

Paper

Comparison of lag screws and double Y-shaped miniplates in fixation of anterior mandibular fractures

Abstract:

Purpose: The aim of this study is to compare the effectiveness of lag screws versus Double Y-shaped miniplates in the fixation of anterior mandibular fractures.

Patients and methods: This study is a prospective randomized controlled clinical trial, performed on sixteen patients with anterior mandibular fractures. Patients were divided equally into two groups, each consisting of eight patients. Group 1: underwent open reduction and internal fixation using two lag screws. Group 2: underwent open reduction and internal fixation using double Y-shaped plates. The following parameters were assessed: operating time in minutes, pain using the visual analog scale, edema, surgical wound healing for signs and symptoms of infection, occlusion status and stability, maximal mouth opening, sensory nerve function. Cone beam computed tomography was done at 3 and 6 months to measure bone density and assess the progression of fracture healing.

Results: The study included 13 males (81.3%) and 3 females (18.8%) with age ranging from 26 to 45 years (mean age was 35.69 ± 6.01 years). The cause of trauma was road traffic accidents in 10 patients (62.5%), interpersonal violence in 3 patients (18.8%), and other causes in 3 patients (18.8%). The fractures comprised 10 parasymphiseal fractures (62.5%) and 6 symphyseal fractures (37.5%). The values of all parameters were comparable in both groups with no statistically significant difference except for the mean bone density at 3 months postoperatively which was 946.38 ± 66.29 for group 1 and 830.36 ± 95.53 for group 2 ($p=0.015$).

Conclusion: Both lag screws and double Y-shaped miniplates provide favorable means of fixation for mandibular fractures in the anterior region. Fractures fixed with lag screws show greater mean bone density at 3 months postoperative, indicative of higher primary stability, and faster early bone healing. Further studies with a larger sample size are required to verify these conclusions.

Introduction

Mandibular fractures constitute about 80.79% of maxillofacial injuries in Alexandria University, either as isolated mandibular fractures or as a part of panfacial fractures. The combination of symphyseal and parasymphiseal fractures represent 47.09% of the total mandibular fractures. (1) However; this percentage of anterior mandibular fractures in comparison to other mandibular fractures is variable among different studies and locations. (2)

Lag screws have been described as a reliable, stable, and safe method of internal fixation for anterior mandibular fractures. The absence of anatomical hazards, the thickness of the bone cortices, and

curvature of the anterior mandible are all factors contributing to the suitability and success of using lag screws in that region. (3)

Miniplates have been widely used for decades for fixation of mandibular fractures owing to their easy handling and adaptation, in addition to providing functionally stable fixation. (4) Different designs of miniplates variable from the conventional form by Champy have been proposed to provide extra stability of the fracture. A biomechanical study has shown that Double Y-shaped miniplates provide greater resistance to displacement in comparison to conventional straight miniplates.(5)

The aim of this study is to compare the effectiveness of lag screws versus Double Y-shaped miniplates in the fixation of anterior mandibular fractures.

Patients and methods:

This study is a prospective randomized controlled clinical trial. It was performed on sixteen patients with anterior mandibular fractures, selected from those admitted to the Emergency Department of Alexandria University Hospital. This study followed the Declaration of Helsinki on medical protocol and ethics and the Regional Ethical Review Board of Faculty of Dentistry, Alexandria University approved the study (Approval Number: IRB 00010556-IORG 0008839). The study was registered on clinicaltrials.gov (ClinicalTrials.gov ID: NCT04396054). Written informed consent was signed by patients before the operation.

Patients were divided equally into two groups, each consisting of eight patients. The assignment of each patient into one of either group was done using computer random numbers.

Group 1: underwent open reduction and internal fixation using two lag screws.

Group 2: underwent open reduction and internal fixation using double Y-shaped plates.

Inclusion criteria: Patients of both genders with age ranging from 25 to 45 years, suffering from anterior fractures of the mandible (symphyseal or parasymphyseal) were included. Those with old fractures, infected or comminuted fractures were excluded from the current study.

A thorough clinical examination was performed preoperatively for all patients, in addition to panoramic radiographs. All patients were operated on by the same surgeon under general anesthesia with nasotracheal intubation. Complete disinfection of the oral cavity and face was done using povidone-iodine solution, followed by draping with sterile towels exposing the surgical site. Maxillomandibular (MMF) fixation was done to adjust the occlusion using arch bars and eyelet wiring. After that, an intraoral mandibular vestibular incision was done exposing the fracture line where reduction of the two segments was done under direct vision.

