Journal of Chemical Health Risks

www.jchr.org

JCHR (2026) 16(2), 1045-1050 | ISSN:2251-6727

A Comparative Evaluation of Keyhole Plate and Conventional 4-Hole Miniplate in the Management of Fractures of Angle of Mandible

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(Received: 16 January 2026 Revised: 25 February 2026 Accepted: 17 March 2026)

KEYWORDS

Mandibular fracture,

Angle fracture,

Key-hole plate,

Conventional 4-hole miniplate

ABSTRACT:

Introduction: Mandibular angle fractures are common and challenging to treat due to limited surgical access and difficulty in plate adaptation. Conventional 4-hole miniplates, though widely used, often require increased instrumentation and time. The keyhole plate, with a pear-shaped hole design, was introduced to simplify placement and improve surgical convenience. This study aimed to compare the clinical and radiological outcomes of keyhole plate versus conventional 4-hole miniplate in mandibular angle fractures.

Objectives:The objectives of the study are to compare efficiency of keyhole plate and conventional miniplates by assessing certain parameters like 1) Time taken for placement of keyhole plate and conventional miniplate in the fracture site during fixation of fracture 2) Postoperative occlusion 3) Mouth-opening of the patient. 4) Bite force 5) Postoperative complications such as pain, wound healing, mal-union and non union.

Methods: A prospective comparative study was conducted on 30 patients with mandibular angle fractures at Government Dental College and Hospital, Vijayawada. Patients were randomized into two groups: Group A (15 patients) treated with keyhole plate and Group B (15 patients) with conventional miniplates. Clinical parameters evaluated were intraoperative time for plate application, postoperative occlusion and mouth opening, bite force recovery, complications such as pain, wound healing, malunion, and non-union during a 6-month follow-up.

Results: The mean application time was significantly shorter for keyhole plates (18.4 min) compared to conventional plates (24.3 min; $p = 0.00016$). Both groups showed significant improvements in occlusion, mouth opening, and bite force, with no statistically significant intergroup differences. Pain decreased significantly postoperatively in both groups. All patients achieved satisfactory wound healing; 4 patients developed transient paresthesia (1 in Group A, 3 in Group B). No cases of malunion or non-union were observed.

Conclusions: Keyhole plates significantly reduce operative time and improve surgical convenience compared to conventional miniplates, while providing comparable clinical and radiological outcomes. Larger studies with extended follow-up are warranted to validate these findings

1. Introduction

Mandibular angle fractures include the fractures which occur in the area between the anteriorborder of the masseter muscle i.e., distal to the second molar to the posterior border of the muscle [1,2] . They account for about 16.5% to 37% 3 4 5 of all the mandibular fractures. The third molar's presence makes it more susceptible to fractures by creating a weak point as it disrupts the cortical continuity of the external ridge when present partially impacted[5] . Combined with this, biomechanically the angle is looked up as a "lever" area i.e., there is a sudden change from horizontal to vertical ramus which would imply that this region might be prone to more complicated forces when compared with linear geometric shape [6] .The vertical displacement of fragments is due to the pull of the temporalis, masseter, and medial pterygoid muscle. Lateral and medial

Journal of Chemical Health Risks
www.jchr.org
JCHR (2026) 16(2), 1045-1050 | ISSN:2251-6727

pterygoid muscles' pull lead to the horizontal displacement of fractures [2] . The angular fractures of mandible are treated by one of two means, non surgical conservative management or surgical management. This depends on the type, severity, and consequences of fracture. The complexity in the biomechanics of mandibular angle, such as the attachment of the masticatory muscles exhibiting their forces in different vectors, having a thin cross-sectional area, the sudden change in curvature, and the third molars presence make its management difficult [7] .The main aim of the treatment of mandibular fractures is to get back the mechanical strength of the fracture site to its pre-fracture state and achieve harmony with the masticatory muscles'function [2] . Traditionally, two plates were positioned; one plate was a tiny compression plate attached with monocortical screws at the superior border, while the other was a large compression plate attached with bicortical screws at the inferior border. By using a single monocortical tension plate positioned on the external oblique ridge, semirigid fixation can be achieved to avoid neurovascular damage, damage to adjacent teeth, and to return function without maxillomandibular fixation with fewer complications [8,9] . The development of theminiplate was mainly on the improvement of the material, the location and the method of application and the development of the shape of the holes in the miniplate was very little. Depending on the site, different orientations of the circular holes and the straight plate of miniplate have been designed to be L-shaped, Double-Y Shaped, X shaped etc. For individuals who have fractures at the mandibular angle, these miniplates are difficult to fit exactly to the bone segment because of reduced visual field and accessibility [10] . Thus, thehole of the miniplate was modified into a keyhole shape or pear shape which would allow the screw to be placed first followed by the hanging of the miniplate onto the screw. This will help in stabilizing the plate and avoid it from slipping while handling and reduces the instrumentation required to hold the miniplate in position in the low access regions like the mandibular angle hence aiding in better approximation and visualization of fracture fragments [10] .

