Evaluation of Stainless Steel Intermaxillary Fixation Screws in Treatment of Favorable Mandibular Fractures

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ABSTRACT

Background: Numerous methods have been described for achievement of Intermaxillary fixation in the treatment of fractures of facial skeleton. Conventional methods like Erich arch bars and eyelet wires are currently the most common methods for achieving intermaxillary fixation (IMF), however, they have their own disadvantages. Since 1989, IMF using intraoral self-tapping IMF screws has been introduced for treatment of mandibular fractures. The aim of this study was to evaluate the efficacy, advantages, disadvantages and potential complications associated with using of self-tapping IMF screws in the treatment of mandibular fractures.

Material and Methods: Twenty patients with favorable mandibular fractures, attended to Oral and Maxillofacial Surgery unit, AL-yarmuk Teaching Hospital between November 2014 and October 2015, they were treated with IMF screws. The parameters considered were duration of the procedure, perforations in the gloves, patient acceptance, oral hygiene, iatrogenic dental injuries, mouth opening, healing outcome, occlusal discrepancy and needle stick injuries during IMF.

Results: The patients included in this study were 20 (17 males and 3 females). The extremes of age in this study ranged from 12 to 37 years**.** Three patients had 2 fracture lines. Assault was the most common cause of fractures. The most common site of fracture was the body and parasymphysis regions. Two screws (2.5%) from 80 screws became loosened. One patient (5%) ended with malunion and malocclusion. One patient (5%) developed infection at screw site. Three patients (15%) developed screws soft tissue burying.

Conclusion: IMF screws considered to be a useful modality of treatment to establish maxillomandibular fixation. It is safe, and time-sparing technique; however, it is not without limitations or potential consequences in which the surgeon must be aware of in order to provide safe and effective treatment.

Keywords: Mandibular fracture, intermaxillary fixation. **(J Bagh Coll Dentistry 2017; 29(2):83-89)**

INTRODUCTION

Regardless the methods employed in management of mandibular fracture, definite basic surgical principles must be understood and followed closely in order to ensure the successful completion of treatment, and these include reduction, fixation, immobilization and rehabilitation (1).

Any discussion on management of mandibular fracture according to the history and development of treatment, dates back to Edwin Smith, an ancient Greek. He provides a clear cut documentation for the treatment of mandibular fractures dating back as early as the seventeenth century (2).

Mandibular fractures can be treated by intermaxillary fixation alone, or by osteosynthesis with or without intermaxillary fixation. Intermaxillary fixation (IMF) is an age old procedure which is conventionally used for treatment of fractures involving maxillomandibular complex both for closed reduction and as an adjuvant to open reduction. Intermaxillary fixation can be achieved by eyelets, arch bars, bonded brackets, cast metal splints, vacuum formed splints and pearl steel wires. However, these are time-consuming methods, with a constant danger of trauma to the surgeon's fingers by the sharp wire ends. Twisting a wire around a tooth conveys little feel as to its tightness and there is a danger of avulsion if force is too great. Wires tightened during the application of arch bars around the teeth may cause ischemic necrosis of the mucosa and the periodontal membrane and if damage is extensive, tooth loss may result (3).

Intermaxillary fixation screws (also called trans alveolar screws) is a method using screws fixed on the alveolar parts of maxilla and mandible have been advocated for intermaxillary fixation by ***Arthur*** & ***Berardo*** (1989) then Jones (1999). Hence achieving dental occlusion by bone to bone fixation while eliminating the teeth related problems. Holes created in both jaws by drill either through small incision or trans-mucosally. Intermaxillary fixation screws are quick, easy to use and greatly shorten the operating time. They are relatively inexpensive and reduce the risk of needle stick-type-injuries associated with wires. There is also no trauma to gingival margins and gingival health is easier to maintain as compared to arch bars or eyelets. Despite the fact that the method is easy to apply it carries the risk of damage to the roots of the teeth (4).

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Indications OF IMF screws:
1- Fracture mandible.
2- Endotracheal tube fixation in the edentulous patient with facial burns.
3- Post-maxillectomy obturator retention.
4- Orthognathic surgery.
5- Orthodontics [5,6].

