**Original Research**

# Evaluation of trapezoidal shaped 3-D plates for internal fixation of mandibular subcondylar fractures in adults of Kumaon region at GMC Almora

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## ABSTRACT

**Aims**: The purpose of this study is to evaluate the clinical results and to assess the efficacy, stability, and rigidity of trapezoidal 3-D plates for osteosynthesis in adult mandibular subcondylar fracture patients.

**Methods**: This study included 15 cases of trauma having mandibular subcondylar fractures, in which open reduction and internal fixation are indicated. After selecting patient according to the inclusion criteria, all patients underwent open reduction and rigid fixation. Fracture was then stabilized using 4 hole, 2.0 mm trapezoidal-shaped 3-D titanium plates using retromandibular incision. Postoperative clinical examination was carried out on 3rd day; 1st, 2nd, and 4th weeks; and 3rd and 6th months.

**Results:** The results of this study suggest that the fixation of mandibular subcondylar fracture with trapezoidal-shaped 3-D plates provides three-dimensional stability and carries low morbidity.

**Conclusion**: Patients with gross displacement of condylar fragment, major reduction in posterior facial height, and deranged occlusion can be successfully managed by open reduction of condylar fracture and its fixation using 3-D plate

**Keywords:** Trapezoidal Condylar Plates Condylar Fracture Open Reduction



## INTRODUCTION

Mandibular condylar fractures are most commonly encountered mandibular fracture by a maxillofacial surgeon. Incidence of condylar fractures among all mandibular fractures is between 17.5% and 52% [1-5]. According to Killey the most common unilateral fracture is of the condyle, and the most common bilateral fracture is of the condylar heads [6]. Most of these are not caused by direct trauma, but follow indirect forces. Treatment of condylar fractures depends on physical and imaging evidence of the fracture, on the extent of injury (whether it is unilateral or bilateral), the level of the fracture, the degree of displacement and dislocation, the size and position of the fractured condylar segment, the dental malocclusion,etc.In 1924 Perthes' did the first surgical treatment of a condylar fracture .Surgical treatment to re-approximate the fractured segments has been advocated to avoid the complications of open bite, retrognathia, pain, reduced lateral and protrusive mobility and deviation on opening [7,8,]. Open reduction aims at anatomical repositioning and rigid fixation of the fragments, occlusal stability, rapid return to function, maintenance of vertical ramus dimension, no airway compromise and less long-term temporo-mandibular joint dysfunction [9,10,11]. Bilateral condylar fractures cause most malocclusions [12]. It is believed that once condylar non-union has occurred, conservative treatment is ineffective and the joint is prone to arthritic sequelae[13,14].Stable fixation is very important in surgical management of condylar fractures as interfragmentary mobility can lead to non-union, fibrous union or temporomandibular disorders. Fixation with very rigid miniplates gives more stability than transosseous wiring[15,16]. Although single miniplates can be adequate if the fragments are aligned properly, functional forces actually exceed the rigidity of one miniplate, and therefore the use of two

has been proposed, or alternatively a single 2.4mm plate or a single 2.0mm mini-dynamic compression plate that offers more resistance to rotation and 3-point bending[17,18]. However, in the condylar neck the amount of bone is not always adequate to permit placement of 2–3 screws per fragment. To overcome this problem various plate designs have been put forward.

A single L or Y shaped plate as well as 3-D plates have also been used in the treatment of condylar fractures. Recently a modified 3-D plate has been designed by Meyer et al which conform to the tensile stress pattern at the condylar neck region and it is claimed to provide better outcome. Trapezoidal condylar plate (TCP) is shaped for adaptation in the anatomically constricted region of condylar neck. Trapezoidal condylar plate is placed with one arm parallel to the condylar axis and second arm parallel to the mandibular notch. Hence, this plate met the criteria of 2 single miniplates with reduced hardware. This plate also provides three dimensional stability because of its design. Because of reduced hardware, this provides lesser infection rate and requires reduced exposure as compared to 2-4 hole straight miniplates[19].

The Aim of our study was to assess the efficacy and rigidity of trapezoidal 3-D plates for osteosynthesis of mandibular subcondylar fracture in adult patients of Kumaon region At Gmc Almora .The Objectives of this study were to:-

- Check the stability of the fractured fragments.
- Ensure the re-establishment of occlusion.
- Evaluate postoperative complications.

