The Efficacy of self-tapping and self-drilling Inter-Maxillary fixation Screw in maxillofacial surgery

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ABSTRACT

Objective: a common immobilization technique in maxillofacial surgery was dependent to teeth bearing methods. In 1989, a bone bearing method was produced by inter maxillary fixation screws, which represented the first generation. Screws of (Self-tapping and self-drilling) (STSDSs) from (DePuy Synthes) Company represented the second generation of IMF screws.

Aim of the study: The current study evaluated the efficacy of intermaxillary fixation with Screws of (Self-tapping and self-drilling) (STSDSs) in non-displace or little displace mandibular fracture, pathological lesions with or without reconstruction and orthognathic surgery.

Patients and Methods: Thirty five patients were treated by self-tapping self-drilling inter maxillary fixation screws (STSDSs). All the patients were assessed clinically to evaluate: (teeth mobility; the vitality of teeth; oral hygiene; occlusion and comfort of patients). The period extended December 2015 to October 2017. All patients were checked using a panoramic radiograph, one immediately postoperative and a second radiograph after removal of screw to evaluate any possible iatrogenic injury to the teeth.

Results: sex distribution were thirty three males (94.3%) and two females (5.7%). Trauma was shown in twenty nine patients (82%), Pathological lesions were illustrated in three cases (8.6%), Orthognathic surgery was shown in three cases (8.6%). The mean time of inter maxillary fixation (IMF) screws application were 12.23/minutes. Oral hygiene was recorded in follow up periods and the results were shown: good in twenty one patients (60%); fair in nine patients (25.7%) and bad in five patients (14.3%). Complications were recorded in five patients (14.3%); as Screw mobility in three patients (8.6%); Screw fracture in two patients (5.7%) and gingival overgrowth in six patients (17.1%).

Conclusion: The insertion of self-taping and self-drilling inter maxillary fixation (IMF) screws was a quick procedure; safe for the surgical staff; simple; do not need power supply; improvement of tactile feedback; could be applied at the bedside; easy to remove without anesthesia.

Key words: InterMaxillary screw, Fracture mandible, Orthognathic surgery, Reconstructive surgery


INTRODUCTION

Intermaxillary fixation (IMF) was ancient procedure used for treatment of fractures including maxillomandibular complex. Conventionally, the intermaxillary fixation achieved by various types of tooth mounted devices like (arch bars; dental and interdental wiring; metallic and nonmetallic splints). However, the disadvantages of tooth borne devices including (poor oral hygiene; periodontal health; extrusion of teeth; loss of tooth vitality; traumatic ulcer of buccal and labial mucosa, needle stick injury to the operator and the procedure need long time). Also, (multiple missing teeth; grossly carious teeth; crown and bridge work, extensively restored and periodontally weakened teeth) were unsuitable for this procedure, Arthur and Bernado overcome these problems by using bone screws that based upon a bone borne appliance to restore dental occlusion by bone to bone fixation and without problems related to teeth.

At the seventeenth century, Edwin Smith, an ancient Greek who provided a clear cut documentation for the treatment of mandibular fractures. Mandibular fractures could be treated by Intermaxillary fixation either alone or by osteo-synthesis with or without intermaxillary fixation. (Eyelets; Arch bars; Bonded brackets; Cast metal splints; Vacuum formed splints; Pearl steel wires; Self-tapping IMF screws and Self drilling IMF screws) achieved Intermaxillary fixation. The introduction of bone plating system was reduced the prolonged periods of intermaxillary fixation (IMF).

However, there was a need for temporary intermaxillary fixation to assist in reduction of fractures with the teeth in correct occlusion, intraoperatively, and help in fixation or corrected minor occlusal discrepancies, postoperatively. Many methods used for intermaxillary fixation made of metal and acrylic like (custom-made arch bars; eyelet wires and Schuchardt arch-shaped splints). However, these were (time-consuming methods; dangerous of trauma by ends of sharp wire to the surgeon’s fingers; Twisting a wire around a tooth as to its tightness in addition of dangerous of avulsion if force was too much. Wires tightened during the application of arch bars around the teeth caused (ischemic necrosis of the mucosa; the periodontal membrane and tooth loss) resulted if damage was extensive.

