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Evaluation of Screw and Wire Traction in Anatomic Reduction of Mandibular Fracture

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Abstract

Background: Displaced mandibular fractures have numerous ways of being reduced, the aim of proper fracture reduction is to achieve good bone contact to allow for adequate healing. Reduction techniques include, bone holding forceps, manual reduction and reduction using maxilla-mandibular fixation techniques, which restore occlusion and then secondarily reduce the fracture site. Fracture immobilization using rigid fixation following reduction, maintains adequate bone contact allowing fracture line healing. The use of screw and wire traction provides stable fracture reduction anatomically without the need for IMF.

Objective: Evaluation of the efficacy of screw & wire traction in anatomical reduction of mandibular fracture.

Patients and Methods: This is a single arm interventional clinical trial including twenty adult individuals with mandibular fractures. Patients who are fulfilling the inclusion criteria of our study were sampled randomly. Aim of this study is to evaluate the efficacy of screw and wire traction in anatomical reduction of mandibular fracture on the accuracy of reduction, operative time and post-operative pain and edema.

Results: Twenty cases were included in our study. Adequate fracture reduction was done in all patients confirmed by good clinical bone contact, good occlusion and post-operative CT results. Post-operative pain and edema were minimal due to decreased manipulation of the fracture and the simplicity of the technique. The occlusion of the patients was followed up 2 and 6 weeks post operatively with cases showing no occlusal disturbance and return to normal function within 3 months.

Conclusion: Screw and wire traction for reduction of mandibular fractures anatomically showed success as regards to fracture reduction and showed no occlusal complication, we recommend this technique specially in symphyseal, para-symphyseal and angle fracture. The fracture line taking a strictly vertical axis shows the best outcome, however multiplanar fracture lines or L-shaped fractures are not good specimens for this method of reduction.

Key Words: *Mandibular – Fracture – Screw – Wire – Traction.*

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Introduction

Mandibular fracture treatment aims to achieve proper reduction of the fracture segments, to achieve immobilization of the fracture to restore pre-morbid occlusion and to promote direct bone healing **[1]**. Many authors stated that manual repositioning of occlusion could significantly reduce operation time as well as decrease complications associated with other techniques of maxillary-mandibular fixation (MMF) **[2]**. After achieving adequate occlusion, the reduction of the fracture segments can be achieved by several techniques.

Batbayar et al., stated that when performing manual reduction, extra hands to reduce the fracture fragments are needed, there is not always sufficient room to insert osteosynthesis materials via intraoral approach due to the limited access to the fracture when manually aligning fracture fragments **[2]**. Bone holding forceps is of value in the reduction of mandibular fractures specially symphyseal fractures, however its use is limited in para-symphyseal and angle fracture. They noticed that it is not easy to apply this forceps in the posterior region, via an intraoral approach and the complications such as fracture line flaring still can occur due to the design of these forceps **[3,4]**.

Degal and Gupta, stated that the use of screw and wire traction is a simple and easy method to achieve stable reduction of mandibular fractures, however they used an arch bar as well, as a method of achieving occlusion before fixation. In this technique, they used two screws (2mm width) near the upper border of the mandible. The screws were inserted in an-

terior mandibular cortex only to avoid teeth roots. Then a wire loop is inserted around the screws and tightened, with approximation of the fracture segments temporarily till the lower mandibular plate is secured [5].

Later, Ingole et al., proposed Anatomic reduction using screw-wire Traction (ATOM) technique. This method uses screw and wire traction in mandibular fracture reduction using a different way than described by Degal and Gupta. They inserted screws at the the inferior border of the mandible (5-10mm from each fracture segment) bi-cortically. Then a wire loop is inserted around the screws with further tightening till the bone segments are stable. They found that it has advantages over the bone forceps, as there is no need for bulky forceps which may be difficult to apply with the ease of fracture reduction along different fracture lines also the advantage of preventing inner mandibular border splaying during reduction [6]. The aim of our study is to evaluate the efficacy of screw and wire traction described by Ingole et a in anatomical reduction of mandibular fracture on the accuracy of reduction, operative time and post-operative pain and edema.

