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Erich Arch Bar Versus Embrasure Wire For Intermaxillary Fixation In Management Of Mandibular Fractures

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Abstract: Mandible fractures are common facial injuries. While intermaxillary fixation (IMF) is essential for managing these fractures, the advent of open reduction and internal fixation (ORIF) has limited IMF to intraoperative use. This study compares the efficacy of Erich arch bar and embrasure wires for intraoperative IMF in mandibular fractures.

Objectives: To assess and compare the efficacy of embrasure wire versus Erich arch bar as two techniques for intraoperative maxillomandibular wiring fixation in mandibular fracture.

Materials and methods: This study involved twenty patients with mandibular fractures needing ORIF and intraoperative IMF. They were divided into two groups of 10: Group A used the Erich arch bar technique, and Group B used embrasure wires. Parameters evaluated included IMF duration, wire stick injury, occlusal stability, complications, and periodontal status.

Results: Significant differences were noted in application time, operator injury, patient injury, and periodontal health. However, there were no significant differences in occlusion and occlusal stability, IMF technique stability, and bone density over the follow-up period.

Conclusion: The embrasure wire technique is quick, easy, reliable for minimally or moderately displaced mandibular fractures, yielding better clinical outcomes than the Erich arch bar technique.

Keywords: Bone denisty ,CBCT, Erich arch bar , embrasure wire , IMF , Mandibular Fracture .

I. INTRODUCTION

Mandible fractures are occupies a significant portion of maxillofacial injuries which are commonly seen in emergency departments resulting from trauma such as motor vehicle accidents (MVA), physical altercations, industrial accidents, falls from height, and contact sports [(1)]. Important factors should be considered while management of mandibular fractures are reduction of the fracture, fixation, immobilization and occlusal stability to achieve proper occlusion and masticatory function remain stable after surgery. Maxillomandibular fixation (MMF) is needed in maxillofacial trauma management, essential for maxillofacial reconstruction, ensuring occulsal stability, and restoring form and function [(2)]. IMF devices are still the best and most cost-effective way to treat fractures, but they are limited to being a temporary fixation in trauma or orthognathic surgery. Open reduction and internal fixation (ORIF), which uses plating systems and screws to make surgery much easier, has replaced conservative treatment[(3)].Erich's arch bars is a conventional MMF technique,well known for excellent occlusion reproducibility. Despite being widely used and distributed, it has many drawbacks as traumatic injury for the periodontium around teeth, prolonged time for application or removal, difficulty to maintain proper oral hygiene, and risk of teeth avulsion if the force is high. Additionally, wire manipulation increases the risk of needle stick injuries to both operators and patients, and glove perforations for the surgeon and assistants[(4)]. A straightforward technique of intraoperative IMF known as "embrasure wire" was reported by Hollows and Brennan [(5)]. It allows direct view to occlusion during surgery with low wire prick injuries, economic cost and less time consuming. The aim of our study was to assess and compare between two different types of wiring techniques as intraoperative IMF which is Erich arch bar versus embrasure wire during management of mandibular fracture.

II. MATERIALS AND METHODS

This prospective randomized clinical trial was carried out after ethical approval from the Suez Canal University, Faculty of Dentistry's Research Ethics Committee. It was conducted on Twenty Patients having diagnosed with mandibular fracture indicated for ORIF under general anesthesia and each group contain 10 patients divided into group (A) treated with arch bar and group (B) treated using embrasure wire. The patients were selected from the Out Patient Clinic of the Oral & Maxillofacial

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Patients were included in this study with simple linear, minimally or moderately displaced mandibular fractures who are indicated for open reduction and internal fixation under general anesthesia and age ranging between 18-60 years with no gender predilection with accessible interdental spaces. So, edentulous patients, patients with primary and mixed dentition, teeth mobility, generalized spacing in dentition, unilateral or bilateral mandibular condylar fracture, patients with gunshot injuries or pathologic mandibular fracture were excluded from this study. Preoperative assessment was held through taking full medical history, age, gender and all details about trauma was recorded such as mechanism of injury and location of fracture. Clinical evaluation done through extra-oral inspection for laceration, swelling or jaw deviation and palpation for any step deformities or nerve affection for evaluation the integrity of mental nerve, and intra-oral inspection for lingual hematoma or buccal ecchymosis or loose, broken or avulsed tooth and palpation for presence of bony crepitus or tooth / bone segment mobility and occlusion identified as normal or slightly affected or severely affected according to ability of patient to close his mouth in Maximum intercupation and perform efficient mastication. Cone Beam Computed tomography (CBCT) using Sidexis 4 software (DENTSPLY, Sirona, USA) to evaluate location, type, number and displacement of fracture (Fig). Premedication was given to all patient including prophylactic antibiotic (Unictam 1500mg, MUP group), Dexamethasone 8mg (Ameria Pharmaceuticals) and appropriate analgesics were administrated intravenously every 12 hours to prevent postoperative infections. All patients were operated under general anesthesia using endotracheal intubation to secure airway.Inter maxillary fixation (IMF) was temporarily secured to provide proper occlusion that serves as a guide for fracture reduction according to each group.