Although the method was easy to apply, it had the risk of damage to the roots of the teeth. Self-tapping and self-drilling intermaxillary fixation (IMF) screws were quickly; easily to use and take short time for achieving inter maxillary fixation. They multiple advantages like (reducing the risk of needle stick-type-injuries associated with wires; safe to gingival margins and maintained gingival health easily when compared to arch bars or eyelets).

PATIENTS AND METHODS

2.1 Patients:

This was prospective study including (35) patients. They were treated by self-tapping self-drilling inter maxillary fixation screws (STSDSs) (DePuy synthes) in different situation like (trauma; pathological lesions and orthognathic surgery) who had visited the hospital Medical City; Department of Oral and Maxillofacial Surgery, in Al-Shaheed Ghazi Al-Hariry for Specialized Surgeries, in the period between December 2015 to October 2017.

Patient selection

Inclusion criteria

1. Patients with favorable fractured mandible.

2. Patients with pathological lesion (benign, malignant) of mandible.
3. Patients had orthognathic surgery.
4. Patients had reconstructive surgery.

Exclusion criteria
1. Patient's age was below 12 years.
2. Patients had osteoporosis [13].
3. Patients with comminuted fractures include lower border of mandible.
4. Patients complained from severe asthma or severe chronic obstructive pulmonary disease.
5. Patients with poorly controlled seizures.
6. Patients with psychiatric or neurologic disorders.
7. Patients with severe nausea or eating disorders.
8. Patients used Bisphosphonates.

Methods

Preoperative assessment data

Patient's History was included:
- Name, age and gender

Etiology.
Medical history included level of consciousness, illness (local and systemic), and medications.
Clinical examination:
Clinical examination records was contained the results of inspection and palpation of the mandible (extra oral and intraoral) and other facial bones.

Extra oral examination included inspection of swelling, ecchymosis, bleeding, soft tissue lacerations or abrasions difficulty, limitation, or deviation of mouth opening, pain at TMJ region, asking the patient if there was anesthesia or par aesthesia of the area supplied by inferior alveolar nerve and associated other facial fractures. Palpation of site for tenderness, step deformity in continuity of the bone, texture and the site was recorded according to the anatomical location of the fractures, lesion or skeletal anomaly.

Intraoral examination (trauma) seemed for the presence of (sublingual soft tissues ecchymosis (Coleman's sign); lacerations; fractured or avulsed teeth; occlusal derangement; gaging of buccal segment teeth and open bite; step deformity and presence of a tooth at the fracture line). Bimanual manipulation of the fracture area led to assess degree of mobility.

Radio graphical examination:
1. Panoramic radiograph (OPG).

It represented the most important view in radiographic evaluation of mandibular fractures as shown in the Fig (1). It was taken for almost all patients, preoperatively and during follow-up visits.
Figure 1: OPG illustrate right mandibular angle fracture (white arrow) caused by sport injury.

2. Per apical view.
   It was important view to show the position of IMF screw as illustrated in the Fig. (2).

Figure 2: Per apical view to show IMF screw position.

3. Posteroanterior view of mandible (PA):
   It was taken in association with panoramic radiograph for better illustration of the mandible as shown in the Fig. (3) to show horizontal favorable or unfavorable fracture of mandible.

Figure 3: Posteroanterior radiograph view was showed right angle fracture (white arrow).

3- Computed Tomography (CT):
   There was agreement that the exact anatomic identification and quantification of (facial fractures; recognition of the true extent of bone displacements; lesion and precise assessment of major bone and soft tissue

complications) could effectively and accurately image with Computed Tomography (CT), as seen in the Fig. (4) [6, 7].

Investigations:

All patients in this study were sending for virology screen (HIV, HCV and HbsAg). Fifteen of thirty five patients that had operated with general anesthesia (GA) were sending for (complete blood picture; blood sugar; blood urea; serum creatinine; chest X-ray; Echo study; ECG and anesthetic consultations for GA fitness).