Patients and Methods

After obtaining the necessary committee and board agreement in the period between November 2022 till the end of 2023. Single arm interventional trial study targeted patients with mandibular fractures. The study excluded pediatric and sub condylar fractures. All patients gave written informed permission outlining the entire method under investigation in this study. The Type of Study was interventional single blinded controlled clinical trial.

Twenty patients with fracture mandible; single or multiple (symphyseal, para-symphyseal, body or angular fractures), simple or compound fractures displaced fractures and edentulous fractures. Patients with condylar and sub-condylar fractures, pediatric fracture and/or comminuted fractures were all excluded from the beginning. Patients' age, gender, occupation, time, mode of trauma, history of medical importance and surgical relevance, previous occlusion, mouth opening limitation and loose teeth are asked to exclude any existing bite abnormalities. Examination included inspection of bite abnormality using a cheek retractor, bimanual palpation for flail segments and loose tooth evaluation. Routine pre-operative investigations in form of labs were done. All patient underwent thin cuts CT scan with axial, coronal and sagittal cuts and 3D reconstruction to confirm the diagnosis and exclude any other maxillofacial fractures.

Cases were operated within one week after the trauma. After induction od anesthesia and nasal intubation, fractures were exposed for direct visualization, intervening soft tissue or hematoma in the fracture line was removed to allow for adequate reduction, before proceeding for the reduction of the fracture segment using screw and wire traction, interdental wiring was used if needed in fracture lines.

Screws were applied one cm from the fracture line into the lower mandibular border using screws (2mm in width and 12-14mm in length) and wire traction loop was then applied around the screws. The trajectory of screw placement was parallel to the axis as the fracture. Traction was then performed using the wire and thus obtaining anatomic reduction of the fracture segment, leading to fracture alignment (Fig. 1). Internal fixation was then done using a 2.3 rigid plate at the lower border of the fracture and a miniplate as a tension plate. The occlusion was then checked for any abnormality, and if there was any, the plates are removed and readjusted. Finally, Adequate wound irrigation and closure was done in layers and was done. A post-operative CT scan was ordered to evaluate the reduction and fixation.

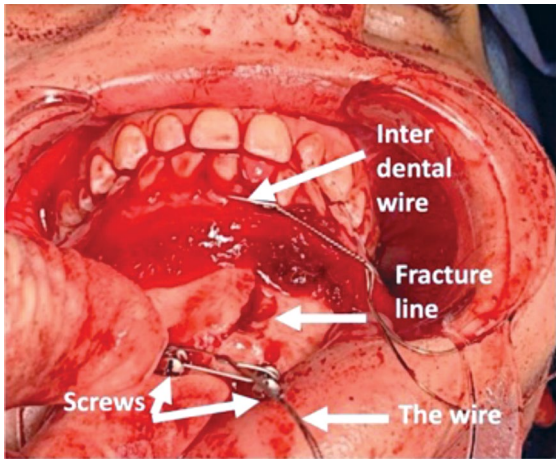

Fig. (1): Shows the technique for Anatomic reduction using screw-wire Traction (ATOM).

Postoperatively, all patients were discharged the next day after surgery. They were instructed to come in regular visits to check for any malocclusion or joint problems. Mouth opening and closing was advised to the patients to prevent ankylosis. Patients were advised to start fluid diet for 2 weeks, followed by a soft diet for another 2 weeks then finally introducing normal food after one month of surgery. In the post-operative clinic visits, suture lines were examined to make sure there is no dehiscence, infection, or plate exposure, edema and pain were followed-up also. Occlusal relation was assessed using a cheek retractor and photography.

Statistical analysis: The information was gathered, edited, coded, and entered a database IBM SPSS (Statistical Package for Social Science) version 23. The mean, standard deviations, and ranges were used to depict quantitative data having a parametric distribution. Qualitative variables were also provided as percentages and figures.

