Comparison of Efficacy of Transalveolar Screws and Conventional Dental Wiring Using Erich Arch Bar for Maxillomandibular Fixation in Mandibular Fractures

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Abstract

Introduction Maxillomandibular fixation is required in nearly all cases of facial fractures which can be achieved by conventional dental wiring techniques or newer methods using transalveolar screws.

Material and Methods A prospective randomized clinical study divided into two groups with thirty adult patients each with mandibular fractures was undertaken comparing the Maxillomandibular fixation technique using transalveolar screws and Erichs arch bar. Total time taken, rate of glove perforation, intraoperative and postoperative complications were noted in both the groups.

Results The time taken for maxillomandibular fixation in minutes and rate of glove perforation was found to be statistically significantly less for transalveolar group

compared to arch bar group ($p < 0.05$). However, there was no significant difference found in the oral hygiene and gingival status using the Glass index and Gingival index. The rate of screw breakage (04.67%), wire breakage (05.12%), non-vitality due to iatrogenic dental damage (01.66%), soft tissue injury and tooth loss were some of the noted complications during the study.

Conclusion We found that transalveolar group offered advantages like less time taken with a definite decreased risk of percutaneous injury, while the iatrogenic complications like dental damage can be reduced by taking adequate precautions.

Keywords Transalveolar screws · Maxillomandibular fixation · Mandibular Fractures

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Introduction

Maxillomandibular fixation (MMF) is required for nearly all cases of fractures of maxilla and mandible to establish and then fix the fractured jaws in their premorbid occlusion. MMF can be obtained by using conventional methods of wiring like arch bar splints, Eby Ivy method, Risdon wiring techniques, Gilmer's and Col Stout method. In recent years, alternatives to conventional wiring techniques have been introduced such as use of orthodontic elastic chains, dimac wires, aliphatic polyketone plastic devices and transalveolar screws.

Arthur and Brenardo [1] introduced self-tapping titanium screws one in each quadrant at the mucogingival junction between canine and premolar for obtaining MMF. The present study was taken up to compare the efficacy of self-drilling self-tapping transalveolar stainless steel screws and conventional dental wiring using Erichs arch bar in obtaining MMF, during open reduction and internal fixation (ORIF) of mandibular fractures.

Materials and Methods

The prospective randomized study was undertaken in 60 adult male patients (age range of 25–54 years) having dentulous, minimally to moderately displaced mandibular fractures affecting the occlusion and requiring ORIF, who reported to Department of Oral and Maxillofacial Surgery, Sri Guru Ram Das Institute of Dental Sciences and Research, between time period of June 2012 to October 2014. Patients with multiple comminuted fractures, dentoalveolar fractures, gunshot injuries, severe crowding of teeth, impacted permanent tooth (except third molars), advanced osteoporosis, patients in mixed dentition stage and below the age of 18 years were excluded from the study. Diagnosis of facial fractures was based on the detailed history, clinical and radiographic examination.

Patients were randomized (using table of Random numbers) into two groups of 30 patients each. In group 1, MMF was achieved using stainless steel self-drilling self-tapping transalveolar screws with a capstan head (2.5 mm in diameter, 10–12 mm length, the requisite length of the screws was selected based on the clinical judgement of the bone width by the operator and clinical stability achieved). A minimum of one screw per quadrant was inserted at mucogingival junction in canine premolar region but the position and number of screws used varied, dependent on the site of fracture. In group 2, MMF was achieved by conventional dental wiring using Erichs arch bar. The arch bar was adapted till the distal most sound tooth present with circumdental secondary wires around rest of dentition. Twenty-six gauge (0.35 mm diameter) stainless steel 10% pre-stretched wires were used in all the patients. All the procedures were done under local anesthesia and patients were advised 0.2% chlorhexidine mouth rinses prior to procedure and to continue till the last follow-up.

Mandibular fractures were treated with miniplates (ORTHO MAX) based on Champys principle. MMF was released in all the patients immediately after ORIF except in patients who had undisplaced unilateral condylar fractures in whom MMF was released after 3 weeks and were treated with closed reduction. However, MMF device (transalveolar screws and arch bars) was removed after 4 weeks in both the groups. All the intraoperative and postoperative complications during the follow-up period were noted.

Procedures in both the groups were performed by single operator, assistant and scrub nurse (right dominant hand). Single sterile latex gloves (Surgicare, Kanam Latex Industries, Tamil Nadu, India) were used. After the completion of MMF, the used gloves were removed and checked for incidence of glove perforations using the water-leak test EN55-1 method by single observer [2]. The

gloves were inflated with water (1000 ± 50 ml) at room temperature, tightened at the cuff at observed for 2 min. Each finger, thumb and palm were gently squeezed to examine number and position of perforations. In case of noticed glove perforation during the procedure, the gloves were immediately changed and perforation noted. New pair of gloves was then used. Any kind of percutaneous injury to the operator and assistant was also noted.