## MATERIAL AND METHOD

This study included 15 cases of mandibular subcondylar fracture alone or in combination with fracture elsewhere in the mandible or mid-face fracture which reported to the Department of Dentistry,at GMC Almora ,treated by open reduction and internal fixation using 2.0mm Trapezoidal shaped 3-dimensional titanium miniplate.

## INCLUSION CRITERIA

Adult patients with mandibular subcondylar fracture.Patients who consented for the surgical treatment and postoperative follow-up.

## EXCLUSION CRITERIA

1. Condylar head fractures (Intracapsular fractures).
2. Paediatric patients.
3. Patients not willing for the procedure.
4. Patients who could not be followed up postoperatively over a minimum period of 6 months.
5. Medically compromised patients.

## METHOD OF STUDY

The study was approved by local ethical committee, and a well informed and written consent was obtained from all patients included in this study. In all the cases a thorough medical history was recorded to rule out any significant systemic conditions that might have had a bearing on patient's treatment protocol. Detailed clinical examination was carried out as per the protocol. All patients consented to use their photographs for discussion and display. Radiographic examination included the orthopantomogram (OPG). Additional radiographic projections were obtained when indicated such as PA view of mandible. The radiographs were assessed for the degree of displacement of the fracture fragments. Trapezoidal shaped 3 dimensional miniplate was used. These designs were formed by modifying the rectangular shaped of conventional 3D plates from rectangular to trapezoidal. The miniplates were manufactured by Orthomax and were made up of titanium (Carbon 0.027%, Titanium 89.34%, Aluminium 6.50%, iron 0.10%, Nitrogen 0.029%,Vandaium 3.96%) having a profile height of 2mm. The screws used were self tapping with head diameter of 3.0mm having thread diameter of 2.0mm and pitch of 0.6mm. The drill used was of 1.5mm. The length of the screws used was 6mm and 8mm. After placement of Erich's arch bars or Ivy eyelets, patient was shifted to the operating room and under general anesthesia with nasoendotracheal intubation, part preparation was done using standardized savlon and betadine solutions and the patient was draped with sterile drapes. Reduction and stabilization of other mandibular fractures were done first, if present, with adaptation of miniplates using Champy's lines of osteosynthesis. All patients were treated using the retromandibular incision. The skin was marked prior to the injection of a vasoconstrictor. The incision for the retromandibular approach begins 0.5 cm below the earlobe and continues inferiorly for 3 to 3.5 cm. It was placed just behind the posterior border of the mandible. Local anesthetic with a vasoconstrictor was injected only subcutaneouslyto aid in hemostasis at the time of incision. The initial incision was carried through skin and subcutaneous tissues to the level of the scant platysma muscle present in this area.

After retraction of the skin edges, the scant platysma muscle overlying the superficial musculoaponeurotic system (SMAS) was visible. A scalpel was used to incise through the fusion of platysma muscle, SMAS, and parotid capsule in the vertical plane. The gland was then clearly visible. Blunt dissection was done within the gland in an anteromedial direction toward the posterior border of the mandible and the facial nerve branches were retracted out of the operative field. After retraction of the dissected tissues anteriorly the posterior border of the mandible with the overlying pterygomasseteric sling was seen. The pterygomasseteric sling was incised sharply with a scalpel.The sharp end of a periosteal elevator was drawn along the length of the incision to strip the tissues from the posterior border of the ramus.

**Figure-1: Incision followed by Blunt dissection of the tissue layers**

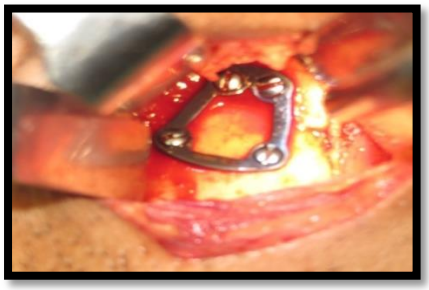


**Fig. 2 – Placement of TCP.**

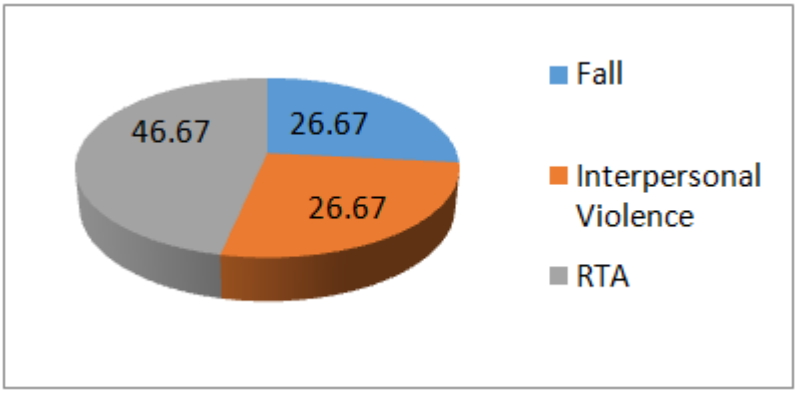
**Figure3-Post -Operative OPG (3rd month)**

