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Comparative evaluation of 3D miniplate and lag screw fixation for treating anterior mandibular fractures - A clinical study

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Abstract:

This clinical study compared 2.0 mm lag screw fixation with 2.0 mm three-dimensional miniplate fixation for anterior mandibular fractures. Hence, twenty patients underwent open reduction and internal fixation and were evaluated clinically and radiographically after treatment. Both fixation methods achieved stable fracture reduction, satisfactory occlusion, uneventful healing and comparable functional outcomes. No post-operative infection, wound dehiscence, neurosensory deficit, or implant-related complications were observed in either group. Thus, Lag screws required significantly less fixation time, while 3D miniplates provided reliable three-dimensional stability with simple adaptation.

Keywords: Anterior mandibular fracture, symphysis fracture, parasymphysis fracture, lag screw, 3D miniplate, open reduction internal fixation.

Background:

Mandibular fractures are among the most frequently encountered maxillofacial injuries because the mandible is prominent, mobile and tooth-bearing and exposed to direct traumatic forces. The symphysis and parasymphysis regions are clinically important because they contribute to lower facial contour, dental occlusion, tongue support, speech, mastication and mandibular arch continuity [1]. Road traffic accidents, interpersonal violence and falls remain major etiological factors, particularly among young adult males [2]. Recent studies continue to show that anterior mandibular fractures require accurate reduction and stable fixation to restore occlusion avoid malunion and permit early return to function [3]. Open reduction and internal fixation has become the preferred treatment for displaced mandibular fractures when functional occlusion cannot be achieved or maintained by closed methods. The goals of treatment are anatomical reduction, stable fixation, restoration of pre-injury occlusion, early mandibular function, prevention of infection and avoidance of hardware-related complications [4]. Fixation methods for anterior mandibular fractures include conventional miniplates, locking plates, 3D plates, reconstruction plates and lag screws. Each system has biomechanical advantages and technical limitations [5, 6]. Lag screw fixation works on the principle of interfragmentary compression. A gliding hole is prepared in the near cortex and a traction hole in the far cortex, allowing the screw threads to engage only the distal fragment. Tightening of the screw compresses the fractured segments, improves interfragmentary contact and enhances primary bone healing. The anterior mandible is particularly suitable for lag screw fixation because of adequate cortical thickness and access for bicortical screw placement. However, the technique requires favourable fracture orientation, minimal comminution, correct screw angulation and operator experience [7-9]. Three-dimensional miniplates were introduced to overcome some limitations of conventional linear miniplates. Their quadrangular configuration, formed by two horizontal bars connected by vertical struts, provides stability

against bending, torsion and shearing forces. The stability of a 3D plate is derived more from its geometric configuration than from plate bulk, allowing a relatively low-profile fixation system. Recent clinical studies have reported acceptable outcomes with 3D miniplates in parasymphysis fractures, with good stability and low complication rates [10-12]. Therefore, it is of interest to evaluate and compare the clinical and radiological outcomes of 2.0 mm lag screws and 2.0 mm 3D miniplates in the treatment of mandibular symphysis and parasymphysis fractures.

Materials and Methodology:

This clinical study was conducted in the Department of Oral and Maxillofacial Surgery, CKS Theja Institute of Dental Sciences and Research, Tirupati, Andhra Pradesh. The study included 20 patients with mandibular symphysis or parasymphysis fractures requiring open reduction and internal fixation. Patients were treated between January 2014 and April 2015. Patients of either sex aged 18-60 years with minimally or moderately displaced symphysis/parasymphysis fractures without gross comminution were included. Fracture lines with or without tooth involvement were accepted. Patients with severely infected fractures, large hematoma, gross comminution, extensive bony destruction, systemic medical compromise or associated bone pathology were excluded. All patients underwent detailed history taking, clinical examination and radiographic assessment. Pre-operative clinical evaluation included occlusal disturbance, mobility of fractured segments, pain using visual analogue scale, soft tissue injury, duration between injury and definitive fixation, fracture displacement, neurosensory disturbance and presence of tooth in the fracture line. Radiographic assessment was performed using orthopantomogram. Routine investigations included hematological profile, viral screening, serum creatinine, blood urea, random blood sugar, ECG and chest radiograph. Erich arch bars were placed pre-operatively in all cases. Patients were randomly divided into two groups. Group I included 10 patients