To compare the qualitative data between the groups, The Chi-square test was used to determine the results. An independent *t*-test was used to compare two independent groups with quantitative data and parametric distribution. A paired *t*-test was used to compare two matched groups with quantitative data and parametric distribution.

The margin of error accepted was set at 5% and the confidence interval was set to 95%. So, *p*-value was judged as following: *p*-values >0.05 are considered nonsignificant (NS), *p*-value <0.05 are considered significant (S), and *p*-values <0.01 are considered highly significant (HS).

Results

The patients' ages ranged from 14 to 55 years, with a mean age of 30.25±12.24. Of these individuals, 75% were male, and 25% were female. Most of the individuals were manual workers (30%), followed by students (20%) and housewives/cashiers (10%). Mode of trauma varied, with 80% of individuals experiencing an road traffic accident, 10% experiencing direct trauma, and 10% experiencing violence. The previous medical history was irrelevant in all patients.

The study reported the premorbid occlusion of individuals, which showed that most of the individuals had normal occlusion (70%), followed by edentulous (10%), midline shift in 5%, class II and cross-bite (10%), open anterior bite (5%). Additionally, all individuals had normal previous mouth opening; nevertheless, after the trauma, 65% experienced a limited mouth opening mostly due to spasm of muscles of mastication, while 35% had normal mouth opening (Table 1).

Table (1): Shows the abnormal premorbid malocclusion in study patients.

Grades	Number	Percentage
Class II	1	5.0
Midline shift	1	5.0
Cross Bite	1	5.0
Edentelous	2	10.0
Good	14	70.0
Open anterior bite	1	5.0

All patients had edema, tenderness, and swelling due to the trauma. Also, the study reported various bite abnormalities in the patients. The most common bite abnormality was an open anterior bite, which was present in 20% of the individuals. Cross-bite was present in 5% of the individuals, and various combinations of cross-bite with open bite were present in another 15%. Additionally, 10% of the individuals were edentulous, and 10% had no bite abnormalities. Furthermore, the study examined the deviation of the mandible and found that 35% of the individuals had a deviation, while 65% had no deviation.

The fracture sites (Fig. 2) varied among the patients, with the most common sites; right para-symphyseal (35%) and angle fractures (35%), combined Para-symphyseal fracture associated with angle fracture (15%) of the cases. The least common sites were angle and body (15%). In addition, most of the patients (55%) had segment mobility. Most of patients (75%) had stepping. Patients suffering from paresthesia or hypoesthesia were 45%. Twenty five percent of patients had open cut wounds. 50% of patients had gingival injury.

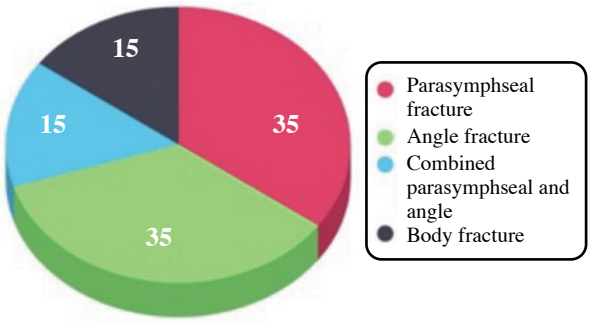

Fig. (2): Shows the frequency of mandibular fracture types.

Table (2): Shows the Immediate post-operative statistics of the patients in the study, including CT Findings post-operative and Complications.