Contraindications OF IMF screws:
1-Pediatric patients with unerupted teeth.
2-Patients with severe osteoporosis.
3- Severely comminuted fractures.
4- Extensive alveolar bone fractures.
5- Missile injuries to the jaws. [2,7]

Advantages OF IMF screws:
1-Reduced risk of percutaneous contamination.
2-The procedure is easy to learn and use.
3- Operating time is reduced (quick and simple procedure).
4- Provide good intra operative fixation.
5- Post-operatively, there is less incidence of infection, trauma to the surrounding tissues and nerve injury.
6- Less pain and edema at the screw site.
7- Oral hygiene is good postoperatively after meticulous oral hygiene instructions.
8- Compatibility with any plating system.
9- No discomfort to the patient.
10- Reduced trauma to the buccal mucosa.
11- Best for use when the teeth have been heavily restored.
12-Reduced risk of needle stick injury as there is no wire fixation.
13- Simple removal.
14-Cheap. [2,5]

Complications OF IMF screws:
1-Fracture of the screws on insertion [8].
2-Iatrogenic damage to teeth and bony sequestrum around the area of screw placement
3-If the speed of the drill is too fast surrounding mucosa and bone may be burnt, resulting in painful ulcerations and even drill tip may break off in bone. If the screws are left in place postoperatively this overheating can cause thermal necrosis of bone around the screw and loosening of head [7].
4-Injury to the roots of the teeth adjacent to the screw fixation site [9].
5-The loosening of the screws [2].
6-Periodontal abscess, cellulitis around screw and displacement of screw into the maxillary sinus [5].
7-Embedded in the soft tissue over a period of time and during their removal necessitate use of stab incision under local anesthesia [2,5,10] .

Aims of the study:
1- To evaluate the efficacy of IMF screws in treatment of favorable fractured mandible.
2- To assess the advantages, disadvantages and complications of IMF screws.

MATERIALS AND METHODS

Patient's Sample:

This is a prospective clinical study included (20) patients with non-complicated fractured mandible attended to the Oral & Maxillofacial Surgery unit, Alyarmuk Teaching Hospital, between November 2014 and October 2015.

In this study, the age ranged from 12-37 years (mean= 24.35), seventeen were males and three were females.

The Armamentarium:

Few instruments are used in this study, which is considered as one of the advantages of this method. The screws are made of stainless steel in different lengths (10-16 mm) and widths (2-3 mm). Two types of screws were used with the following criteria:

Table 1: Characteristic features of the screws

Screws characteristics	No.1	No.2
Screw material	Stainless steel	Stainless steel
Thread diameter	2 mm	3 mm
Overall length	16 mm	14 mm
Shaft Length	14 mm	10 mm
Head diameter	4 mm	6 mm
Head length	2 mm	4 mm
Screw tip	Pointed, no grooves	Pointed, no grooves
Drive	Tapered hexagonal socket	Tapered hexagonal socket
Screw head neck	Small collar flange	Large collar flange
Drill bit diameter	1.6 mm	2.5 mm

In addition to screws the following materials and instruments were used: **Fig. (1)**.
1-Stainless steel wires for IMF (0.5-0.6 mm)
2-Screw driver
3-Drills
4-Cutter
5-Dental mirror
6-Dental syringe
7-Dental needle
8-Local anesthetic solution
9-Povidone iodine solution
10-Normal saline
11-Hypodermic syringe
12- Hand piece
13-Wire clamp

Figure 1: IMF screws with instruments set.

The procedure:

After the diagnosis of the fracture the patients are prepared for operation, stay (bridle) wire was placed to 7 patients. All operations were done under local anesthesia except for 3 patients were done under general anesthesia. 2-3 cartridges of infiltration anesthesia are given to each patient (in the buccal mucosa of each quadrant).

In the maxilla trans-mucosal drilling was done with drill bit under coolant (normal saline) just above the mucogingival junction between canine and first premolar teeth. Left index finger was placed in the canine fossae which not only acts as a guide but also compress the vestibular tissue volume hence minimizing entangling of soft tissue to the drill bit. IMF screw was inserted into the pre-drilled hole until the screw head just in touch with the underlying mucosa. The procedure is repeated for corresponding side.

In the mandible the screw position was determined by the location of fracture line. The most preferred site was between canine and first premolar teeth followed by the space between the premolars. Intermaxillary fixation was done with 0.5- 0.6 mm stainless steel wire secured to the IMF screws after reduction of bone fragments. **Fig. (2).**

Figure 2: IMF screws in situ.

