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Original Research

Evaluation of efficacy of intermaxillary fixation screws in maxillofacial trauma: A clinical study

Swetha K, Gayathri Goudar, Harsha Bhayya, Subramanya Gopinath and Pooja VK

Abstract
Background: Maxillomandibular Fixation (MMF) is a basic and fundamental principle in the management and treatment of the maxillofacial trauma patient. Stable IMF can be achieved by various techniques, the standard being the use of arch bars applied to both the dental arches and others like eyelets, bonded brackets, cast metal splints, pearl steel wires, self-tapping IMF screws and self-drilling IMF screws.
Aims and Objective: The aim of the study is to Evaluate the Efficacy of Intermaxillary Fixation Screws as means of achieving intermaxillary fixation and to highlight the advantages and disadvantages of using IMF screws.
Materials and Methods: 25 trauma patients were selected, based on thorough clinical examination and radiological examination requiring intraoperative maxillomandibular fixation to fix fractures. A stainless steel Intermaxillary fixation Screw of 8 mm length and 2 mm width were selected based on the type and severity of maxillofacial trauma. Regular clinical follow up was done after screw placement for evaluation of pulp vitality, loss of screws, loose screws/loose wires, breakage of screws or screws covered by oral mucosa and post-operative occlusion, pain, oral hygiene and in addition, any discomfort.
Results: Among the 25 patients, 15 patients (60%) underwent closed reduction, five patients (20%) underwent ORIF with no MMF postoperatively and five patients (60%) underwent ORIF with IMF postoperatively. Percentage of pulp vitality, loss of screws, loose screws/loose wires, breakage of screws or screws covered by oral mucosa and post-operative occlusion, pain, oral hygiene were recorded. Students t test was performed to compare pre and post-operative mouth opening.
Conclusion: IMF screws present a more viable alternative to arch bars, as they are very easy to handle and it is a speedy way to achieve a reliable temporary preoperative, perioperative and post-operative MMF in an economic manner. They are also considered as an ideal treatment modality for chronic generalized periodontitis cases who have met with trauma.

Keywords: Maxillomandibular, Trauma, Arch bar, Fixation Screw, Intermaxillary

Introduction
Maxillomandibular Fixation (MMF) is a basic and fundamental principle in the management and treatment of the maxillofacial trauma patient. MMF serves as a cornerstone of Maxillofacial Reconstruction, providing a stable base from which facial form and function can be restored. It re-establishes the patient's pre-morbid occlusion assisting in the reduction and fixation of simple and complex facial fractures. [1]
In 1492, Gughelmo Salicetti describes the theory of maxillomandibular fixation (MMF). The concept of closed reduction persisted through the early 1990's, which included bandages, extraoral appliances, intraoral splints, mono-maxillary wiring and intermaxillary wiring as the mainstay of treatment. [2] For treatment to be successful for mandibular fractures it totally depends upon reduction, temporary IMF with correct registration of occlusion. The origin of immobilization started in Greece where fractured mandible used to be bandaged. [3]
Stable IMF can be achieved by various techniques, the standard being the use of arch bars applied to both the dental arches[4] and others like eyelets, bonded brackets, cast metal splints, pearl steel wires, self-tapping IMF screws and self-drilling IMF screws. [5]
IMF with bone screws was used first in 1981 [3].

In 1989, Arthur and Berardo introduced a simplified technique of maxillomandibular fixation by the use of cortical bone screws and stainless steel wire. This technique offers several advantages over traditional closed reduction techniques, including ease of technique, reduced operative time, and diminished chance of glove penetration and transmission of human immunodeficiency virus (HIV) and hepatitis B virus. [6]

This study was designed to evaluate the efficacy of Intermaxillary Fixation Screws and their potential advantages in management of maxillofacial trauma.

Materials and Methods

25 trauma patients referred to outpatient unit of Department of Oral and Maxillofacial Surgery, Sri Siddhartha Dental College and Hospital, Tumkur, were selected, based on thorough clinical examination and radiological examination requiring intraoperative maxillomandibular fixation to fix fractures. All the subjects who had almost full or partially dentulous to provide stable occlusion, simple stable fractures of mandible, fractures of the mandibular condyle, un-cooperative to arch bars, dentoalveolar fractures with associated maxillofacial fractures were included in present study. Patients with comminuted maxillofacial fractures, Edentulous patients, Pediatric patients with mixed dentition, Medically compromised patients, Dentoalveolar fractures only and Osteoporotic patients were excluded.