Variables	Descriptive statistics	
	Number	Percentage
CT Findings post-operative:		
Good Reduction	20	100.0
Slight gapping	0	0.0
Slight stepping	0	0.0
Stepping	0	0
Complications:		
Dental infection over fracture site	1	5.0
Exposed sulcus	1	5.0
None	14	70.0
None resolving parasthesia	2	10.0
Plate exposure	1	5.0
Stitch sinus over extra oral incision	1	5.0

Regarding CT findings post-operative, 100% of cases showed a good reduction. In terms of complications, dental infection over the fracture site, exposed sulcus, plate exposure, and stitch sinus over extra-oral incision were each observed in only 5% of cases. None of these complications were observed in 70% of cases. Non resolving paresthesia was observed in 10% of cases, indicating that some patients experienced ongoing numbness or tingling after the surgery. Regarding the Occlusion variable, 65% of the patients had a good occlusion, while the rest had different occlusion issues such as Class II and cross bite which were present as a premorbid occlusion. Midline shift, slight cross-bite, and Open anterior bite with good molar contact were present in 2 patients, however they were also present as premorbid occlusion. Regarding edema, 55% of the patients presented with edema, while the rest had minimal edema (5%) or none (30%). Two patients (10%) had resolved edema. Third, Regarding the Pain variable, 35% of the patients reported mild pain, 30% had no pain, and the remaining 30% had pain. One patient's pain (5%) was resolved. Finally, all patients (100%) had no ecchymosis (Table 2).

Table (3): Shows the post operative occlusion.

Grades	Number	Percentage
Class II	1	5.0
Midline shift	1	5.0
Cross Bite	1	5.0
Edentulous	2	10.0
Normal	14	70.0
Open anterior bite	1	5.0