Postoperative instructions:

1-Maintain good oral hygiene by frequent tooth. brushing and mouth wash during IMF period.
2-Liquid or semi liquid diet until IMF was removed.
3-Psychological support by asking the patients to withstand the period of IMF.
4-Avoid any recurrent trauma to the region.
5-Return back if any of the screws become loose or dislodged.

Statistical analysis

Data collected from clinical and radiological follow up was analyzed by statistical package for the social science(SPSS) software and Microsoft office excel software version 21 for tables and figures, the analysis include:

1-Descriptive statistics
2-Tables for number and percentage
3-Inferential statistics that is

- T test: paired sample T test (assess reliability of data)
- P value: the assessment of significance of result is as follow:

A- If p value is <0.05 then it is significant
B- If p value is >0.05 then it is not significant
C- If p value is <0.01 then it is highly significant

RESULTS

Age and gender:

Twenty patients enrolled in this study, 17 males (85%) and 3 females (15%) with male to female ratio (5.6:1) Fig. (3), with age ranged from 12-37 years with mean of 24.3 years. The age group 20-29 years involved in this study was the dominant one, **Fig. (3)**.

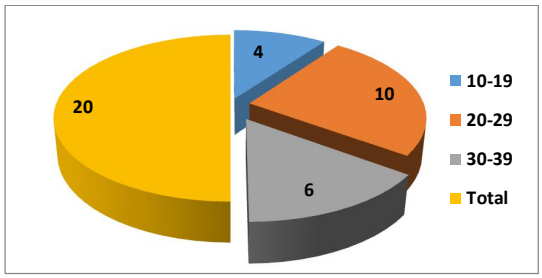

Figure 3: Age distribution in relation to decades.

Etiology of trauma:

Assaults were the most common etiology of fractures, found in 9 patients (45 %), followed by RTA in 6 patients (30 %), fall in 4 (20%) patients and blast injury in 1 (5%). **Table (2)**.

Table 2: Etiology of trauma

Cause	Assault	RTA	Fall	Blast injury	Total
No. of patients	9	6	4	1	20
%	45	30	20	5	100

*Chi-square=33.62 P<0.01 highly significant

Stability of screw:

Most of patients in this study ended the IMF period with 78 fixed screws in position (97.5%), while only 2 screws in 2 patients became loosened

at the 3rd week of IMF (2.5%), however, this did not influence fracture healing. **Table (3)**.

Table 3: Stability of screws

Stability of screw	Fixed	Loose
No. of screws	78	2
%	97.5	2.5

*Chi-square=9.88 P<0.01 highly significant

Postoperative occlusion:

Ten out of 20 patients included in this study present preoperatively with disturbed occlusion (50%). Postoperatively one patient (5%) ended with disturbed occlusion **Fig. (4)**.

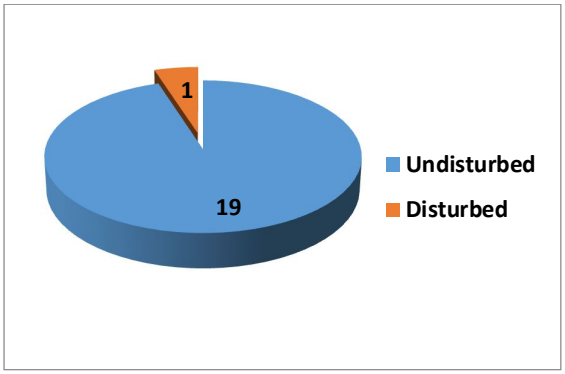

Figure 4: Post-operative occlusion

*Chi-square=22.36 P<0.01 highly significant

Healing outcome:

All patients included in this study completed IMF period with good union (95%), except for one patient (5%) who has subcondylar fracture ended with malunion. **Table (4)**.