All surgeries were performed under local anaesthesia, preoperatively; prophylactic antibiotics and analgesics were given. The screw site was predetermined based on the radiographic findings and the fracture sites. Most of the cases the screw site was between canine and lateral incisor for maxilla and in between the canine and premolars for mandible respectively. A stainless steel Intermaxillary fixation Screw of 8 mm length and 2 mm width were selected based on the type and severity of maxillofacial trauma. In very simple, mandibular fractures 8 mm length and 2 mm width, Intermaxillary Fixation Screws were selected with drill bit of 1.5mm width. Four Intermaxillary Fixation screws were used in most of the cases to achieve stable occlusion, additional screws were placed if required and based on the severity of the trauma. Holes were drilled in between the roots of the teeth taking care to avoid any root damage, with copious irrigation of saline. After IMF screws were fixed, Stable occlusion was achieved by using stainless steel wires of 26 gauges.

All patients were be evaluated post operatively using OPG immediately. Regular clinical follow up was done after screw placement for evaluation of pulp vitality, loss of screws, loose screws/loose wires, breakage of screws or screws covered by oral mucosa and post-operative occlusion, pain, oral hygiene and in addition, any discomfort.

Screws were removed after 4-6 weeks when fracture healed completely. A clinical testing was carried out to check the vitality of the teeth adjacent to the site of screw placement and to rule out any iatrogenic damage caused to the tooth or tooth roots. Any abnormal mobility of teeth and discoloration of teeth was noted and recorded. A regular follow up was done to all the

Results

Among the 25 patients, 15 patients (60%) underwent closed reduction, five patients (20%) underwent ORIF with no MMF postoperatively and five patients (60%) underwent ORIF with IMF postoperatively. The mean time for MMF was 7 -30 days. A total 103 screws were placed with an average of four screws per patient (93.20%), except in one patient, we have placed seven screws (6.80%) [Table-1], with an average screw fixation time of 15.56 minutes.

Pre-operatively all the 25 patients complained of pain. Post-operatively pain subsequently reduced by the end of one week [Table-2]. Pre-operatively all the 22 patients had swelling and post-operatively reduced on seventh day [Table-3].

Preoperatively 16 patients (64%) presented with deranged occlusion, nine patients (36%) the occlusion was stable. Postoperatively satisfactory occlusion was achieved in all the 16 patients. The average mouth opening preoperatively on admission was 30.95 mm and post-operatively patients achieved mean mouth opening of 38.68 mm [Table 4]. Students t test was performed to compare pre and post operative mouth opening, which showed highly statistical significant increase in mouth opening post operatively.

Postoperatively none of the patients had infection. In none of the patients hardware complications were seen. There was no needle stick injury noted during the placement of wires in any of the patients or there was no incidence of glove perforation noted during the procedure. The most common complication was wire impinging mucosa, which was seen in 10 patients (40%) and the total number of wires impinging on mucosa were 20. These were replaced with new wires. The second most common complication was mucosal coverage of screws, nine patients (36%). 20 screws presented with mucosal coverage (19.41%), 16 patients (83 screws) did not have mucosal coverage. In these nine patients an additional incision was placed at the time of screw removal. Most of the screws covering the mucosa was seen in mandibular teeth. Mucosal tear/ulceration were reported in two patients (8%) at two sites, which healed uneventfully within one week [Table 5].