The Technique:

According to the cases, the patients divided in two groups:

(a) Twenty patients treated under local anesthesia. Each patient seated on the dental chair, two-three carpules of local anesthesia were giving on the buccal and palatal mucosa for each quadrant.

(b) Fifteen patients were operated with general anesthesia (GA).

The anterior vestibular regions as well as the anterolateral transitional zones (canine and premolar regions) of maxilla and mandible were considered the best because these areas were accessible and supplied an appropriate bone stock out of tooth roots, the screw was inserted trans-mucosally between canine and first premolar tooth using screw driver with holding sleeve. The most appropriate site for this procedure was the mucogingival junction [4]. The retractor was hold by the left hand for retraction of cheek. IMF screw was inserted gradually until the head of the screw touched the mucosa as illustrated in the Fig. (4). For opposing side, the procedure repeated.

Figure 4: The position of Inter- Maxillary Fixation screw in maxilla.

The intermaxillary fixation was made using (0.5- 0.6) mm stainless steel wire ligated to the intermaxillary fixation (IMF) screws after reduction of fracture or elastics as illustrated in Fig. (6). To produce harmonic occlusion, then changed to stainless steel wire after (24) hours as in the Fig. (7).
Figure 6: Inter Maxillary Fixation screws with elastics (sport injury).

Figure 7: Inter Maxillary Fixation screws in situ by (0.5) mm stainless steel wires.

Follow up:

✓ Weekly during IMF period.
✓ Every 2 weeks for one month as in the Fig (8).
✓ One time monthly for 6 months.

Postoperative Assessment:
The treatment outcome were evaluated clinically and radiographically as shown in Fig. (8).

Figure 8: Post-operative panoramic radiograph.
The following parameters were recorded as postoperative data:-

- Length of follow-up period ranged 2 to 6 months.
- Healing of the operating sites, it was categorized as united or stable fracture, delayed union, nonunion and malunion. The site of operation was examined by gentle manipulation after release of IMF and by radiographical examination.

**RESULTS**

3.1 Gender of study sample

The total number of patients in this study was 35 patients treated by self-taping IMF screws, the sex distribution was 33 males (94.3%) and 2 females (5.7%) as shown in Fig. (9).

![Figure 9: Sex distribution of the sample.](image_url)

3.2 Indication of Immobilization

In this study; Trauma, oncology and orthognathic surgery were the main causes which needed immobilization. The patients occupations were divided in tow main groups; military and civilian (doctors; students; merchant and housewife) as illustrated in table (3.1).

Table 1: Occupation of patients and causes of immobilization.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>33</td>
<td>94.3</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>5.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Military</td>
<td>27</td>
<td>77.1</td>
</tr>
<tr>
<td>Doctor</td>
<td>2</td>
<td>5.7</td>
</tr>
<tr>
<td>Student</td>
<td>4</td>
<td>11.4</td>
</tr>
<tr>
<td>Housewife</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Merchant</td>
<td>1</td>
<td>2.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cause</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trauma</td>
<td>29</td>
<td>82.9</td>
</tr>
<tr>
<td>Oncology</td>
<td>3</td>
<td>8.6</td>
</tr>
<tr>
<td>Orthognathic</td>
<td>3</td>
<td>8.6</td>
</tr>
</tbody>
</table>

| Total  | 35        | 100.0   |
Trauma:
In this study, the trauma was divided into: blast; bullet, road traffic accident (RTA); fall from height (FFH) and sport. The blast trauma was showed the highest ratio and the fall from height (FFH) was shown the lowest ratio as shown in the Fig. (10).

Figure 10: Trauma causes.

Types of application
Trauma
The trauma sites were distributed in mandible alone twenty eight cases or combined mandible and other facial bones. The mandibular fracture was recorded in symphisia; parasymphisia; body; angle and sub condylar area or combined with other facial bones fractures. One case suffered from perforation of hard palate post trauma as shown in the Fig. (3.3) & Fig. (3.4).