Table 4: Healing outcome

Outcome	Good union	Malunion
No. of patients	19	1
%	95	5

*Chi-square=23.66 P<0.01 highly significant

Complications:

The majority of patients in this study completed IMF period without complications. Two screws were loosened (2.5%) in two patients (10%), post-operative malocclusion and malunion occur in the same patient (5%), bone infection occur in one screw site (1.25%) and soft tissues burying occur in nine screws site (11.25%) in three patients. **Table (5)** and **Table (6).**

Table 5: Complications related to the number of patients

Complication	No. of patients	%
Screws loosening	2	10
Malocclussion	1	5
Malunion	1	5
Bone infection	1	5
Soft tissue burying	3	15

Table 6: Complications related to the number of screws

Complication	No. of screws	%
Screws loosening	2	2.5
Bone infection	1	4.3
Soft tissue burying	9	11.25

DISCUSSION

The main goals in successfully treating mandibular fractures include: reduction, stabilization of the fracture, and achievement of proper dental occlusion. In the process of fully satisfying these criteria, it is also advantageous to use techniques that reduce the risk of percutaneous transmission of blood-borne diseases, operating time and duration of general anesthesia and hospital costs [2] .

Most of the patients included in this study were young (12-37 years), and males were more than female with male to female ratio is about (5.6:1). This indicate that fractured mandible occur more commonly in active young age groups and more frequent in males than females this may be due to the more outdoor activities in Iraqi society.

One of the advantages of this procedure is the short time for insertion and removal of screws (time saving) when compared with other conventional methods of IMF. ***Biswas*** (2012) reported that the time needed for insertion of screws was about 10 min [12], while ***Mathieu*** (2009) registered the time needed for insertion of of about 13 min. In this study the time of insertion of the screw ranged from 7-20 min with a mean of 10.5 min, while the time of removal ranged from 3-8 min with a mean of 4.4 min. Only one patient needed 8 min for removal because of soft tissue burying (mucosal overgrowth) which necessitate using of stab incision under local anesthesia. In general it has been noticed an obvious differences in time between IMF screws and other conventional method like arch bar (45-60 min) [2] .

All patients were satisfied with IMF screws both during the procedure and during IMF period. This is belonged to:

1-Little tissues trauma
2-Short operation time
3-Simple procedure

Safety for the surgeon and assistants by this method is published in the literature. In this study the researcher didn't face any of complications related to the safety as there is no needle stick injury and gloves perforation for both the surgeon and the assistants.

Fracture of screws is another complication of. [8,14,15] reported a case of fracture of screw at the junction of screw head and threaded portion. Fortunately, there was no case of screw fracture that may be attributed to the proper surgical technique.

Another complication mentioned with the screws was the injury to the roots of the teeth adjacent to the screw fixation site. [9] reported one case of root damage using self-tapping screws, [16] recorded 4% root damage. In this study, also no case of root or tooth injury owing to the enthusiastic surgery.

During transmucosal drilling, cooling is of a prime importance. The soft tissue acts as a cuff around the drill bit, preventing coolant to reach the bone. It causes thermal necrosis and subsequent loosening of screw. Screw loosening was noticed in 6.5% (15 out of 229) of the screws placed in the most recent report [15], while [17] reported 6 (3.2%) IMF screws in four patients being loose and 7.5% (5 out of 66) of screw loosening was reported by. In this study Screw loosening was noticed in 2.5% (2 out of 80). Both screws became loose at the 3rd week of IMF. Those patients informed the operator that they tried to open the screws by any way. Retightening of screws was done and the treatment was completed without affecting the final outcome.

Another complication associated with self-tapping IMF screws is that, they become embedded in the soft tissue over a period of time and during their removal necessitate the use of stab incision under local anesthesia. [18] reported 2.04% of patients with mucosal overgrowth, whereas [18,19] reported multiple cases of soft tissue burying and [15] reported 11 (5.8%) screws in 11 (45.8%) patients showed partial mucosal overgrowth. In the present study 11.25% (9 of 80 screws) in three patients (15%) developed mucosal overgrowth, two screws needed stab wound for removal and the remaining 7 screws removed by reflection of mucosa and exposing the screw head.

Maintaining good oral hygiene is easy when IMF screws are used for fixation. This is because screws allow better cleaning and brushing of teeth and gum. IMF screws are different from other conventional methods like arch bars or circumdental wiring, which may cause trauma to interdental gingiva and allowing food debris to stick under arch bar or wire loops which become difficult to be removed. This may cause considerable degree of gingivitis and even periodontitis. All patients in this study presented with good oral hygiene.