Table 1: Number of Screws Used

No. of Screws Used	No of Patients	Frequency	Percentage (%)
4	24	96	93.20
7	1	7	6.79
Total	25	103	100

Table 2: Pain Perception in Post-Operative Period

PAIN	1st DAY	3rd DAY	7th DAY	1st MONTH	3rd MONTH
Mild	18	5	3	0	0
Moderate	7	0	0	0	0
Severe	0	0	0	0	0
No pain	0	20	22	25	25
Total	25	25	25	25	25

Table 3: Swelling In Post-Operative Period

Swelling	1st DAY	3rd DAY	7th DAY	1st MONTH	3rd MONTH
Present	22	9	0	0	0
Absent	3	16	25	25	25
Total	25	25	25	25	25

Table 4: Mouth Opening of the Patients

Mouth opening	N	MEAN ± SD	T	P value
Pre operative	25	30.95 ± 5.3	6.836	0.000***
Post operative	25	38.68 ± 1.97		

*** = highly significant

Table 5: Percentage of Screw Complication

Parameters	Number of Screws Covered By Mucosa(Screws)		Wire Impinging on Mucosa (Patients)		Mucosal Tear/ Ulceration (Patients)	
	Yes	No	Yes	No	Yes	No
Frequency	20	83	10	15	2	23
Percentage	19.42	80.58	40	60	8	92

Discussion

The main goals in successfully treating mandibular fractures include: reduction of the fracture, stabilization of the fracture and the jaw, and achievement of proper post reduction functional dental occlusion. In the process of fully satisfying these criteria, it is also advantageous to use techniques that reduce the following: the risk of percutaneous transmission of blood-borne diseases, operating room and general anesthesia times, and hospital costs. [7] Numerous forms of IMF have been described in the literature (eyelet loops, skeletal suspension wires, and Erich arch bars), and few studies have compared them in a scientific manner. [1] Arch bars are a time-proven method of applying MMF with well-recognized advantages; they are useful for re-approximating and immobilizing comminuted segments. The bar itself serves as a tension band in the treatment of mandible fractures, and it is versatile in directing complex vectors for fracture reduction. They remain the treatment modality of choice in complex fracture cases. Application of arch bars is time-consuming, removal of arch bars is difficult, and patients have speech and feeding difficulties. Blood borne disease transmission has been described: a 50% incidence of glove penetration with wiring for MMF has been reported, and 11.4% of perforations resulted in a skin penetration injury. The risk of damage to dental papillae and oral mucosae is important. Wire encircled around the teeth may cause ischemic necrosis of the mucosa and periodontal membrane, with a risk of tooth loss. Dental hygiene and gingival health are not easy to maintain, all these can lead to bacteremia. [6] Teeth are subjected to traction; when a wire is twisted around a tooth, there is a danger of avulsion if the force is too great. [8]

To overcome these complications of arch bar a simplified technique of Maxillomandibular fixation by using self tapping screws was introduced by Arthur and Berardo in 1989. They advocated the use of self tapping bone screws of variable length and generally 2 mm in diameter. The screw was inserted into a drilled pilot hole through the stretched mucosa into bone of selected site sufficient enough to allow stability and permit a loop of wire to fit over head. They also suggested the use of screws bilaterally. [9]

A modification was done by DC Jones [10] with a capstan headed design for the screws. The use of screws with capstan style heads is important as it allows the wires or elastics to be held away from the gingivae, preventing local damage.

AJ Gibbons [11] described about the drill free bone screws made of stainless steel with a diameter of 2mm and in lengths of 8 mm-12 mm. The head of the screw is cruciform with a groove beneath it around which wire or elastic IMF may be applied. To obtain more secure IMF two holes penetrate the screw head at right angles through which the IMF fixation may be threaded. Similar screws were used in the present study.

This method is mainly used in cases of single or double mandibular fractures with minimal displacement, compound condylar fractures, and fractures in edentulous patients if the proper dentures are available. [4] However, these screws is not indicated where the function of a “tension band” and postoperative directional traction are required, as in multiple comminuted mandibular fractures, alveolar bone fractures or gunshot fractures. In present study most of the fractures were undisplaced and simple fractures.

Carl Peter Cornelius and Michael Ehrenfeldn [12] recommended the anatomical site for the placement of MMF screws based on given fracture location, the dentition, the extent of surgical exposure, the availability and the quality of bone in the direct proximity of the fracture line. The anterior vestibular regions as well as the anterolateral transitional zones (canine and premolar regions) of both jaws are often times considered ideal, because these areas are conveniently accessible and supply an appropriate bone stock clear of tooth roots. This protocol was followed in the present study.

