: 21	Group A: 9.5 Group B: 3.2
Total duration of surgery (min)	Unpaired t-test	0.0001	Group A: 173 Group B: 93.333	Group A: 41.07 Group B: 32.302
Wire prick injury	Fisher's exact test	0.112	NA	NA
Oral hygiene score	Fisher's exact test	0.01	Group A: 3.8 Group B: 1.73	Group A: 1.27 Group B: 0.518
Age (years)	Unpaired t-test	0.951	Group A: 31.43 Group B: 31.27	Group A: 9.47 Group B: 11.41
Gender distribution	Fisher's exact test	0.424	NA	NA

$P < 0.05$ considered significant finding. SD: Standard deviation, NA: Not available

Table 2: Comparison of clinical parameters

Parameter evaluated	Erich arch bar	Hanger plate method	P
Surgical time taken for Intermaxillary fixation(min)	60-100	15-26	0.0001
Postoperative occlusion			
Satisfactory	30	30	1
Unsatisfactory	0	0	
Wire prick injury			0.011
Present	11	2	
Absent	19	28	
Oral hygiene score	3.88	1.73	0.001

$P < 0.05$ considered significant finding



Figure 7: Occlusion at 3 month (Group A)



Figure 8: Occlusion at 3 months (Group B)

DISCUSSION

The most commonly fractured bone of the facial skeleton after high-velocity trauma, especially road traffic accidents, is mandible.^[5] Optimum and timely treatment has the potential to restore normal form and function in majority of cases. The successful achievement of these two goals depends on optimum fracture reduction and its maintenance in this position during fracture fixation and postoperatively. Temporary IMF is the first and foremost essential component for fracture reduction and its stabilization to achieve pretrauma dental occlusion.^[6] Various techniques of IMF have evolved over time, but arch bars have been the mainstay for the treatment of faciomaxillary fractures since World War I. Erich arch bar is the most evolved form of arch bar being used till date. Although arch bars provide a useful and versatile method of IMF, their use is not without inherent risks. These risks include wire prick injury, increased duration of surgery, trauma to tooth and gingiva, and difficult application in case of crowded, misaligned, extensively crowned, bridge worked, partial, or absent dentition. Introduction of IMF screw by Arthur and Berardo in 1989 brought relief to a majority of problems related to arch bar. The IMF screws were costly and had the risk of damaging tooth roots, injury to gingiva, screw fracture, and dislodgement. Hanger plate method is the other bone-supported method described by the AO-CMF for IMF. It has been less frequently used. The literature review showed many studies on comparison of IMF screw with arch bar method for IMF, but none on hanger plate method.^[7-9] We compared this technique of IMF with Erich arch bar method.

Patients in our study ranged from 18 to 66 years and majority (50%) were in the second decade age group. A similar type of young population group had been reported in studies done by Calderoni *et al.*, Natu *et al.*, and Naveen Shankar *et al.*^[10-12] Younger age group individuals are functionally productive population and are involved in outdoor work activities and traveling, and hence they are prone to have injuries.

The male-to-female gender ratio of 8:1 in the present study is similar to the other studies by Nandini *et al.*, Calderoni *et al.*, Natu *et al.*, and Naveen Shankar *et al.* on maxillofacial injuries.^[9-12]

In our study, average time to complete IMF was 81 and 21.20 min in Erich arch bar and hanger plate method, respectively. The data show that hanger plate method is significantly quicker than arch bar method ($P = 0.0001$). Similar findings have been reported in comparative studies by Qureshi *et al.* and Nandini *et al.*,^[7,9] The use of nontapping screw and multiple fractures of mandible in our study could

be the reason for slightly longer time for IMF as compared to studies using IMF screw. In our study population, we have also recorded the time taken from completion of IMF to the end of surgery and the total time taken for surgery. We found that the comparison of average time duration from IMF to completion of surgery in the Erich arch bar group (92 min) and hanger plate group (76 min) was not statistically significant (0.077). The comparison of total time of surgery was statistically significant ($P = 0.001$). It was attributable to the lesser time taken for IMF by the hanger plate technique.

In our study, the incidence of wire prick injury in the arch bar group was 36% compared to 6.6% in hanger plate group. The results were inconsistent with the data from previous studies by Qureshi *et al.*, Rai *et al.*, Nandini *et al.*, and van den Berg *et al.*^[7-9,13] The stability of IMF was found to be satisfactory and comparable in both groups during intraoperative assessment. Similar results were reported by Nandini *et al.*^[9]

The review of literature described screw loss between 0.03% and 25%^[14-18] and screw loosening between 2.5% and 16.9%.^[1,13,19-24] We recorded four cases (13.3%) of screw loosening which required only tightening during the follow-up period. There was no recorded incidence of screw dislodgement or loss. We did not record any screw or plate fracture. This incidence was found to be in accordance to the low incidence of 0%–4% in other studies by Roccia *et al.*, Rai *et al.*, and Coletti *et al.*^[8,16,25]

The incidence of tooth root injury has been reported in literature from 0.53% to 14% by Rai *et al.*, van den Bergh *et al.*, West *et al.*, and Roccia *et al.*^[8,13,15,17] In our study, we recorded no incidence of tooth root injury. The possible reason could be attributed to the use of 1.5-mm screw and preoperative planning with investigations such as orthopantomogram and NCCT.

In our study, an index was specially designed to assess oral hygiene and mucositis with fixation device *in situ* and was assessed just before the removal of device. The scoring was done as debris index, gingival bleeding index, and gingival enlargement index. The oral hygiene scores were better in hanger plate group as compared to that of arch bar group. Similar results were reported by Rai *et al.*, Roccia *et al.*, and Fabbroni *et al.*^[8,17,22]

We found that the status of occlusion at the end of 3 months by the patient as well as a blinded observer was equally good in both groups. These findings were in accordance with those reported by van den Berg *et al.*, Roccia *et al.*, and Gordon *et al.* in their study.^[13,17,26]

In our study, we observed that excluding factors such as the cost of general anesthetic agents, operation theater hours

used, and implant, the average cost incurred for IMF was higher in the hanger plate group as compared to that of arch bar group (Rs. 1250 vs. Rs. 550). However, one observation that hanger plate technique offers all the advantages of IMF screw technique (average cost Rs. 8000–12,000) at significantly lower cost (Rs. 1250).

CONCLUSION

Hanger plate method of IMF is more safe and quick to perform in comparison to Erich arch bar. It allows maintenance of better oral hygiene than Erich arch bar. Hanger plate method gives equally good results of postoperative occlusion with less risk of wire prick injuries. The cost of material for hanger plate method is more than Erich arch bar method.

We conclude that Hanger plate method of IMF is a safe and effective alternative to Erich arch bar in uncomplicated mandibular fractures. This method is not indicated in cases of pediatric, osteoporotic, and comminuted mandibular fractures. As this is first study on small sample size so its conclusion needs further confirmation by more studies in future.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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