Bone infection and interdental sequestration are rare reported incidents were noticed in the articles [8]. In this study one screw site (1.25%) developed periapical infection and sinus tract which lead to resoption of root and the tooth became non-vital three month after screw removal, this may due to infection from periodontium. Patient was referred for endodontic therapy. **Fig. (4) and (5)**.

[13,18] were reported 4% of patients end with malocclusion, whereas [16] reported 2% of patients ended with this complication. 95% of patients included in this study completed IMF period with good occlusion and good alignment except for one patient (5%) developed malocclusion and malunion. This is may be due to imperfect reduction of the fracture.

[13] reported 4% incidence of mandibular deviation when the mouth was opened. All patients in this study completed IMF period without any mandibular deviation.

[13,20] were reported 2% of patients end with limitation of mouth opening. In this study no one of patients complained from this consequence.

In conclusion, self-tapping IMF screws provided good IMF for the 20 cases in the present study. Postoperatively, there was no incidence of trauma to the surrounding tissues and nerve injury. There were no signs and symptoms of pain and edema at the screw site in all the cases at the end of 1st and 5th postoperative week. Only one case of infection occur in periapical area of screw site. It was easier to maintain oral hygiene with IMF screws compared to other conventional methods. The procedure ended with reasonable outcomes with few complications provided that it is performed in the right manner.

Figure 4: Screw site infection developed sinus tract after its removal.

Figure 5: OPG of the same patient illustrating periapical radiolucent lesion at the adjacent tooth.

REFERENCES

1-Barber, H.D., Woodbury, S.C., Silverstein, K.E., Fonseca, R.J.: Mandibular fractures, in Textbook of Oral & Maxillofacial Trauma, Vol. 1, 2nd Ed. W.B. Saunders Company, Philadelphia, p 493, 1997.

2-Nandini G. D., Ramdas Balakrishna, and Jyotsna Rao: Self Tapping Screws v/s Erich Arch Bar for Inter Maxillary Fixation: A Comparative Clinical Study in the Treatment of Mandibular Fractures J Maxillofac Oral Surg. 10(2): 127–131, Jun 2011.

3-Ayoub AF, Rowson J.: Comparative assessment of two methods used for interdental immobilization. J Craniomaxillofac Surgery. 31:159–61, 2003.

4-Aldegperi A.: Pearl steel wire: a simplified appliance for maxillo mandibular fixation. Br J Oral Maxillofac Surg. 10.1054/bjom, 1998.

5-Christopher Fowell, Sunil Bhatia, Brian Castling: A novel use of intermaxillary fixation screws for post-maxillectomy obturator retention British Journal of Oral and Maxillofacial Surgery 51 e195–e196, 2013.

6-Fleissig Y., Rushinek H., Regev E.: Intermaxillary fixation screw for endotracheal tube fixation in the edentulous patient with facial burns. Int. J. Oral Maxillofac. Surg. 43: 1257–1258, 2014.

7-Jones DC. The intermaxillary screw: a dedicated bicortical bone screw for temporary intermaxillary fixation. Br J Oral Maxillofac Surg. 37(2):115–116, 1999.

8-Coburn DG, Kennedy DW, Hodder SC.: Complications with intermaxillary fixation screws in the management of fractured mandibles. Br J Oral Maxillofac Surg. 40(3): 241–243, 2002.

9-Majumdar A.: Iatrogenic injury caused by intermaxillary fixation screws. Br J Oral Maxillofac Surg. 40(1):84–88, 2002.

10-Bush RF.: Maxillomandibular fixation with intraoral cortical bone screws: A 2 year experience. Laryngoscope.104:1048–1050, 1994.

11-Kathiravan Purmal, Mohammad Khursheed Alam,* Abdullah Pohchi, and Noor Hayati Abdul Razak: 3D Mapping of Safe and Danger Zones in the Maxilla and Mandible for the Placement of Intermaxillary Fixation Screws PLoS One. 8 (12): e84202, 2013.

12-Biswas KP, Ahuja A, and Singh VP: Efficacy of intermaxillary fixation screws; Health Renaissance, Vol 10 (No. 1):69-71. January-April, 2012.