In group A Erich arch bar was used. A prefabricated arch bar with hooks (Dentaurum, Germany) was cut accurately to the length of both upper and lower dental arches from 1st molar to 1st molar in both arches and adapted to the buccal surface with hooks arranged in an upward dirction in upper jaw and downward manner in lower jaw with using prestretched 26- gauge stainless steel wire passed from the mesial surface of teeth to the lingual side and back on the buccal side from the distal surface of the tooth, making sure that one end of the wire is passing above the arch bar and the other below it and both ends of the wire were twisted together in a clockwise manner. Occulsal stabliztion with Intermaxillary fixation of upper and lower jaw together using a stainless steel wires. In Group B, embrasure wires were used. The number and position were based on the fracture's type and location. A single 22-gauge wire (Dentaurum, Germany) was passed through the facial embrasure between the maxillary first molar and second premolar, then looped through the opposite lingual embrasure in the mandible. This process was repeated on the other side and after achieving proper occlusion, the ends of the wire were twisted together on the buccal surface of the lower premolar and molar teeth on both sides to achieve intermaxillary fixation. An intraoral mandibular vestibular approach was made to provide wide exposure to the planned surgical site in all patients. Once the reduction of the fracture and the maximum intercuspation of teeth were assured, two 2.0mm miniplates were cut, and passively contoured and adapted to the inferior and superior borders of the outer surface of the mandible and fixed in their place using miniscrews. Removing IMF Immediately after surgery to allow anaesthesiologist to remove oral pack and suction fluids to recover the patient from G.A.

Study parameters was time of application for each technique recorded in minutes, injury to operators with wire prick injuries or any direct or indirect gloves perforations, postoperative occlusion after 24hours and stability of occlusion in 3 months follow up, stability of IMF technique based on stability of device during ORIF and maximum intercuspation of occlusion acieved, periodontal health was assessed through simplified oral hygiene index, injury to patient for any lacerations, mucosal tears, tooth mobility or avulsion.

The collected data was revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (SPSS 27.0 version). Data was presented and suitable analysis was done according to the type of data obtained for each parameter. Student t-test was used to compare the time of application of each technique, mann-whitney test was used to compare wire stick injuries and gloves perforations and fisher exact test was used to compare occlusion, stability of MMF technique and oral hygiene index

III. RESULTS

Twenty patients was included in our study. Their age ranged between 20-24 years with a mean of 22.2 ± 1.14 years for group A (arch bar) and 22.5 ± 1.27 for group B (embrasure wire) and thus there was no statistical significance between the age of the two groups as P-value 0.584., Regarding cause of injury most patients had road traffic accident (RTA) in both

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groups, without statistically significant difference between two groups as P-value 1.00

In terms of time taken for application of technique, the mean time of arch bars (group A) was 33.01±4.74 minutes, while the mean time of embrasure wire group (group B) was 6.44±1.29 minutes. There was highly statistically significant increase in time of operation (p<0.001) (Table 1).

In term of injury to operators, the wire stick injury and the incidence of perforations in the gloves of surgeon was identified by water inflation method of double gloving system. There was highly statistically significant increase in gloves perforation (direct) among the Arch bars (Group A) as P-value <0.001, while there was statistically significant increase in gloves perforation (indirect) among the Arch bar (Group A) as P-value 0.005 and there was a statistically high significant results regarding wire prick injuries as P-value <0.001

In term of injury to patient, an iatrogenic injury such as tooth avulsion, teeth fracture, interdental papilla striping, and tooth mobility, any mucosal tear or lacerations during the placement of wires were recorded after completion of the procedure. There was highly statistically significant increase in injury to patient among the arch bar (Group A) as P-value <0.001. There were eight cases in arch bar (group A) had wire injury. While two cases in embrasure wire (group B) had wire injury (Figure)

Oral hygiene was identified through simplified oral hygiene index using 6 surfaces of teeth (4 posterior teeth and 2 anterior teeth) then calculation of calculus index and depris index for each surface and it was recorded as good (0.0 :1.2) , fair (1.3 :3.0), and poor (3.1:6.0). There was statistically significant increase in oral hygiene index among the study group; most patients had good index as P-value 0.001. In Arch bar (group A) two cases showed a poor oral hygiene, eight cases showed oral fair hygiene, and there was no case showed good oral hygiene. While in Embrasure wire (group B) no case showed a poor oral hygiene, two cases showed fair oral hygiene and eight cases showed good oral hygiene (figure).