In the first group, fixation of the reduced segments was done using 2 lag screws (O&M medical GmbH Eschenweg, Germany). The diameter was 2.7 mm and the length ranged from 18-24mm. Screw fixation

was performed by passage of the screw through a larger gliding hole into a smaller traction hole on each side of the fracture (Figure 1). In the second group, fixation of the reduced segments was done using double Y-shaped plates (Stryker-Leibenger, Germany) with 6 monocortical 2.0 mm diameter screws (Figure 2).

After direct fixation was done in both groups, the incision was closed using layered suturing and the Maxillomandibular (MMF) fixation was removed. Postoperative care for all patients included the following:

- Each patient received intravenous Cefotaxime 1 gm/12 hours (Cefotax, by EIPICO) for one day postoperatively followed by Amoxicillin clavulanate (Augmentin, manufactured by MPU) 1 gm given orally twice daily for the next 5 days.
- Analgesic anti-inflammatory drug in the form of Diclofenac Sodium (Rheumafen, by GlaxoSmithKline) 75 mg vial till the second postoperative day followed by Diclofenac Potassium (Rheumafen tablets, by GlaxoSmithKline) 50 mg tablets three times daily for the next 5 days.
- All patients were instructed to use chlorohexidine mouth wash (Hexitol, by Arabic drug company, ADCO) for maintenance of good oral hygiene.
- Instruction of soft high-calorie diet was given for all patients to be followed for 4 weeks postoperatively.

Postoperative follow-up:

Patients were followed up at the second, third postoperative days, first and second weeks, then after one, 3, and 6 months. The following parameters were assessed: operating time in minutes, pain using the visual analog scale (VAS), edema, surgical wound healing for signs and symptoms of infection, occlusion status, and stability, maximal mouth opening, sensory nerve function using a dental probe to assess sensory changes along the mental nerve distribution and comparing it to the contralateral side. Cone beam computed tomography was done at 3 and 6 months to measure bone density and assess the progression of fracture healing.

Statistical analysis:

Data were fed to the computer and analyzed by the appropriate statistical tests using IBM SPSS software package version 21.0. Significance of the obtained results was set at the 5% level. Qualitative data were described using number and percent. Quantitative data were described using range (minimum and maximum), mean and standard deviation. The Independent Samples t-Test was used to compare the means of quantitative data.

Results:

This study was conducted on 16 patients suffering from anterior mandibular fractures. The study included 13 males (81.3%) and 3 females (18.8%) with age ranging from 26 to 45 years (mean age was 35.69 ± 6.01 years). The cause of trauma was road traffic accidents in 10 patients (62.5%), interpersonal

violence in 3 patients (18.8%), and other causes in 3 patients (18.8%). The fractures comprised 10 parasymphseal fractures (62.5%) and 6 symphyseal fractures (37.5%).

In group 1, patients were treated with open reduction and internal fixation using lag screws where the mean operating time from the start of hardware application to the end of fixation was 14.38 ± 1.92 minutes. In group 2, patients were treated with open reduction and internal fixation using double Y-shaped miniplates where the mean operating time was 15.63 ± 1.53 minutes. The difference between the two groups regarding the mean operating time was statistically insignificant ($p > 0.05$) [Table 1]

Concerning postoperative edema, only 2 patients of the study sample showed severe edema (12.5%), while all other patients demonstrated mild to moderate edema (87.5%) on the second postoperative day. By the end of the first week, the edema has resolved completely in all patients.

The mean pain intensity in the first postoperative week was 4.125 ± 1.25 in group 1 and 4.75 ± 1.04 in group 2 with no statistically significant difference ($p = 0.294$). It was completely resolved by the end of the second week.

The mean maximal mouth opening measured two weeks after operation was 38.25 ± 2.38 mm in group 1, and 37.63 ± 2.92 mm in group 2 with no statistically significant difference ($p = 0.646$).

The surgical wounds have healed uneventfully in all patients of both groups except for one patient in group 2 who had wound dehiscence that was managed conservatively using irrigation and antiseptic mouthwashes until secondary intention healing was achieved. No sensory nerve impairment was detected postoperatively in any patient of either group. Satisfactory occlusion and normal inter-cuspal relation were evident in all patients except for one patient in group 1 who had slight malocclusion postoperatively, which was managed by selective grinding.