13-Mathieu Laurentjoye, Claire Majoufre-Lefebvre, MD,François Siberchicot, MD, and Anne Sophie Ricard, MD: Result of Maxillomandibular Fixation Using Intraoral Cortical Bone Screws for Condylar Fractures of the Mandible, J Oral Maxillofac Surg. 67:767-770, 2009.

14-Holmes S, Hutchison I.: Caution in use of bicortical intermaxillary fixation screws. Br J Oral Maxillofac Surg. 38(5):574, 2000.

15-van den Bergh B. , Blankestijn J. , van der Ploeg T., Tuinzing D.B., Forouzanfar T.: Conservative treatment of a mandibular condyle fracture: Comparing intermaxillary fixation with screws or arch bar. A randomised clinical trial. Journal of Cranio-Maxillo-Facial Surgery, 2015.

16-Sahoo N. K. and Ritu Mohan IMF Screw: An Ideal Intermaxillary Fixation Device During Open Reduction of Mandibular Fracture. J Maxillofac Oral Surg.9 (2): 170–172, Jun 2010.

17-Zanyar, Mustafa Amin: Reliability of Intermaxillary fixation screw in the treatment of fractured mandible, Prospective Clinical Evaluation 2010.

18-Roccia F, Tavolaccini A, Dell'Acqua A, Fasolis M.: An audit of mandibular fractures treated by intermaxillary fixation using intraoral cortical bone screws. J Craniomaxillofac Surg. 33(4):251–254, 2005.

19-Hoffmann A, Mast G, Ehrenfeld M.: Verwendung von IMFSchrauben zur mandibulo-maxilla¨ren Fixation [Usage of IMF screws for mandibulo-maxillary fixation]. OP Journal. 19:70–75, 2003.

20-Thaller SR: Management of mandibular fractures. Arch Otolaryngol Head Neck Surg. 120:44, 1994.

المستخلص

الخلفية: هنالك عدة طرق قد وصفت لتحقيق التثبيت بين الفكين لعلاج كسور عظام الوجه والفكين. و هنالك مجموعه من الطرق التي تعتبر الاكثر شيوعا في التثبيت مثل الاسلاك الفولاذية والجسور الفولاذية ولكل منهما عيوبه الخاصة . في عام 1989 تم استخدام المسامير داخل الفم في عمليه تثبيت الفكين لعلاج كسر عظم الفك السفلي لأول مرة. ان الهدف من هذه الدراسة هو تقييم الفعالية، المزايا والعيوب، والمؤشرات والمضاعفات المحتملة المرتبطة باستخدام مسامير التثبيت بين الفكين في علاج كسور عظم الفك السفلي.

المواد والطرق: شملت الدراسة عشرون مريضا يعانون من كسور عظم الفك السفلي حضروا لقسم جراحة والوجه والفكين في مستشفى اليرموك التعليمي للفترة ما بين تشرين الثاني 2014 وتشرين الاول 2015. وكانت المقاييس في هذه الدراسة هي : الوقت الذي يستغرقه وضع المسمار، الثقوب في الكفوف، درجة تقبل المرضى، نظافة الفم، تلف الأسنان وإصابات وخز الإبر.

النتائج: سبعة عشر مريضا كانوا من الذكور وثلاثة من الإناث شملوا في هذه الدراسة. تراوحت اعمارهم بين 12- 37 عاما. ثلاثة مرضى كانوا يعانون من كسرين في الفك السفلي. كانت الاعتداءات هي السبب الأكثر شيوعا للكسور . كان المكان الأكثر شيوعا للكسر في منطقة جسم الفك السفلي . اثنين من المسامير (2,5٪) من 80 مسمار أصبحا مرتخيان . مريض واحد (5٪) انتهى بسوء الالتحام وسوء الإطباق. مريض واحد (5٪) انتهى بالتهاب العظم في موقع المسمار. ثلاثة مرضى (15٪) انتهوا بانغمار المسامير داخل اللثة .

الاستنتاجات: لقد أظهرت الدراسة الشاملة ان مسامير التثبيت الفكية طريقة مفيدة لتثبيت كسور الفكين. حيث أنها طريقه آمنة و وقتها قصير. ومع ذلك، لم تكن من دون قيود أو عواقب لذلك يجب أن يكون الجراح على علم بهذه العواقب من أجل توفير علاج أفضل وفعال للمرضى .