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.

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.

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.

Complications OF IMF screws:
1- Fracture of the screws by insertion.
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.
4- Injury to the roots of the teeth adjacent to the screw fixation site.
5- The loosening of the screws.
6- Periodontal abscesses, cellulitis around screw and displacement of screw into the maxillary sinus.
7- Embedded in the soft tissue over a period of time and during their removal necessitate use of stab incision under local anesthesia.

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

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

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
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 1: IMF screws with instruments set.

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 range 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

<table>
<thead>
<tr>
<th>Cause</th>
<th>Assault</th>
<th>RTA</th>
<th>Fall</th>
<th>Blast injury</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>9</td>
<td>6</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>%</td>
<td>45</td>
<td>30</td>
<td>20</td>
<td>5</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Stability of screw</th>
<th>Fixed</th>
<th>Loose</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of screws (%)</td>
<td>78.2%</td>
<td>2.5%</td>
</tr>
</tbody>
</table>
*Chi-square=9.88 P<0.01 highly significant

Postoperative occlusion:
Ten out of 20 patients included in this study 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

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Good union</th>
<th>Malunion</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>%</td>
<td>95.5%</td>
<td>5%</td>
</tr>
</tbody>
</table>
*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%), postoperative 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

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. of patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screws loosening</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Malocclusion</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Malunion</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Bone infection</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Soft tissue burying</td>
<td>3</td>
<td>15</td>
</tr>
</tbody>
</table>

Table 6: Complications related to the number of screws

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. of screws</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screws loosening</td>
<td>2</td>
<td>2.5</td>
</tr>
<tr>
<td>Bone infection</td>
<td>1</td>
<td>4.3</td>
</tr>
<tr>
<td>Soft tissue burying</td>
<td>9</td>
<td>11.25</td>
</tr>
</tbody>
</table>

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.

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, while Mathieu (2009) registered the time needed for insertion 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).

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 (13), 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 resorption 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.
REFERENCES


المستخلص

العنوان: هناك عدة طرق قد وصفت لتحقيق التثبيت بين الفكين لعلاج كسور عظام الوجه والفكين. و هنالك مجموعة من الطرق التي تعتبر الأكثر شيوعا في التثبيت مثل الأسلاك الفولاذية والجسور الفولاذية ولكن معتمدة على المستشفى. في عام 1989 تم استخدام الأساليب الخارجية في عملية تثبيت الفكين لعلاج كسر عظام الفك السفلي لأول مرة. إن الهدف من هذه الدراسة هو تقييم الفعالية، المزايا والعوائق، والمشكلات والمصطلحات المرتبطة باستخدام أساليب التثبيت بين الفكين في علاج كسور عظام الفك السفلي.

المواد والطرق: نشرت الدراسة عروضًا يتناولون عن كسور عظام الفك السفلي وضعت في علاج وجوه الفكين في مستشفى البرمود التعليمي للفترة ما بين شهرترين الثاني 2014 وتشرين الأول 2015. وكانت المعايير في هذه الدراسة هي: الوقت الذي يستغرقه وضع المسامير، التكلفة، تكلفة الأسنان وال yatعيبات. الأسنان وال yatعيبات، وظائف الفم، عدد الأيام الخاصة بإصابات والفوق. النتائج: سبعة عشر برنامج كتبمومن مرتين في الدراسة. تواجهت عواقبهم بين 12-37 عاما نشأت من ثلاثة مرضى كانوا يعانون من كسر في الفك السفلي. نشأت حالات الإصابة في الفك السفلي كانت عملية صعبة. السبب الأكثر شيوعًا للكسور كان الاهتزاز. كان هناك أكثر شروعاً للتكسير في مرحلة حجم الفك السفلي. أثناء من المسامير (20%) من 80 من المسامير. أثناء 20% من السوسات كان مشائعاً. مرضياً واحد (5%) هي الالتباس أو الانتماء. مرضياً واحد (5%) انتمى بالحذاء المصراع. في موقع مسافر. ثلاثة مرضى (15%) انتهوا بالضرورة المسامير داخلي ثالث.

الاستنتاج: لقد أظهرت الدراسة الشاملة أن أمثلة الأساليب الفركية طريقة فعالة لعلاج كسور الفكين. حيث أنها طريقة أمنة و وقتها قصير. ومن تلك، لم تكن من دون قيود أو عواقب. لذلك يجب أن يكون الجراح على علم بهذه العواقب من أجل توفير علاج أفضل وفعال للمرضى.