Oncology
Pathological lesion was noticed in the three cases; ramus and body of the mandibleas shown in the Fig. (3.4) and table (3.2). Reconstruction was done in three cases as illustrated in table (3.3).

Table 2: Types of pathological lesions

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>32</td>
<td>91.4</td>
</tr>
<tr>
<td>Ameloblastoma</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Pindborg tumor</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Angiosarcoma</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 3: Types of reconstruction

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td>32</td>
<td>91.4</td>
</tr>
<tr>
<td>bone graft(ilium)</td>
<td>2</td>
<td>5.7</td>
</tr>
<tr>
<td>tongue flap</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>100.0</td>
</tr>
</tbody>
</table>
3.4.3 Orthognathic surgery.

Orthognathicsurgery were down in three cases; two cases of sagittal split osteotomy (SSO) and one case bimaxillary surgery (bimax), as shown in the Fig. (11).

![Figure 11: Sites and types of surgical intervention.](image)

**Time of application**

The time of application of inter maxillary fixation (IMF) screw was recorded in minutes in all cases as shown in the table (4).

<table>
<thead>
<tr>
<th>Time of application</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>9</td>
<td>19</td>
<td>12.2</td>
<td>2.390</td>
<td></td>
</tr>
</tbody>
</table>

**Oral hygiene.**

The oral hygiene of all samples was divided into three groups: good; fair and bad as shown in Fig. (3.5), Fig. (12) and table (4).

- **Good:** 1-no gingivitis & no plaque accumulation.
- **Fair:** gingivitis or plaque accumulation.
- **Bad:** gingivitis & plaque accumulation.
Complication.

In this prospective study, the complications were observed and mentioned as screw mobility; screw fracture and gingival overgrowth as shown in the table (5).

Table 5: Complication of Inter Maxillary Fixation screw.

<table>
<thead>
<tr>
<th>Complications</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>5</td>
<td>14.3</td>
</tr>
<tr>
<td>No</td>
<td>30</td>
<td>85.7</td>
</tr>
<tr>
<td>Screw mobility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3</td>
<td>8.6</td>
</tr>
<tr>
<td>No</td>
<td>32</td>
<td>91.4</td>
</tr>
<tr>
<td>Screw fracture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2</td>
<td>5.7</td>
</tr>
<tr>
<td>No</td>
<td>33</td>
<td>94.3</td>
</tr>
<tr>
<td>Gingival overgrowth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>6</td>
<td>17.1</td>
</tr>
<tr>
<td>No</td>
<td>29</td>
<td>82.9</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Mouth opening.

The mouth opening of the patients were checked after removal of inter maxillary fixation (IMF) screw and it was observed in follow up period and it was found normal in thirty one patients (88.6%); one patient limited mouth opening (2.9%) and deviated mouth opening in three patients (8.6%) as shown in the Fig. (3.7).

The measurement included inter incisal distance (distance between the maxillary and mandibular incisal edges on maximum mouth opening normally about (42 to 55 mm) and maximum protrusion and lateral excursion (normally 7 mm for each patient).

DISCUSSION

Gender of samples

In the last decade, Iraq become international field of terrorist’s fight. One third of Iraqi land was takeover by DAISH . The Iraqi army and associated forces were start battles of liberation so the military trauma was increased substantially. In our study most of the patients were males (94.3%), military (77.1%).

Time of applications

The insertion of IMF screws was a rapid to achieve immobilization of the jaw with either wire or elastic loops and coordinate occlusal relationships [4, 12]. In our study the mean time of immobilization procedure was (12-23min).

Oral hygiene

The simplicity of technical handling; good stability of skeletal anchorage for realignment of the pre injury occlusion; Minimal amount of hardware in the oral cavity; improved comfort for the patient and improved oral hygiene; Suitable for using in prosthodontics restoration (crown and bridge); Compatibility with open reduction and bone plating; Painless and fastly removal in the office [4, 3]. In our study improved patient comfort and oral hygiene were observed good oral hygiene in (21) patients (60%), fair in (9) patients (25.7%), bad in (5) patients (14.3%). Compatibility with bone plating was shown in oncology after resection of pathological lesion (benign or malignant) with or without reconstruction and open reduction after osteotomy in orthognathic surgery.