## RESULTS

All the patients had a uneventful postoperative period and were discharged on the third day after surgery. Age of patients ranged from 18 to 50 years. More than half the patients (66.7%) were aged between 21 and 40 years, mean age of 29.07 . Surgery was performed under general anesthesia with naso-endotracheal intubation. Reduction and stabilization of other mandibular fractures were done first, if present. Retromandibular incision was used to expose the subcondylar fracture. The skin was marked prior to the injection of a vasoconstrictor . Fracture site was exposed and identified (Fig. 1) and reduced in normal anatomic position using bone-holding forceps. Maxillo-mandibular fixation was done. Fracture fragments were fixed with TCP using 6 or 8 mm screws (Fig. 2). Follow-up period was of at least 6 month where patients were periodically recalled on 3rd day; 1st, 2nd, and 4th weeks; and 3rd and 6th months postoperatively. Patients were evaluated for any signs of malocclusion, facial nerve injury, or infection with local rise in temperature, inflammation, and pus discharge. Radiographic evaluation with OPG was done on the 3rd postoperative day and 3rd (Fig. 3)and 6th months .

A total of 15 patients were enrolled in the study.

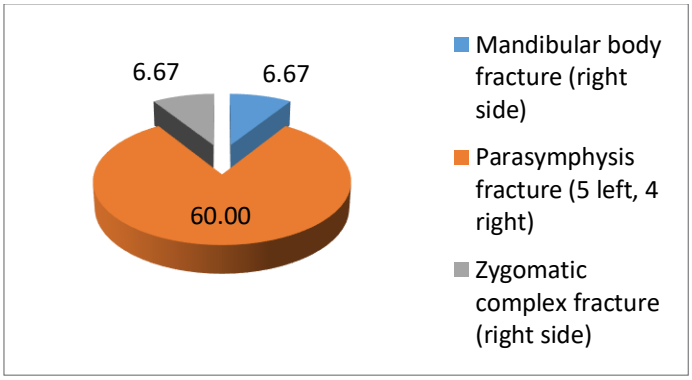
**Table 1: Distribution of Subjects according to Etiology (n=15)**



Road traffic accident was the most common etiology (46.67%) followed by interpersonal violence (26.67%) and fall (26.67%). There was 1 (6.7%) patient in whom the etiology was iatrogenic.

**Table 2: Distribution of Patients according to Type of Associated Injury (n=15)**

| S.No. | Type of Associated Injury | No. of Cases | Percentage |
|---|---|---|---|
| 1 | Mandibular body fracture (right side) | 1 | 6.67 |
| 2 | Parasymphysis fracture (5 left, 4 right) | 9 | 60.00 |
| 3 | Zygomatic complex fracture (right side) | 1 | 6.67 |




A total of 4 (26.6%) patients had no associated injury. Mandibular parasymphysis fracture was the most common associated injury (n=9; 60%). There was 1 (6.67%) patient which had mandibular body fracture while 1 patient had zygomatic complex fractures (6.67%). Clinical assessment was done for mouth opening, occlusion, post-operative infection.

**Table3 : shows outcome of clinical assessment for mouth opening at different time intervals:**

| SN | Time interval | Mouth opening in mm | | Change from baseline | | Significance of change (Wilcoxon Signed rank test) | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | "z" | "p" |
| 1 | Day 1 Pre op | 26.2 | 9.47 | | | | |
| 2 | Day3 p.o | 26.78 | 9.54 | -3.73 | 6.87 | -1.8519 | 0.06432 |
| 3 | Day 10 p.o. | 27.07 | 9.38 | 6.07 | 4.45 | -0.4892 | 0.62414 |
| 4 | 1 Month p.0. | 27.23 | 9.74 | 10.26 | 4.81 | -1.0507 | 0.29372 |
| 5 | 3 Month p.o. | 27.58 | 10.09 | 14.8 | 4.94 | -2.6978 | 0.00694 |
| 6 | 6 month p.o. | 27.81 | 10.55 | 19.13 | 5.27 | -3.2958 | 0.00096 |

Before the procedure, mean mouth opening was 26.2±9.47 mm. At day 10 post-operative interval, mean mouth opening increased to 27.07±9.38 mm. At 6 months post-operative interval, mean mouth opening was 27.81±10.55 mm.