The insertion of MMF screw is a rapid and elegant technique minimizing the operating time. The operating time has been reduced from over one hour to approximately 15 minutes. Gordon KF *et al.,* [6] reported an average time of 25.8 minutes in 23 patients, an average of five minutes was reported by NK Sahoo and Ritu Mohan. [13] The average operating time required in our study was about 15.56 minutes with a time period ranging from 15-20 minutes, a similar time period was reported by Vartanian AJ and Alvi A. [14]

The risk of glove and skin penetration with the risk of glove and skin penetration with the traditional arch bar technique carries risk of HIV or hepatitis B virus transmission and is of concern to most facial trauma surgeons. The intraoral bone screw fixation technique may reduce this risk by decreasing the number of wires used and by eliminating the passage of wires through gingival mucosa. Avery and Johnson reported a 50.5% incidence of glove penetration with wires for intermaxillary fixation; 11.4% of perforations resulted in a skin-penetrating injury.

Gordon KF *et al.*, [6] in a pilot study reported a lower incidence of glove perforation using MMF screws with a ratio of 9:1 in arch bars compared with no penetrations of MMF screws. In the current study there was no incidence of needle stick injuries or no case of glove perforation reported, whilst the use of other methods of fixation reported such injuries to be very common.

With the use of Intraoral cortical bone screw fixation various authors have reported infrequent complication occurring during placing or removal of screw. Vartanian AJ, Alvi [7] observed 3 (14.3%) patients with lower lip anesthesia. We observed no lower lip anesthesia attributable to the placement or removal of the bone-screws. A copious irrigation of saline was done during the placement of bone screws to minimize the thermal damage to the adjacent nerves. Gordon KF *et al.*, [6] reported screw covering mucosa in eight patients (27.6%) which were removed under local anesthesia. Roccia F *et al.*, [15] reported 13 screws (4.9%) covered by mucosa during removal, since the placement was in mobile mucosa or close to a surgical incision used to expose a mandibular fracture. Sahoo NK *et al.*, [4] reported a total of 18 (2.04 %) screws covered by oral mucosa at the time of removal which were placed either in mobile mucosa or at the site of surgical incision. Rai AJ *et al.*, [16] reported 14 screws covered by mucosa out of 20 total screws used and stated that the reason could be the smaller screw head and the site of screw

placement above attached gingival. The single most adverse event in our study was mucosal coverage of screws, which was found in nine patients (36%). Reason for mucosal coverage was, if the screw was placed between attached and mobile mucosa it could damage the roots, and hence the screws were placed slightly apically which resulted in mucosal coverage.

Roccia F *et al.,* [15] noted iatrogenic damage to dental roots in 1.5% of patients and was a result of lower density than the dental roots, with consequently different resistance to the bur. Sahoo NK *et al.,* [4] reported with 4% dental injuries of tooth roots, these injuries consisted of scratching the roots which carried no consequences for vitality or stability of teeth concerned and only in 2 premolars the damage was caused due to holes passing through the roots, which were treated endodontically. Root injury to 1% of cases in this study was a result of limited skill of the surgeon. In our study we noted that, there was no response to the electric pulp tester in five patients (20%). A total of 10 teeth gave lack of response. All the five patients were asymptomatic.

Busch RF [17] in his study reported with 3% localized infections. Fabbroni G *et al.,* [18] reported a patient with granulation tissue in the site of the screw hole which was curretted under local anesthesia. Mucosal tear and ulceration (infection) was another infrequent complication we noted in our study at two screw sites in two patients (8%). Mucosal tear/ulcer seen was very minimal and healed uneventfully since the patient was already on post operative antibiotics and required no other treatment.

The two basic modalities for anchoring wires or elastics to establish MMF after craniofacial trauma- Arch bars and IMF screws do not present a perfect solution for MMF and each one of them have their advantages and drawbacks. IMF screws present a more viable alternative to arch bars, as they are very easy to handle and it is a speedy way to achieve a reliable temporary preoperative, perioperative and post operative MMF in an economic manner. We have to determine the biomechanical demands associated with their use through design modification and customized placement, hence we can reduce the complications and potential morbidity.

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