Gingival overgrowth

Mucosal overgrowth and soft tissue burying of intermaxillary fixation (IMF) screws was only noticed in studies with placement of screw adjacent to or through the mobile mucosa [4]. The wire in an X-pattern that provided maxillomandibular stabilization and reduced lateral excursions [5]. In our study the gingival overgrowth were observe in (6) patients (17.1%), (2) patients over wire (X pattern), (4) patients over screw as shown in Fig (4.1) and (4.2).
The explanation in points;

**a-** The gingival growth over wires were shown in X pattern caused heavy pressure on the gingiva in our study. Injured epithelium has a genetically programmed regenerative ability that allowed it to (re-establish its integrity throughout proliferation; migration and contact inhibition). In general, any free edge of normal epithelium continued to migrate by proliferation of germinal epithelial cells that advance the free edge forward until it came into contact with another free edge of epithelium, where it was signaled stopped growing laterally [8].

**b-** The gingival growth over screw was caused by changed in screw position. It was putting through the free gingiva to get sufficient bone width for screw insertion and avoid root injury.

**Mouth opening**

The mouth opening of the patients were cheeked after removal of IMF and it was observed in follow up period (2-12 months) that it was normal in (31) patents (88.6%), limited (1) patient (2.9%) and deviated in (3) patients (8.6%). The limitation was caused by fibrosis of facial soft tissue that resulted from multiple wounds (blast injury). Deviation was observed in (3) patients (Two patient with himamandibulectomy and one with condylar distruction by built injury). It was found that no relation between IMF screws and mouth opening.
Teeth Vitality

The vitality test and through radiographic protocol mentioned percentages of root contact per total number of applied screws. The injuries were either peripheral or did not reach through pulp chamber [4]. All teeth have scratched roots remained vital and without abnormal mobility, throughout follow-up [12]. In our study no teeth vitality was observed in our cases just mild dental pain in (2) patients and relief after 1-2 weeks. These patient were put under close follow up and routine teeth vitality test by (endo ice) and the teeth were stilled vital and agree with [12].

Clinical considerations

“Reduction intraoral manipulation with sharp stainless steel wire ends minimized the possibility of perforations of gloves and puncture injuries as -risk factors for blood borne virus transmission like (hepatitis B; hepatitis C and HIV) [12, 4, 11].

The second-generation intermaxillary fixation (IMF) screws had smoothed and polished which either capstan or spool style heads with milled channels for the uptake of the ligature wires to reduce damage to the labial mucosa and increase the patient’s comfort [4, 11].

Self-drilling IMF screws were doing by ( hand inserted without predrilling; without need power equipment; also it provided additional safety against contamination by infectious aerosols and blood or saliva splashes generated during drilling with hand pieces and avoids thermal necrosis of the mucosa orthe bone”[4].

The number of screws were inserted in each patient's ranged from (4) in (32) patients and (6) in (3) patients; the diameter (2 mm) and the length of screw (8 to 12 mm) as the mono- or bicortical insertion mode [11]. In our study insertion in mono cortical mode was shown mobility of screw after two weeks when wire load was applied. it was observed in (3) cases (8.6%).

Self-drilling IMF screws when compared with predrilling of holes, it provided a super tactile feedback as soon as tooth roots touched [4].

This verifiable feature was supposed to supply (a prophylactic removal of screw; redirection of the insertion path or /repositioning to another site) [4]. In our study, screw fracture was shown when reposition of screw in new site .it may be caused by Fatigue of the screws and we disagree with [4] and we suggested to use a new screw.

Self-drilling IMF screws could be applying at the bedside [4]. Easy to remove without need for anesthesia [1, 3, 10, 9, 12].

REFERENCES