The mean bone density at the fracture line (measured in greyscale using the CBCT OnDemand3D™ software [310 Goddard Way, Suite 250 Irvine, CA USA, <https://www.ondemand3d.com>]) at 3 months postoperatively was 946.38 ± 66.29 for group 1 and 830.36 ± 95.53 for group 2. The difference between the two groups was statistically significant ($p = 0.015$). At 6 months postoperatively, the mean bone density for group 1 was 1062.66 ± 63.89 and for group 2, it was 1083.86 ± 82.83 , with no statistically significant difference between the 2 groups.

Discussion:

The current study compared the use of lag screws versus double Y-shaped miniplates in fixation of anterior mandibular fractures and comparable results were found in most evaluation parameters except for a statistically significant higher mean bone density in the lag screw group at 3 months postoperative. The male to female ratio in the study sample showed a marked male predilection (4.33:1) in agreement with other studies(1, 6). It is suggested that the high-speed driving and larger participation in outdoor activities is probably more characteristic to men rather than women in our society, which renders them more susceptible to accidents in that age group. Moreover, in accordance with previous studies, road traffic accidents have been the major cause of trauma followed by personal violence and other causes.(1, 7)

The present study has demonstrated comparable mean operating time in both groups with no statistically significant difference, starting from hardware application to the end of fixation. This is in contrast to other studies that have shown a shorter time for lag screw fixation in comparison to miniplates.(8, 9)

The mean pain score at the end of the first week was numerically (but not statistically) lower in the first group. Bhatnagar et al(10) have got similar results with less pain in the lag screw group, where they explained their findings by the higher stability of the fracture line provided by lag screws in comparison to miniplates and less hardware applied leading to reduced persistent postoperative pain.

No postoperative sensory nerve impairment was detected in either group after fracture fixation, owing to the gentle fracture manipulation, careful dissection of the mental nerve, and cautious application of screws in close proximity to the nerve. This goes hand in hand with the results of the study by Agarwal et al(11) who did not face any postoperative nerve deficit and stressed the importance of skills and patience during hardware application in anterior mandibular fractures.

The difference in mean bone density was statistically significant between both groups at 3 months postoperative suggestive of early bone healing. This is consistent with previous studies (9, 12) using lag screws in fractures of the anterior mandible. This may be due to their compressive effect on the fracture segments, facilitating the progression of primary bone healing. However, by the end of the follow-up period both groups had comparable mean bone density values indicative of adequate fracture healing and stability. Double Y-shaped miniplates with their special design have shown predictable biomechanical behavior with greater resistance to displacement when compared with straight miniplates. (5)

To our knowledge, this is the first clinical trial comparing lag screws to double Y-shaped miniplates in the fixation of anterior mandibular fractures. This special design of miniplates provides better stability than

straight miniplates and more ease of application/adaptation than 3-dimensional miniplates in the anterior region. However, the main limitation of the current study is the small sample size which in some way, might have affected the interpretation of the results. The small number of patients included is attributed to the meticulousness in case selection to meet all the inclusion criteria and minimize the variability between cases as much as possible.

Conclusion:

Both lag screws and double Y-shaped miniplates provide favorable means of fixation for mandibular fractures in the anterior region. Fractures fixed with lag screws show greater mean bone density at 3 months postoperative, indicative of higher primary stability, and faster early bone healing. Further studies with a larger sample size are required to verify these conclusions.

Conflict of interest:

No conflict of interest

Funding:

No funding received.

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Tables:

Table 1: Mean operating time

Group
N
Mean
Std. Deviation
t
Sig. (2-tailed)
Operating time
1
8
14.3750
1.92261
.172
2
8
15.6250
1.52947
-1.439

Table 2: Mean bone density in the 2 groups at 3 and 6 months postoperatively

Group

N
Mean
Std. Deviation
t
Sig.(2-tailed)
Bone density 3 months
postoperative
1
8
946.3825
66.29304
2.822
.015*

2
8
830.3625
95.52573

*p<0.05

Group
N
Mean
Std. Deviation
t
Sig.(2-tailed)
Bone density 6 months
postoperative
1

8

1062.6575

63.88916

-.573

.576

2

8

1083.8550

82.82562

Figure legends:

Figure 1: Symphyseal fracture fixed with two lag screws

Figure 2

Figure 1

Figure 2: Parasymphyseal fracture fixed with double Y-shaped miniplate.