In term of occlusion, the maximal intercuspal position (centric occlusion) to ensure proper occlusal relationship including molar relation, canine relation, and midline centralization were checked. Any occlusal disturbance including open bite or improper tooth contact was noted after 24-hours, and 3 months. Postoperative occlusion was recorded 24 h after the surgery and third month postoperatively as stable or unstable occlusion. In Arch bar group, one case had occlusal disturbance. The occlusal review revealed that the rest of the patients had normal occlusal and intercuspal relations. There was no need for selective grinding during the follow-up period. Regarding occlusion after 24 hours and after 3 months there was no statistically significant difference in occlusion as P-value 1.00 (Table 1)

		Group		Test of significance		
		Control (N= 10)	Study (N= 10)	Value	P-value	Sig.
Time (min)	Mean±SD	33.01±4.74	6.44±1.29	*t = 17.108	< 0.001	S
	Range	(25.81-0.2)	(4.38-8.02)			
Gloves perf (direct)	Median (IQR)	2 (1-3)	0 (0-0)	* *z= -3.882	< 0.001	S
	Range	(1-3)	(0-1)			
Gloves perf (indirect)	Median (IQR)	1 (1-2)	0 (0-0)	z = -2.799	0 .005	
	Range	(0-2)	(0-2)			
Wire stick injury	Median (IQR)	2 (1-2)	0 (0-0)	z = -3.837	< 0.001	S
	Range	(1-3)	(0-1)			
		N (%)	N (%)			
Occlusion After 1 day	Unstable	1 (10%)	2 (20%)	* **FE	1 .00	S

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	Stable	9 (90%)	8 (80%)			
Occlusion After 3 months	**Unstable**	0 (0%)	1 (10%)	**FE**	**1.00**	**S**
	Stable	10 (100%)	9 (90%)			
Injury to patient	**No**	2 (20%)	8 (80%)	**FE**	**0.023**	
	Yes	8 (80%)	2 (20%)			
	Stable	9 (90%)	8 (80%)			
Oral hygiene index	**Poor**	2 (20%)	0 (0%)	**FE**	**0.001**	
	Fair	8 (80%)	2 (20%)			
	Good	0 (0%)	8 (80%)			

*Student t-test of significance (t).
**Mann-Whitney test of significance (z).
***Fisher's Exact test of significance (FE).

Table (1): Intra-operative data between two study groups

IV. DISCUSSION

Intermaxillary fixation (IMF) is the cornerstone of management of patients with maxillofacial injuries Further on, it has been utilized to immobilize fracture segments, apply traction force to reduce fracture segments, and preserve occlusion [6] [7].

In this study, exclusion criteria included Edentulous above 60 years old patients, patients with primary and mixed dentition, pathologic mandibular fracture and with gross generalized spacing in dentition. This correlates to **Rastogi S et al.,** [8] who excluded patients with generalized interdental spacing, and a history of diabetes, uncontrolled hypertension, prolonged steroid therapy, compromised immunity, or associated bone pathologic features. While the inclusion criteria of this study included patients with mandibular fractures, and fit for surgery with age ranging between 18-60 years old age. Also agreeing with **Rastogi S et al.,**[8] who included patients isolated mandibular fractures (single or multiple) which require open reduction and internal fixation, and patients age range from 17-60 years old.

In terms of time taken for the placement of MMF using embrasure wires/arch bars revealed a statistically highly significant difference ($p<0.001$), thereby making embrasure wires a comparatively much quicker procedure. The mean time (minutes) taken for group A (arch bars) was 33.01±4.74 minutes, whereas for group B (embrasure wires) it was 6.44±1.29 minutes. **Engelstad and Kelly**[9] found that the time difference between the embrasure wires and the arch bar was also statistically significant (25.5 vs. 2.5 minutes). Furthermore, **Rastogi S et al**.[8] reported (7.85±0.81) minutes for embrasure wires, but (45.05±5.96) minutes was recorded for arch bars. Also, **Satpute A et al,**[2] reported that average of time taken was 48.08 minutes for arch bar group versus 3.48 minutes for embrasure wire group. According to **Kaur et al,**[3] average time taken was recorded (41.32±8.32) minutes for arch bar group while time was (3.47±0.85) minutes in embrasure wire group.

