A comparative clinical study among intermaxillary fixation screw, Erich arch bar and Ivy eyelet in mandibular fracture

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ABSTRACT

Introduction: Management of mandibular fractures requires intermaxillary fixation (IMF) as an adjunct to open reduction and internal fixation (ORIF). IMF is fixing mandible to maxilla with the help of a metallic framework around teeth or dentoalveolar segment to secure correct inter-arch relationship before plating. The methods for IMF are Erich Arch bars and Ivy Eyelet and IMF screw. Thus, the aim of this study was to compare the outcomes of IMF screws, Erich arch bar and Ivy Eyelet in achieving intraoperative IMF. **Methods:** The study included 45 patients with mandibular fracture who underwent ORIF and required IMF as part of treatment, under general anesthesia. Patients were divided equally into three groups. Group A: patients who were treated using Erich arch bars, Group B: patients who were treated using Ivy Eyelets and Group C: patients who were treated using IMF screws. The outcomes were compared among three groups to draw an inference on surgical time, gloves perforation and post-operative occlusion. **Results:** The study showed mandibular fractures among 16 to 52 years of age with mean age of 26.62 ± 8.497 years, more common in 21 to 30 years of age groups. The median time were 65 minute, 28 minute and 35 minute for Erich arch bar, Ivy eyelet and IMF screw respectively ($p<0.05$). Gloves perforation was present in all cases of Group A, nine cases of Group B and only four cases of group C ($p<0.05$). There was no significant difference in post-operative occlusion among three groups ($p>0.05$). **Conclusions:** IMF screw was more effective than Erich arch bar and Ivy eyelet in terms of surgical time and gloves perforation.

Keywords: Erich's arch Bar, IMF screw, Ivy eyelet, mandible fracture.

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INTRODUCTION

According to Killey and Rowe, mandibular fractures comprise about 40 to 65% of all facial fractures.[1] Mandible plays an important role in mastication, phonation, deglutition and maintenance of dental occlusion. The ultimate goal of treating mandibular fracture is to restore the mandibular form and function to its pre-traumatic condition. Open reduction and internal fixation (ORIF) has become the gold standard for managing simple as well as complex mandibular fractures.[2-4] ORIF includes fixation of fracture segment with the use of titanium miniplates and healing by osteosynthesis.

Intermaxillary fixation (IMF) refers to temporarily fixing the mandible to the maxilla with the help of a metallic framework attached to teeth or dentoalveolar segment before plating.[3] The sole purpose of IMF during ORIF is to achieve and secure correct occlusion, and facilitate in reduction and stabilization of fracture segment till completion of ORIF.

The arch bar has been considered as a reliable fixation device for a long because of its rigidity, versatility, effectiveness, and superior stability.[4-5] Ivy eyelet introduced by Robert Ivy[6] is economical requiring minimum technique and armamentarium. They have

disadvantages like poor oral hygiene, trauma to the periodontium, reduced patient compliance, longer time required for placement, and risk of needle stick injury.[7,8]

The cortical bone screw or IMF screws were first introduced by Arthur and Berardo in 1989 and later modified by Carl Jones with a Capstan-shaped head design.[9] These provide bone-borne support for the ligature wires to achieve IMF instead of tooth-borne support as in arch bars and Ivy Eyelets. Several complications like poor oral hygiene and periodontium trauma is avoided with IMF screw.

The purpose of this prospective study was to compare the outcomes of the IMF screw, Erich arch bar, and Ivy eyelet in terms of surgical time taken, gloves perforation, and post-operative occlusion in the surgical management of mandibular fracture.

METHODS

This is an observational, analytical prospective study conducted at the Department of Oral and Maxillofacial Surgery, Department of Emergency and Major Operation Theatre, Universal College of Medical Sciences, Bhairahawa from September 15, 2020 to September 14, 2023. Ethical approval was obtained from the Institutional Review Committee of Universal College of Medical Sciences, Nepal. Patients with mandible fractures who required IMF as a part of their treatment and satisfied the inclusion criteria were included in the study. The sample size of 45 was calculated by taking 50% prevalence.[10]

Since the study on prevalence of mandibular fracture among normal population at UCMS or nearby region of Nepal and India could not be found, the prevalence is assumed as 50%. Thus applying the formula of sample size as

$$n = \frac{Z^2 P(1-P)}{d^2}$$

where, n = sample size, Z= standard normal variate at 5% type 1 error it is 1.96, P= expected prevalence in population taken as 50%, d= absolute error or precision taken as 15%. The minimum sample size for the study was 43. Thus, for convenience the sample size was taken as 45. Patients were allocated one of the three treatment modalities on the basis of lottery methods. In this study, 15 patients were assigned randomly in each group. Group A: Erich arch bar Group B: Ivy eyelet and Group C: IMF screw.