All patients were assessed for their oral hygiene and gingival status using Glass Index [3] and Gingival Index [4], respectively.

Both the groups were thus assessed for the time consumed for application (in minutes), any percutaneous injury/glove perforation and cost of application of device. The patients were followed up in both the groups at the 7th day, 2nd, 4th, 6th week and 3rd month to note the Glass index and Gingival index.

The data collected were recorded, tabulated and analyzed statistically using Microsoft Office XP (Excel) and SPSS version 17.0 software (SPSS inc., Chicago, IL, USA). The data for glove perforation were checked for normality using Kolmagrov Smirnov test. Differences between the groups were examined with the significance value was set at the 0.05 level ($p < 0.05$) and ($p < 0.001$) for highly significant using independent 't' test.

Results

Distribution and the number of fractured sites involved in both the groups are shown (Table 1). The difference in the mean calculated time taken between both the groups was statistically highly significant ($p = 6.45$; Table 2).

Mean cost calculated was found to be Rs. 336.00 with a range of Rs. 320–400 for group 1 as compared to Rs. 73.33 with a range of Rs. 20–180 for group 2 (4.58 times more than group 1).

The incidence of glove perforation was expressed as number per procedure (Table 3). The non-dominant hand encountered more glove perforations (70.3% in group 1 and 68.8% in group 2) than the dominant hand (29.6% glove perforation in group 1 and 31.2% in group 2). More than half of perforations occurred on index fingers in both the groups. Perforations on index finger were 55.5% ($n = 30$) in group 1 with 86.6% ($n = 26$) of these on non-dominant hand and 13.33% ($n = 4$) on dominant hand. In group 2, 51.5% ($n = 80$) were present on index fingers with 82.5% ($n = 66$) on non-dominant hand and 17.5% ($n = 14$) on the dominant hand. Glove perforations on the index fingers were followed (22.22%) in group 1 and (20.77%) in group 2 on thumb.

The difference between preoperative and various other time postoperative observations for Glass Index and

Table 1 Distribution and number of fractured sites in both the groups

Fracture site	Group 1			Group 2		
	No. of fracture sites	Right side	Left side	No. of fracture sites	Right	Left
Symphysis	3			4		
Parasymphysis	17	8	9	16	11	5
Body	5	2	3	6	2	4
Angle	5	3	2	3	2	1
Unilateral Condyle	10	6	4	12	7	5
Total	40			41		

Table 2 Time taken (in minutes)

	Group 1	Group 2	<i>t</i> value ($p < 0.001$)
Mean $\pm$ SD	17.66 $\pm$ 6.23	41.32 $\pm$ 8.32	6.45
Range	10–30 min	29–55 min	

Gingival Index for both the groups was not found to be significant (Table 4).

Intraoperative and postcomplications noted in both the groups are shown in (Tables 5 and 6) during the follow-up visits.

Discussion

The aim of the present study was to compare the efficacy of transalveolar screws with conventional dental wiring using Erichs arch bar for achieving MMF.

The mean time taken for the conventional dental wiring was significantly more than group 1 which is in accordance

with the literature [5, 6]. The six screws broken in present study were left in situ and removed later, and a different site was selected for the placement of another screw. In group 2, 38 (5.12%) wires broke intraoperatively. Overstretching of 0.35 mm stainless steel wires by 10% lead to work hardness, brittleness with easy breakage [7]. Any wire (circumferential secondary wires secured around arch bars and MMF wires) if broke during the tightening process clockwise was considered under the heading of wire breakage). Most of the stretching in our study was done by the nursing staff.

The mean cost of MMF device for group I was significantly more than mean calculated cost for group 2. Short operatory time with low percutaneous injury risk tend to offset the high cost of screws [8].