THE KEYHOLE PLATE SYSTEM CONSISTS OF: ● The keyhole plate is a modification of a sliding plate. ● The plate is made of stainless-steel metal of thickness 0.8mm. The plate consists of 3 circular and 1 pear shaped hole. ● It has a 2.5mm hole in its front portion and three 2mm holes in its rear portion.

Objectives

The objectives of the study are to compare efficiency of keyhole plate and conventional miniplates by assessing certain parameters like 1) Time taken for placement of keyhole plate and conventional miniplate in the fracture site during fixation of fracture 2) Postoperative occlusion 3) Mouth-opening of the patient. 4) Bite force 5) Postoperative complications such as pain, wound healing, mal-union and non union.

2. Methods

This study was conducted on patients who reported to the Department of Oral and Maxillofacial Surgery, Government Dental College ,Vijayawada with Mandibular Angle Fractures from Novemeber 2020 to December 2022 after obtaining approval from the institutional ethical committee. A total of 30 patients were included in this study who were diagnosed with mandibular angle fractures and planned for open reduction followed by miniplate fixation. The inclusion criteria included- 1) Age 18 to 60 years. 2) Patients with ASA I and relatively healthy ASA class II. 3) Patients with fractures of the angle of mandible requiring surgical intervention. 4) Patients who had given written informed consent. 5) Patients who are willing for visits of follow up. Exclusion criteria- 1) Medically compromised patients not fit for surgery. 2) Patients not willing or unable to give informed consent. 3) Patients who are non-cooperative. 4) Patients with pathological or comminuted fractures of the mandible. 5) Edentulous patients. In this study, patients were randomly divided into two groups (15 in each group). Group-A: Fractures of angle of mandible treated with conventional 4-hole miniplate. Group-B: Fractures of angle of mandible treated with keyhole plate. In both the groups surgery was carried either under local anesthesia or general anesthesia under aseptic conditions. To get pre-injury occlusion, fixation was done by Erich's arch bar. Approach to the fracture was gained via the intraoral vestibular approach. Reduction of fracture fragments was done. Intermaxillary fixation was maintained intraoperatively using a 26-gauge wire. After achieving proper occlusion, fixation of fracture segments was done with either a keyhole plate or a conventional 4 hole miniplate placed on Champy's line of ideal

Journal of Chemical Health Risks
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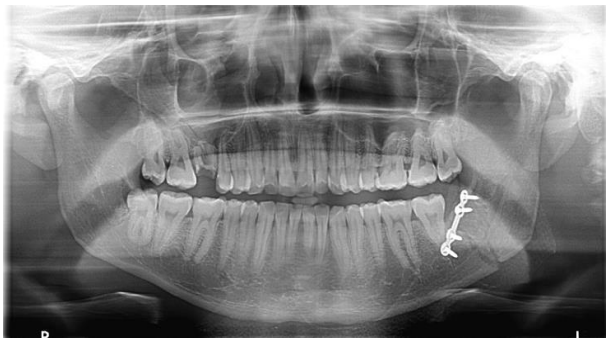
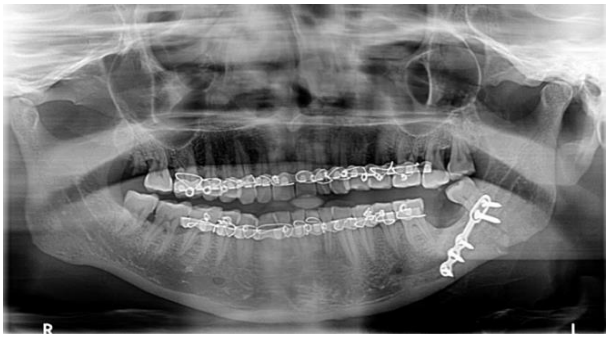
JCHR (2026) 16(2), 1045-1050 | ISSN:2251-6727