Therefore, the research and current literature support the use of embrasure wires in cases where intraoperative time is more important.

In terms of Occlusion and occlusion stability, a statistical comparison of the postoperative complications in respect of hardware failure and occlusal disturbance in both the groups (A and B) was found to be nonsignificant (P-value 1.00). In (group A) arch bars, one case had occlusal disturbance, while. The occlusal review revealed that the rest of the patients had normal occlusal and intercuspal relations. There was no need for selective grinding during the follow-up period.

In terms of Injury to the operator, there was highly statistically significant increase in gloves perforation (direct) among the arch bars (group A) as P-value <0.001, while there was statistically significant increase in gloves perforation (indirect) and injury to operators among the arch bars (group A) as P-value 0.005. There were five cases in arch bars (group A) in direct gloves perforation, and one

case in indirect glove perforation. While there was no case in both direct or indirect gloves perforation in embrasure wires (group B).

The incidence of glove perforation is in agreement with **Kaur et al**.[3] The mean rate of glove perforation in group A (5.13±1.30) was comparable to the observations of **Pieper et al.**[10] and **Avery et al.**[11], who reported 5.07 and 4.62 ± 3.25, respectively. On the other hand, while using Erich arch bar wiring for MMF, **Gaujac et al.**[12] found a low rate per operation of 2.45 when using arch bar for IMF. The study conducted by **Kaur et al,**[3] found that the rate per operation for glove perforation in embrasure wires was (1.80 ± 1.47), which was 2.85 times lower than the rate for arch bars group. This suggested that, in comparison to Erich arch bars, embrasure wire resulted in fewer gloves perforations, lowering the risk of occupational hazards and blood borne disease transmission.

Regarding wire prick injuries, in this study we found prick injures due to sharp edges of the wire used ranging (1-3) per case in arch bars (Group A) while there is no wire prick injuries in embrasure wires (Group B) which is highly significant ($p < 0.001$). The result of this study has the same observation as in **Rastogi S et al.**[8] study, as no surgeon suffered a prick injury due to sharp ends of the wire used while placing the embrasure wire intraoperatively, on the other hand, a high incidence of wire injury during MMF was reported in arch bars, accounting for 4 cases out of 20 (20%), which is deemed statistically significant ($p < 0.05$).

Regarding oral hygiene index in this study, there was statistically significant increase in oral hygiene index among the embrasure wires (group B); most patients had good index as (P-value 0.001). In arch bars (group A), two cases showed a poor oral hygiene, eight cases showed oral fair hygiene, and there was no case with good oral hygiene. While in embrasure wires (group B) no case showed a poor oral hygiene, two cases showed fair oral hygiene, and eight cases showed good oral hygiene. Similar findings were observed by **Satpute et al,**[2] all patients in arch bars group had decent oral hygiene, and 20 patients in embrasure wires group had good oral hygiene while 5 patients had fair oral hygiene. The chi-squared test results show that the difference between the two groups is 34.00 and statistically significant ($p < 0.05$).

Regarding the iatrogenic injury to patient such as tooth avulsion, teeth fracture, interdental papilla striping, and tooth mobility, any mucosal tear or lacerations during the placement of wires were recorded after completion of the procedure. There was statistically significant increase in injury to patient among the Arch bars (Group A) as (P-value 0.023). There were two cases in embrasure wires (group B) had papilla injury. While eight cases in arch bars (group A) had papilla injury. Similar result were noted by **Satpute et al,**[2] as he reported eight patients had iatrogenic damage with the placement of a traditional Erich arch bar for IMF, while two patients experienced it during the placement of embrasure wires. Although patients with embrasure had more severe iatrogenic injuries, including as crown fractures and tooth avulsions, eight patients who had a traditional Erich arch bar inserted for IMF also suffered significant iatrogenic injuries. The two groups' difference is statistically significant. ($P < 0.05$).

V. CONCLUSION

It was concluded that, for the treatment of simple mandibular fractures, the embrasure wire approach for intraoperative IMF offers a useful technique over the conventional arch bar technique regarding time taken for the procedure, maintaining safety of the surgeons and patients by reducing gloves perforation and lowering wire prick injuries and providing superior periodontal health. So, the embrasure wire technique had demonstrated a greater promising results.

VI. CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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