Glove perforations and needle stick injury do occur during surgical intervention and might go unnoticed though immense precautions are taken. Majority of glove perforations in our study were unnoticed during the procedure and proved by water test in both the groups (88.8% in group 1 and 90% in group 2) which is concurrent to literature and of clinical importance as it leads to prolonged

Table 3 Incidence of glove perforations

	Number		Rate per procedure (mean $\pm$ SD)		Sig. (two-tailed)
	Group 1	Group 2	Group 1	Group 2	
Total perforations	54	154	1.80 $\pm$ 1.47	5.13 $\pm$ 1.30	<0.001**
Noticed perforations					
Yes	6	14	0.20 $\pm$ 0.414	0.477 $\pm$ 0.743	0.235
No	48	140	1.60 $\pm$ 1.24	4.67 $\pm$ 1.29	<0.001**
Personnel					
Surgeon	30	84	1.00 $\pm$ 1.00	2.80 $\pm$ 1.14	<0.001**
Assistant	24	64	0.80 $\pm$ 0.775	2.13 $\pm$ 0.834	<0.001**
Scrub nurse	0	6		0.20 $\pm$ 0.414	0.072
Total gloved used	186	194	6.20 $\pm$ 0.414	6.47 $\pm$ 0.915	0.313

Data were checked for normality by Kolmagrov Simmnov test with independent *t* test for comparison between the two groups

Statistically significant difference could not be demonstrated for the incidence of noticed perforations ($p = 0.235$), scrub nurse ($p = 0.072$), and total number of gloves used ($p = 0.313$)

**Highly significant observation was found ($p < 0.001$) between both the groups regarding total perforations, unnoticed perforations and perforations on both surgeon and assistants gloves

Table 4 Comparison of Glass Index and Gingival Index for groups 1 and 2

	7th day	2nd week	4th week	6th week	3rd month
Glass Index	$\bar{d}_1 = 0.06$	$\bar{d}_1 = 0.06$	$\bar{d}_1 = 0.2$	$\bar{d}_1 = 0.53$	$\bar{d}_1 = 0.66$
	$\bar{d}_2 = 0.06$	$\bar{d}_2 = 0.2$	$\bar{d}_2 = 0.2$	$\bar{d}_2 = 0.6$	$\bar{d}_2 = 0.60$
		SE = 0.63		SE = 0.68	SE = 0.62
	$t = 0$	$t = 0.41$	$t = 0$	$t = 0.1$	$t = 0.9$
Gingival Index	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$
	$\bar{d}_1 = 0.26$	$\bar{d}_1 = 0$	$\bar{d}_1 = 0.2$	$\bar{d}_1 = 0.4$	$\bar{d}_1 = 0.26$
	$\bar{d}_2 = 0.06$	$\bar{d}_2 = -0.13$	$\bar{d}_2 = 0.33$	$\bar{d}_2 = 0.46$	$\bar{d}_2 = 0.40$
	SE = 0.53	SE = 0.64	SE = 0.69	SE = 0.58	SE = 0.55
	$t = 0.38$	$t = 0.2$	$t = 0.19$	$t = 0.1$	$t = 0.25$
	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$	$p > 0.05$

The difference between pre-op and various other time of observations (7th day, 2nd week, 4th week, 6th week and 3rd month) was compared among group I and group 2, and it was seen that the difference was not significant at each time of observation for both Glass Index and Gingival Index

$\bar{d}_1$ is the mean of difference for group 1

$\bar{d}_2$ is the mean of difference for group 2

Table 5 Complications in group I

Intraoperative screw breakage Total screws used $n = 126$		Mucosal coverage (Partial/complete) Total mucosal coverage $n = 19$			Iatrogenic dental damage Total teeth evaluated $n = 240$		Non-vitality Total teeth evaluated $n = 240$		Mucosal ulceration
Broken screw	%age	1st week	2nd week	4th week	Major contact	Minor contact	Non-vital	%age	Number
06	(4.76%)	07	16	19	10 (04.16%)	12 (05%)	4	(01.66%)	02

Table 6 Complications in Group 2

Intraoperative wire breakage Total wires used $n = 742$		Total number of mucosal ulcers		Total number of teeth lost	
Broken wires	%age	18		02	
38	05.12%				

breach in barrier between patient and surgeon with the suction action of perforations resulting in hand contamination which may enter skin abrasions [9–11]. The overall rate of glove perforation per procedure was 1.80 ± 1.47 in group 1 which was 2.85 times less than observed in group 2. This is due to very less number of wires used for MMF using the transalveolar screws as compared to Erichs arch bar and thus decreased the risk of disease transmission and occupational injuries. No wire stick injury using MMF screws was reported [12, 13].

Majority of wire stick injuries occurred due to snagging of gloves by the wires being passed through interproximal areas [11, 14]. Wire manipulation was the main cause of noticed glove perforation in both the groups (100% in group 1 and 71.4% in group 2), and only 28.6% of glove perforations were due to glove snagging over arch bars in group 2. Fortunately, none of the noticed and unnoticed

glove perforations resulted in wire stick injury in any group.