**Table 4: shows outcome of clinical assessment for malocclusion at different time intervals:**

| SN | Time interval | Cases with Malocclusion | | Change | | Significance of change |
|---|---|---|---|---|---|---|
| | | No. | % | No. | % | (Fisher exact test) |
| 1 | Pre op | 13 | 87 | | | |
| 2 | Day3 p.o | 0 | 0 | -13 | -86.67 | <0.001 |
| 3 | Day 10 p.o. | 0 | 0 | -13 | -86.67 | <0.001 |
| 4 | 1 Month p.0. | 0 | 0 | -13 | -86.67 | <0.001 |
| 5 | 3 Month p.o. | 0 | 0 | -13 | -86.67 | <0.001 |
| 6 | 6 month p.o. | 0 | 0 | -13 | -86.67 | <0.001 |

Preoperatively, 13(87%) patients had malocclusion. However, from day 1 post-operative interval onwards none of the patients had malocclusion. Thus, showing a statistically significant change from day 1 post-operative interval itself and thereafter showing sustenance of this change till the 6 months.

**Table5: Clinical Assessment for Infection at different time intervals (n=15)**

| SN | Time interval | Cases with Infection | | Change | | Significance of change |
|---|---|---|---|---|---|---|
| | | No. | % | No. | % | (Fisher exact test) |
| 1 | Pre op | 0 | 0 | | | |
| 2 | Day3 p.o | 0 | 0 | – | – | – |
| 3 | Day 10 p.o. | 0 | 0 | – | – | – |
| 4 | 1 Month p.0. | 0 | 0 | – | – | – |
| 5 | 3 Month p.o. | 0 | 0 | – | – | – |
| 6 | 6 month p.o. | 0 | 0 | – | – | – |

At day 1 preoperatively till the 6 months follow up , none of the cases had infection.

The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 15.0 statistical Analysis Software. The values were represented in Number (%) and Mean±SD.

## DISCUSSION

Closed reduction has been associated with shortening of ramus, deviation of jaw on opening, occlusal discrepancies, formation of false joint, and late complications, leading to internal derangement of the joint. Today, open reduction and internal fixation of condylar fractures is the acceptable method in the management of condylar fracture, especiall in cases with gross displacement of condylar fragment, major reduction in posterior facial height, and deranged occlusion. The principle behind open reduction and internal fixation using miniplate osteosynthesis is ‘‘functionally stable osteosynthesis’’. [20,21] Champy determined the ideal line of osteosynthesis in the region of mandibular body, but no such line was proposed in the region of condyle because of limited data. Meyer[19] attempted to fill this void to determine the ideal line of osteosynthesis in the region of condyle. During biting forces in the region of molars, strain lines were detected in the condylar region. Hence, adaptation of single 4-hole miniplate, as was initially proposed, did not provide dynamic osteosynthesis and resulted in fracture of the plate during function. Two-plate fixation (a miniplate parallel to condylar axis and secondminiplate parallel to mandibular notch) met with the fulfillment of dynamic osteosynthesis, but adaptation of 2 miniplates in the region of condylar axis is difficult due to the constriction of condylar neck. Hence, use of TCP has been proposed in open reduction and internal fixation of the condylar fractures. TCP is shaped for adaptation in the anatomically constricted region of condylar neck. TCP is placed with one arm parallel to the condylar axis and second arm parallel to the mandibular notch. Hence, this plate met the criteria of 2 single miniplates, but with a reduced hardware. This plate provides three-dimensional stability because of its design. Infection rate is less because of the reduced hardware and requires reduced exposure as compared to 2–4 hole straight miniplate. Titanium 3-D plating system was developed by Farmand[22] to meet the requirements of semirigid fixation with lesser complications. The 3-D plate is a misnomer as the plates are not three-dimensional but hold the fracture fragments rigidly by resisting the forces in three dimensions namely shearing, bending, and torsional forces. The basic concept of 3-D fixation20 is that a geometrically closed quadrangular plate secured with bone screws creates stability in three dimensions. The stability is gained over a defined surface area and is achieved by its configuration and not by thickness or length, and also the large free areas between the plate arms and minimal dissection permit good blood supply to the bone. Our study evaluated the osteosynthesis in mandibular subcondylar fracture with trapezoidal-shaped 3-D miniplates. The results of this study indicate that the trapezoidal-shaped 3-D miniplates can be a good alternative for osteosynthesis in mandibular subcondylar region. In our study, the majority of patients were male (80%) and 67% were of age group 20–40 years, which is in concordance with study conducted by Mitchell.[23] The major etiological factors in our study were road traffic accident (47%), followed by interpersonal violence (27%), and fall (26%). Similar findings were also observed by Singh.[24] Higher incidence of road traffic accident can be explained by the fact that there are no comprehensive rules for traffic safety in our country as seen in western countries. These need to be formulated and strictly enforced. Infection was not observed in any of our cases, similar to Singh.[24] However, Hammer[25] reported an infection rate in more than one-third (35%) of the group stabilized with a single adaptation miniplate. Thus, it can be presumed that stability in three-dimensional is important for the prevention of infection, the criteria which TCP fulfills. Evidence of hardware failure was observed radiographically till sixth month postoperatively. Hardware failure in our study was 0%. Contrastingly in other studies,[25] plate fracture was exclusively observed in cases stabilized with single miniplate. The reason for hardware failure may be that this plate is located on the compression strain lines when placed conventionally along the condylar neck and goes completely against the principles of functionally stable osteosynthesis. TCP is placed with one arm parallel to the condylar axis and second arm parallel to the mandibular notch, thus providing stable osteosynthesis and minimizing the rate of hardware failure. Mandibular parasymphysis fracture was the most common associated injury (60%), similar to findings of Sawazaki,[26] who showed that multiple mandibular fractures are more common and