osteosynthesis. In the angle region, fixation was done in the superior border of the mandible. After achieving proper haemostasis, the incision site was closed using 3 -0 vicryl. Application of keyhole plate: • The first screw is inserted about 2/3 of the total length into a part of the displaced bone segment. • The inserted screw head is passed into the plate through the wide part of the front hole of the keyhole plate and the plate is pulled into the fracture line. • After the screw is inserted into the remaining holes of the plate, the entire length of the first screw is completely inserted. • An oversized head screw is inserted into the oversized hole to complete its sturdy fixation. All the patients in both groups were given Injection Cefotaxime sodium 1gm i.v. twice a day, Infusion Metrogyl 500mg i.v. thrice a day, Injection Diclofenac sodium 75mg i.m. twice a day, Injection Pantop 40 mg i.v. once a day, Injection Dexamethasone 8mg i.v. as required, Infusion 1-unit Ringer lactate 100 ml/hr for 1 day, Infusion 1-unit Normal saline 100 ml/hr for 1 day for five days post operatively. Patients were recalled on regular intervals at 1 week, 4 weeks, 3 months and6months.



Fracture of angle of mandible treated with conventional 4-hole miniplate.



Fracture of angle of mandible treated with keyhole plate

3.**Results**

TIME FOR PLATE APPLICATION: The average time taken for the plate application in Group A was 18.4 minutes with minimum time taken being 15 min. and the maximum time taken being 22 min. Whereas in Group B the mean time taken was 24.27 minutes with minimum being 19min. and maximum being 31min.

POSTOPERATIVE OCCLUSION

In Group A, out of 15 patients, 11 (73.33%) patients had no occlusal derangement, and 4 (26.67%) patients had mild occlusal derangement. In group B, 11 (73.33%) patients had no occlusal derangement, 1 (6.67%) had mild occlusal derangement, 2 (13.33%) had moderate derangement of occlusion and 1 (6.67%) patient had severe derangement of occlusion.

MOUTH OPENING: In group A, The mouth opening was measured preoperatively as 32.4 ± 6.84 mm and 1 month post operatively as 46.73 ± 7.95 mm. In group B, it was measured preoperatively as 32.53 ± 6.48 mm and 1 month postoperative as 46.47 ± 7.55 mm

MOLAR BITE FORCE: The molar bite force in group A was measured 1 week postoperatively as 58.93 ± 27.02 newton and 3 months post operatively as 182.73 ± 56.99 newton. In group B, it was measured 1 week postoperatively as 61.87 ± 29.99 newton and 3 months post operatively as 151.07 ± 68 newton.

PAIN-

The pain experienced by patients in Group A on immediate postoperative day was 7.07 ± 1.22 , on 1week postoperatively it was 1.77 ± 0.70 and on 1 month postoperatively it was 0. In Group B on immediate postoperative day it was 7.13 ± 1.35 , on 1week postoperatively it was 1.67 ± 0.9 and on 1 month postoperatively it was 0.07 ± 0.26.

WOUND HEALING: In Group A, the wound healing 1 week post operatively was good in 2 (13.33%) patients and very good in 13 (86.67%) patients. All the patients had excellent wound healing 1 month postoperatively. The p value of the chi-square test performed was 0.00000489 (<0.05) showing statistically significant wound healing.