Glove perforations were seen more in the surgeons gloves followed by assistant and the nurse in the present study. Non-dominant hand glove in both the groups had significantly higher number of perforations as it is used to support and protect the soft tissues. This finding is very similar to the documented literature [9, 10, 14]. Index finger was the most common site for glove perforation in the present study with more than half of perforations (55.5% in group 1 and 51.5% in group 2) followed by thumb as also found by Gujac et al. [10] and concluded that the rough edges of arch bars and stainless steel wires carry significant risk of perforation and recommended the use of proper surgical instruments, separators, tweezers and dynaplast adhesive tape on finger tips and advised that sharps must be removed quickly from surgical field after

Fig. 1 Post operative radiograph showing transalveolar screw in contact with root of left mandibular 1st premolar

Fig. 2 Post operative radiograph after retrieval of transalveolar screw demonstrating a major contact with root of left mandibular 1st premolar

usage [11, 15]. We feel chances of glove perforation and needle stick injury are much more when the procedures are performed under local anesthesia as compared to general anesthesia. The patient is fully conscious and aware. Moreover, full cooperation of the patient is required during the procedure as any inadvertent movement of the patient can enhance the chances of such injuries.

Compliance of all the patients, effects on the marginal gingival and peridontium were observed by noting the Glass Index and Gingival Index at their subsequent follow-up visits. Both the two indices were simple to perform and follow. However, the data analyzed were found to be nonsignificant between both the groups. Better oral hygiene maintenance and less trauma to the peridontium with transalveolar screws are documented [12]. All the patients were instructed to use 0.2% chlorhexidine mouth wash and soft brushing twice daily and were reinforced at every follow-up visit. Emphasis laid on the chances of implant

failure due to poor oral hygiene also allows patient to put extra efforts to maintain his hygiene. Short duration of MMF device placement, regular follow-up and patients willingness to follow oral hygiene instructions postoperatively were the main reasons we felt for better hygiene maintenance in this study.

Nineteen screws (15.07%) had partial or complete mucosal coverage at the time of their removal which required a small incision, while rest of the screws was removed without local anesthesia (no local anesthesia was used to remove the arch bar splints in group 2). Soft tissue coverage was seen on screws where their angulation or screw site was changed due to resistance felt during insertion or where the site was adjacent to the incision site for ORIF. To overcome this common complication, authors have recommended use of washer on the screw [16]. Ulceration was observed in two patients in group 1 in relation to mandibular premolar site at the time of removal.

It was observed that the capstan head of the screw was jutting more buccally as compared to its intraoperative position and the screw was found to be loose. All the screw sites had an uneventful healing postremoval within a week. However, 18 mucosal ulcers developed in 12 patients with arch bar splints. The circumdental wires were adjusted, and Gutta percha stick was applied over the lugs for patient comfort and uneventful healing achieved within a week.

Iatrogenic damage to roots of adjacent is the most common complication observed with transalveolar screws [6, 17–19]. Estimation of major and minor contacts was done on radiographic evaluation after the removal of screws based according to study by Fabbroni et al. [17], contacts were judged to be major if more than 50% of the diameter of the screw hole impinged on the root of adjacent tooth and minor if less than 50% of diameter of screw hole was in contact with adjacent root (Figs. 1 and 2). Non-vitality was found in 4 (1.62%) teeth in four patients in group 1 during their subsequent follow-up visits. These teeth continued to give a delayed response on EPT till 4 weeks followed by no response. These four non-vital teeth were endodontically treated during follow-up visits. Authors suggested major complication leading to non-vitality, but can be minimized by experienced surgeon, thorough clinical judgement and radiographic assessment [20–22].

Intraoperative stability of the MMF device was satisfactory in both the groups. However, during the follow-up period screw loosening was observed in few patients while none of the screws was either lost or displaced. Screw loosening has been documented which could be due to infection, non-perpendicular placement of screws to the occlusal plane or due to musculature forces [23]. Two mandibular anterior teeth were lost in two patients during the follow-up visits in group 2. One tooth was in line of fracture while the other was periodontally involved.

Conclusion

Thus to conclude, the transalveolar screws when used in minimally displaced facial fractures offer less operator time, easy placement and removal, with potential low risk of acquiring percutaneous injuries which tend to offset the increased cost over the arch bars. However, their usage is limited in comminuted fractures and those requiring longer immobilization period where arch bars serve as tension band and are the golden standard.

Compliance with Ethical Standards

Conflict of interest The author declares that they have no conflict of interest.

Ethical Approval Study has been approved by the institutional ethic committee.

Informed consent All patients in the study have given informed consent to participate in the study.

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