The inclusion criteria were the patients aged 16 years and above, with mandibular fractures treated with ORIF and required IMF intra-operatively or post-operatively, and patients treated under general anaesthesia. The exclusion criteria were pathological fracture, comminuted fracture, dentoalveolar fracture of mandible, edentulous patients, concomitant other facial fractures such as panfacial fractures, Lefort fractures, patients not willing to participate in the study. Informed written consent was taken from all the patients and confidentiality was maintained regarding patients' information and publication of their data.

A detailed history was taken regarding demographic data of patients and mechanism of injury. Diagnosis of mandible fracture was made with the help of clinical and radiographic examinations and type of fracture were recorded. Other associated injuries including head injuries were ruled out and if present were managed initially.

IMF methods were selected on the basis of lottery method for all patients. After proper painting and draping, oral cavity was irrigated and disinfected with povidone iodine and normal saline. IMF procedures were performed prior to ORIF and following clinical parameters were recorded.

1. **Surgical time** taken was noted in minutes as placement time and IMF time. Placement time was taken from the point of intraoral irrigation till the completion of procedure. IMF time was taken from the end of incision and exposure of fracture site till the IMF was achieved. Both placement time and IMF time were added.
2. **Needle stick injury or incidence of gloves perforations** of surgeon and first assistant was identified by water leak test (WLT).[11] Double gloves were used in the procedure. Gloves perforation were noted as present or absent based on leakage when tap water were poured into gloves through a plastic tube.
3. **Post-operative occlusion** were check on first or second postoperative day and recorded as satisfactory or non-satisfactory based on difference in occlusion from pre trauma state. Satisfactory occlusion[12] was assessed as:

   a. Maximum intercuspation of teeth

   b. Angle's Molar relation / Canine relationship

   c. Lingual-labial/ buccal relationship

   d. Vertical relationship

RESULTS

During the study period, total of 89 patients with mandibular fractures were reported to the Department of Oral and Maxillofacial Surgery. Out of which, 45 patients were selected for the study who met inclusion criteria and

divided into three equal groups. All data were compiled and managed digitally in Microsoft Excel 2016. Statistical analysis was performed using IBM statistical package for the social sciences (SPSS) version 20.0. Kolmogorov- Smirnov test showed most of these data were non- parametric. Descriptive as well as comparative analysis were done. The patients' age ranges from 16 to 52 years with median of 24 years and mean of 26.62±8.497 years. Mandibular fractures were most common in 21 to 30 years of age group. It includes 38(84.4%) male and 7(15.6%) female patients with a male-to-female ratio of 5.42:1. The most common mode of injury were road traffic accident (RTA) followed by fall injury.

Among 45 patients, 36(80%) patients had single site fracture, and 9(20%) had two site fractures. Thus, a total of 54 fractures were noted among 45 patients. The most common fracture was parasymphysis (57.4%) whereas least common fracture was body of mandible fracture (11.1%) among 54 fractures.

When clinical parameters like surgical time, gloves perforation, and post-operative occlusion were compared among three groups using the chi-square test, statistically significant differences were seen in terms of surgical time and gloves perforation. None of the Erich arch bars were completed before 30 minutes and none of IMF screw procedures took more than 60 minutes whereas, Ivy eyelet took less than 30 minutes in nine cases and more than 60 minutes in only one case ($p<0.05$). The gloves perforation was present in all cases of Erich arch bar followed by nine cases of Ivy eyelet and four cases of IMF screw ($p < 0.05$). There was no statistically significant difference in post-operative occlusion among three groups. (Table 1)

Table 1: Comparison of clinical variables among three groups

Clinical parameters		Type of IMF			Chi square value	p-value
	Erich Arch bar	Ivy Eyelet	IMF screw			
Surgical time	Up to 30 min	0	9	6	22.210	<0.001*
	31 to 60 min	7	5	9		
	>60 min	8	1	0		
Gloves perforation	Absent	0	6	11	17.206	<0.001*
	Present	15	9	4		
Post-operative occlusion	Unsatisfactory	2	1	0	2.143	0.343
	Satisfactory	13	14	15		

*p<0.05 denotes statistical significance

Median surgical time was 65 minutes, 28 minutes and 35 minutes for Erich Arch bar, Ivy eyelets and IMF screw respectively. When median surgical time was compared between two individual groups at a time using Mann-Whitney U test, time taken for placement of Ivy eyelets and IMF screw were significantly lesser in comparison to Erich arch bar ($p < 0.05$). There was no statistically significant difference in median surgical time between Ivy Eyelet and IMF screw ($p>0.05$). (Table 2) Comparing three groups for median surgical time shows significant difference among groups. (Table 3)