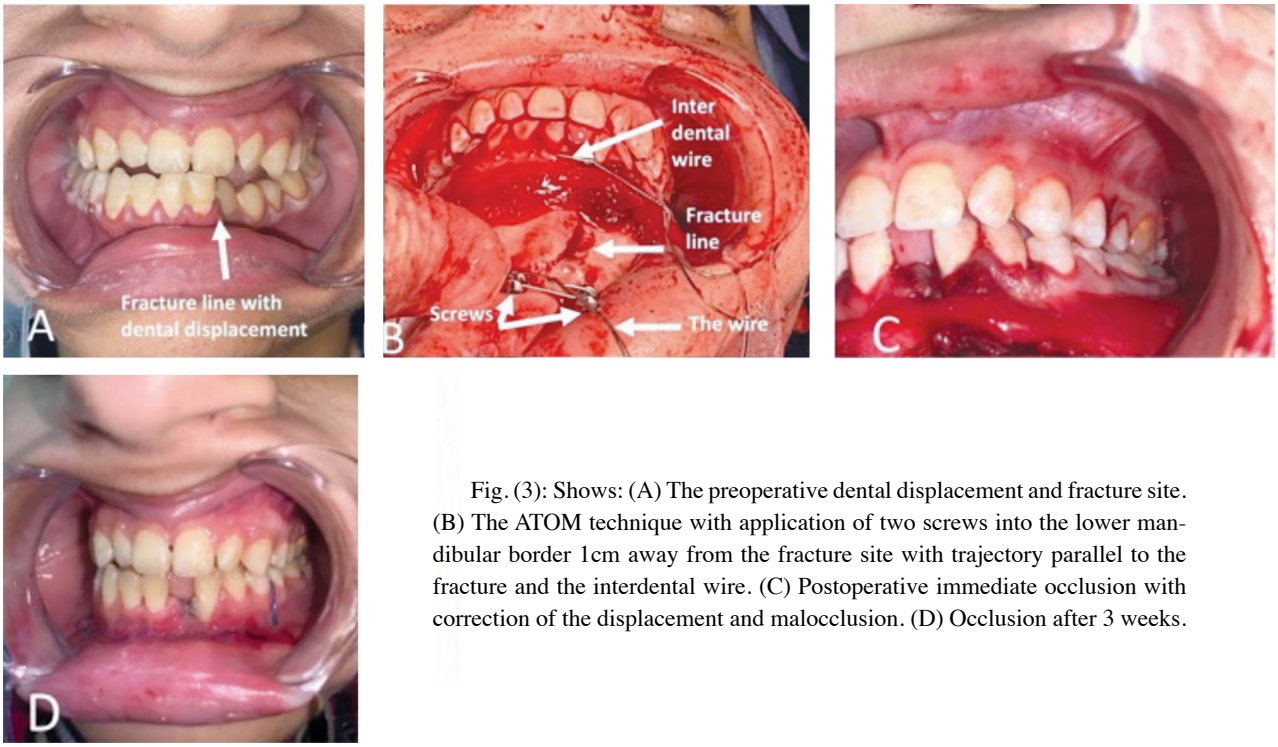

Fig. (3): Shows: (A) The preoperative dental displacement and fracture site. (B) The ATOM technique with application of two screws into the lower mandibular border 1cm away from the fracture site with trajectory parallel to the fracture and the interdental wire. (C) Postoperative immediate occlusion with correction of the displacement and malocclusion. (D) Occlusion after 3 weeks.

Discussion

Proper management of mandibular fractures is very important for proper occlusion that is mandatory for adequate chewing. The standard way for mandibular fracture treatment is secure proper occlusion first then apply plates and screws to the mandibular bone. The application of maxilla-mandibular fixation may increase the operative time and is also traumatic to the buccal mucosa and gingiva. The anatomical reduction using screw-wire Traction (ATOM) technique is used to obtain reduction of fractured mandible without the need for maxilla-mandibular fixation. It was first mentioned by Degala and Gupta who applied the screws for taction to the upper mandibular border. Then the technique was refined more by Ingole et al., who applied full thickness screw to the lower mandibular border that prevented posterior border splaying and allowed for more rigid bone reduction. The proposed advantages of the technique are elimination of the use of bulky reduction forceps that need a wide area of exposure and are traumatic to the tissues, the risk of accidental injuries can be decreased, precise anatomical reduction and segment compression can be achieved, and a reduction in the time taken during surgery.

Bell et al., 2008 found in their study that the use of Erich arch bars with Maxillo-mandibular fixation during surgery is not always necessary for successful outcome, and that manual reduction of occlusion can provide sufficient occlusal reduction provided that there is a fracture reduction method that is use to achieve fracture segment alignment **[7]**. Moreover, Dimitroulis et al., stated that the use of Maxillo-mandibular fixation for the management of angle fractures of the mandible is unnecessary provided that manual reduction of the fracture site for plating is done. This led to reduction of the operating time by up to 1 hour and accelerates discharge times by up to half a day **[8]**. A Systematic review and meta-analysis in 2022 suggested that the manual reduction results in a better anatomical reduction, less occlusal disturbance, fewer revision procedures and less infective complications compared to the IMF and takes less operative time **[9]**.

In our study, we performed the ATOM technique on 20 patients with different variants of mandibular fractures with exclusion of condylar and sub-condylar fractures, pediatric fracture and/or comminuted fractures. The patient's premorbid occlusion was restored manually, and reduction of the fracture was then maintained by the screw and wire traction, we found satisfactory results as regards to ease of reduction, good fracture alignment, operative time reduction. Anatomic reduction using screw and wire traction technique is of great use in edentulous mandible fracture, or in patients with incomplete dentition or lost teeth. Patients with HIV or hepatitis would benefit from the technique as the screw and wire traction along with anatomical reduction removes the need for arch bar and multiple wire usage.

The main advantage of the technique is the avoidance of using and IMF, this has reduced the operative time, puncture incidences and patient satisfaction, as patients will not need to have a second session of Arch bars removal, dental hygiene post operatively is easily maintained and it is a cost-effective method for avoiding use arch bars, too much wires. Operative time was objectively reduced in most of our cases, around 30-60 minutes were saved, as this was the time usually taken for arch bar placement.

Conclusion:

This study concluded that the use of screw and wire traction (ATOM) technique mentioned by Ingol et al., for reduction of mandibular fractures before hardware fixation, is considered highly effective method as it saved time and provided good occlusion. We recommend this technique specially in symphyseal, para-symphyseal and angle fracture. The fracture line taking a strictly vertical axis shows the best outcome, however multiplanar fracture lines or L-shaped fractures are not good specimens for this method of reduction. Further studies may be needed to evaluate the use of this technique in fixation of other patterns of mandibular fractures excluded from this study.

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