symphyseal fractures were significantly associated with mandibular condyle fractures. Higher incidence of mandibular symphysis/parasymphysis can be explained by the prominent anatomical position of mandible in maxillofacial skeleton. Earlier resolution of pain in our patients can be attributed to better stability of the fragments provided by TCP. Restoration of occlusion is one of the most important goals of the management of fractures of dentofacial region. The effect of not restoring the occlusion to its original condition is disabling and can cause severe effects especially on the temporomandibular joint. In our study, we also found that trapezoidal-shaped 3-D plates are very convenient to apply in subcondylar fracture area and provided good stability. The results of this study suggest that the fixation of mandibular subcondylar fracture with trapezoidal-shaped 3-D plates provides three-dimensional stability and carries low morbidity. The small sample size and limited follow-up could be considered as the limitations ofthis study, but all incision sites healed uneventfully and were less conspicuous by the third month follow-up. However, a larger number of cases should be studied over a longer period of time for better postoperative analysis. It is recommended to have a multicenter study with large number of patients and correlation among these studies to authenticate our claims.

## CONCLUSION

The condylar region is one of the most frequent sites for mandibular fractures. Controversy has existed regarding the management of the fracture. Open reduction and rigid internal fixation of dislocated mandibular condylar fractures has, in the last decades, become more prevalent because it provides the possibility of restoring the pretraumatic anatomic relationships, gives adequate stability to the fracture, facilitates rapid fracture healing including restoration of early function, and avoids prolonged maxillomandibular fixation.

Small fixtures have to be used for osteosynthesis of condylar fractures because of the small size of the fragments. Thus, strict application of dynamic osteosynthesis principles as stated by Champy should be applied.Patients with gross displacement of condylar fragment, major reduction in posterior facial height and deranged occlusion can be better managed with open reduction of condylar fracture and adequate anatomic reduction with successful outcome can be achieved in majority of cases with very minimal surgical morbidity.

All fractures in 15 patients were found to be adequately fixed when checked. In all the patients there was marked reduction in pain from the day 1 itself and gradual improvement was seen in the mouth opening. The occlusion was well restored and none of the patients showed any signs of infection and hardware failure.

The small sample size and limited follow-up could be considered as the limitations of this study. All patients in present study appreciated early recovery of normal jaw function, primary healing and good union at fracture site with minimal weight loss due to early functional rehabilitation. Our study showed that the single trapezoidal shaped, 3D titanium miniplate is a versatile procedure for treating fractures of the mandibular subcondyle. However, a larger number of cases should be studied over a longer period of time for better postoperative analysis.

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