Table 2: Comparison of surgical time between two groups

Surgical time (min)		Median surgical time (25th – 75th percentiles)	Mann-Whitney U test value	p-value
Erich Arch bar vs Ivy Eyelet	Erich Arch bar	65 (55-72)	16.5	<0.001*
	Ivy Eyelet	28 (23-40)		
Erich Arch bar vs IMF screw	Erich Arch bar	65 (55-72)	10.0	<0.001*
	IMF screw	35 (25-45)		
IMF screw vs Ivy Eyelet	IMF screw	35 (25-45)	98.5	0.559
	Ivy Eyelet	28 (23-40)		

Non-parametric, Mann-Whitney U test, *p<0.05 denotes statistical significance

Table 3: Comparison of surgical time among three groups

Clinical parameter	Type of IMF	N	Mean rank	p-value
Surgical time (min)	Erich Arch bar	15	36.23	<0.001*
	Ivy Eyelet	15	15.67	
	IMF screw	15	17.1	
	Total	45		

Non-normal distribution, Kruskal-Wallis test; *p<0.05 denotes statistical significance

DISCUSSION

Mandible is unpaired and the only mobile bone of the facial skeleton which plays an important role in mastication, speech and deglutition.[13] Mandibular fractures are one of the commonest fractures of facial skeleton.[14] When fractures occur, they have the ability to affect the patient's occlusion significantly, cause infection and lead to considerable pain. Interventions to prevent these sequelae require either closed or open forms of reduction and fixation. IMF is conventionally used as a means of reduction, immobilization and stabilization during open reduction.[15] Among various techniques of IMF described in literature, the most commonly used techniques are Erich arch bar, Ivy eyelet and IMF screw which have their own advantages and disadvantages from patients and surgeons' point of view.[16]

In the present study, patients range from 16 to 52 years with a median of 24 years and mean of 26.62±8.497 years. Mandibular fractures were most common in 21 to 30 years of age group. This may be because people in this age-group are most active and are involved in outdoor activities. Fractures were more common in males than females with male and female ratio of 5.42:1 which may be due to male being more exposed to risk factors of facial trauma such as motor vehicle accidents and physical aggression. The most

common site of fracture was parasymphysis among 54 fractures.

The most frequent etiology of fractures was RTA followed by fall from height and physical assault. The most common reason for this may be due to low socio-economic status of people leading to the use of high numbers of two-wheelers like bicycles, motorbikes, etc.; lack of awareness in using safety measures in the form of helmets; use of alcohol while driving; poor road conditions and hilly areas.[17]

The median surgical time for Erich arch bar, Ivy eyelets and IMF screws were 65 minutes, 28 minutes and 35 minutes respectively. When surgical time was categorized into three different time intervals and compared among three groups: None of Erich arch bar were completed before 30 minutes and none of the IMF screw procedure took more than 60 minutes whereas, Ivy eyelet took less than 30 minutes in nine cases and more than 60 minutes in only one case.

Thus, surgical time was significantly lesser in Ivy eyelets and IMF screw techniques in comparison to Erich arch bar. These results are in consistent with studies done by Qureshi et al.,[18] Jain et al.,[11] Rai et al.[19] and Kumar et al.[20] Although, there was no statistically significant difference in surgical time when Ivy eyelet was compared to IMF screw in this study ($p>0.05$). In contrast, a study done by Hussain et al.[21] and Ingole et al.[22] showed IMF screw as more efficacious in surgical time in respect to Ivy eyelets.

The present study showed significant difference in surgical time when Erich arch bar was compared with Ivy eyelets. Whereas, other studies showed no statistical difference in surgical time between Erich arch bar and Ivy eyelets.[2,23]

Gloves perforation was significantly lesser in IMF screw compared to Erich arch bar and Ivy eyelet. This is in accordance with results of previous studies between IMF screw and Erich arch bar[9,16,19,24] between IMF screw and Ivy eyelets.[21,22] In contrast, studies comparing Erich arch bar and Ivy eyelet showed no significant difference in gloves perforations.[2,23]

There was no significant difference in post-operative occlusion and IMF stability among three groups. Similarly, previous studies had not shown any significant difference in post-operative occlusion among three groups.[9,18,19,22]

CONCLUSIONS

The present study showed that the IMF screw and Ivy eyelet were equally effective in terms of surgical time but IMF screw is more safe and effective method in terms of gloves perforation. In addition, post-operative occlusion was similar to Ivy eyelet and Erich arch bar. Hence, IMF screw can be a better alternative to Ivy eyelets and Erich arch bar in treatment of mandibular fractures.

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AUTHORS' CONTRIBUTION

DY did concept and study designing. DY and NC searched literatures and collected data. Statistical analysis was done by RM and LK with the help of statistician. Manuscript preparation was done by NC. Manuscript edit was performed by DY and SA. Final manuscript was reviewed by RM and LK.

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