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www.jchr.org
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Discussion

The mandible comprises of a number of components: two condyles, two coronoid processes, the rami, the angles, and the two halves of the body joined anteriorly at the symphysis. Functionally, the mandible can be regarded as two conjoined L-shaped cantilevers, acting under the influence of the masticatory muscles [11] . The U-shape of the mandible has an important feature known as the 'ring bone rule', which states that in case of a fracture in one location, another fracture or displacement is most likely to appear over the opposite side [12] . Between the anterior border and the posterior superior attachment of the masseter muscle is a triangle-shaped anatomical area known as the mandibular angle. Angle fractures are present at anatomically distinct locations that are bordered by the masseter and medial pterygoid muscles laterally and medially, respectively. The anatomical weak point in this area is caused by the absence of third molars, and concomitant fractures such condyle fractures may change how an angle fracture is displaced. Vertical and horizontal fracture lines in this area determine the reduction of choice. The angle fractures that are not favorable can move medially and superiorly [2] . The AO/ASIF (1994) gave four updated care guidelines for mandibular fractures which are 1) Anatomic reduction, 2) Functionally stable fixation (previously "rigid fixation"), 3) Atraumatic surgical technique and 4) Immediate active function [13] . The ideas of favorable and unfavorable have been replaced by the new conceptions of regions of tension and compression, i.e. tension at superior border and compression at inferior border, since the introduction of rigid internal fixation for mandibular fractures in the 1970s. For body and angle fractures, the tension and compression theory is valid [14] . Compared with other fractures, the angle fracture has the maximum positive bending moment resulting in compression at the inferior border and tension at the alveolar ridge of the fragments, maximum shear forces leading to a caudal displacement of the fragment posterior of the fracture and cranial displacement of the fragment anterior of the fracture. The transition zone between areas of tension in the superior mandibular border and compression in the inferior border has been referred to as a "line of zero force" running along the inferior alveolar nerve. Champy suggested a single non-compression miniplate on the superior border for mandibular angle fractures in light of these biomechanical findings (Champy technique) [15] .The AO faculty chose a single miniplate on the superior border (Champy technique) with or without arch bars [15]. This was stable, easiest to perform and was associated with the lowest number of complications based on several variables, including the amount of time it took to perform the surgery and postoperative wound problems according to various studies [16,17,18,19]. The reduced intraoral accessibility of the angle region of the mandible make miniplates difficult to be used in this area. Keyhole plate system was introduced which was unlike the existing plates. It had pear-shaped hole which allows for easy application of the plate and increase the convenience of plate placement in the angle region of mandible. The surgical convenience could also be improved by using the first screw that is inserted as an anchor screw. A study by In-Hee Woo(2016) detailed that the YK plate system has shown a similarstability to the existing method and the success and efficiency of the miniplate [20] .The present study was a prospective comparative study of 30 patients with mandibular angle fractures divided into 2 groups of 15 each at the Department of Oral and Maxillofacial Surgery in Government Dental College and Hospital, Vijayawada. Group A were treated with keyhole plates, and Group B were treated with conventional 4 hole miniplates. Group A comprised 14 males and 1 female with a mean age of 33 years and Group B comprised 13 males and 2 females with a mean age of 29 years. The patients were assessed for intraoperative time taken for plate application, malocclusion, mouth opening, molar bite force on affected side, fracture reduction and post operative complications like pain, wound dehiscence, malunion and non-union till 6 months of follow-up period. The findings of present study have shown that, the time taken to fix the keyhole plate was significantly less than the time taken for miniplate application with a p value of 0.00016. On comparison of occlusion in group A and group B patients, there was no significant difference noted. The mouth opening, and molar bite force on the affected side had significantly increased in both the groups but when compared between group A and group B, no statistically significant difference was shown. The fracture reduction was type3 in 8 and type2 in 7 patients in Group A. In Group B it was type3 in 6, type2 in 8 and type 1 in 1 patients. There was no significant difference between Group A and Group B. There was significant decrease in pain in both the groups

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JCHR (2026) 16(2), 1045-1050 | ISSN:2251-6727

in post operative follow ups with no significant difference when compared between the two groups. All of the patients had excellent wound healing by 1 month post operative period and none of them had dehiscence. Paresthesia was encountered in 4 patients as in 1 patient in group A and 3 in Group B with no statistically significant difference. In present study none of the patients in either group had any complication of malunion or non-union when evaluated clinically and radiographically after 3 months of the surgery. On conclusion with the present study, the time taken for application of keyhole plate is less and clinically convenient than the conventional 4 hole miniplate. The limitations of the present study include a small sample size and a short follow up period. Studies with greater sample size are needed to support the findings of the current study.

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