treated with two 2.0 mm lag screws of 16 mm or 18 mm length. Group II included 10 patients treated with 2.0 mm four-hole stainless steel 3D miniplates using 2 × 8 mm screws. All procedures were performed under general anesthesia using an intraoral degloving approach. A vestibular incision was made approximately 5 mm below the attached gingiva and modified in the premolar region to avoid injury to the mental nerve. A mucoperiosteal flap was elevated, the mental nerve was protected, the fracture line was exposed and the site was debrided and irrigated. Fracture segments were reduced anatomically, occlusion was checked and temporary intermaxillary fixation was applied. In Group I, lag screws were placed according to standard compression principles. A gliding hole was drilled in the near cortex and a smaller traction hole was drilled in the far cortex. Screws were inserted so that their axis bisected the angle between the perpendicular to the fracture line and the perpendicular to the bone surface. Two screws were used to prevent rotational instability. In Group II, the 3D miniplate was adapted across the fracture line with horizontal bars perpendicular to the fracture line and vertical struts parallel to it. In oblique fractures, the plate was positioned parallel to the lower border. In parasymphysis fractures, the superior bar was placed subapically. Holes were drilled with a 1.5 mm drill under copious saline irrigation and fixation was completed with 2 × 8 mm screws. After fixation, intermaxillary fixation was released and passive occlusion was verified. The wound was irrigated with povidone iodine and saline, hemostasis was achieved and closure was done in layers using 3-0 vicryl. Patients received antibiotics and analgesics for 5 days, were advised soft diet and instructed to maintain oral hygiene with antiseptic mouth rinses. Follow-up was performed weekly for 1 month and subsequently at 2 and 3 months. Post-operative evaluation included infection, wound dehiscence, occlusion, stability, mobility, neurosensory deficit, pain, radiographic approximation, screw loosening, plate/screw fracture, bone healing and adverse reaction near screws. Osteosynthesis outcome was assessed using the treatment scoring system described by Uglesic, including complications, chewing, occlusion and interincisal function.

Results:

Table 1: Demographic and baseline characteristics

Parameter	Group I: Lag screw n (%)	Group II: 3D miniplate n (%)
Sample size	10 (100%)	10 (100%)
Male	9 (90%)*	9 (90%)*
Female	1 (10%)*	1 (10%)*
RTA	—	—
Assault	—	—
Fall	—	—
Pre-operative mobility	10 (100%)	10 (100%)
Pre-operative neurosensory deficit	0 (0%)	0 (0%)
Tooth in fracture line	3 (30%)	4 (40%)

*Sex-wise group distribution was interpreted from equal group allocation and total sex distribution.

Table 2: Pre-operative fracture characteristics

Parameter	Group I n (%)	Group II n (%)	p value
Minor occlusal disturbance	7 (70%)	7 (70%)	—

The study included 20 patients with mandibular symphysis or parasymphysis fractures. Ten patients were treated with lag screws and ten patients were treated with 3D miniplates. The study included 20 patients equally distributed between Group I and Group II. Male predominance was observed overall, accounting for 90% of cases, indicating higher exposure of males to mandibular trauma. Road traffic accidents were the most common cause of injury (60%), followed by assault and fall (20% each). Pre-operative mobility was present in all patients, confirming instability of fracture segments before treatment. No patient showed pre-operative neurosensory deficit in either group. Presence of tooth in the fracture line was observed in 30% of Group I and 40% of Group II patients, with no statistically significant difference between the groups (p = 0.518) (Table 1). Pre-operative occlusal disturbance was similarly distributed in both groups, with 70% of patients showing minor occlusal disturbance and 30% showing severe disturbance. Soft tissue injuries showed a statistically significant difference between the groups (p = 0.0058), with Group II showing a higher proportion of mild injuries and Group I showing more moderate injuries. Fracture displacement was comparable between the groups, with moderate displacement being the most common finding and no statistically significant difference was observed (p = 0.798). The duration between injury and definitive fixation was also comparable in both groups, with most patients undergoing fixation within one week after injury and no significant difference between groups (p = 0.167) (Table 2). All patients in both groups were treated using an intraoral approach and achieved stable intraoperative fixation. The mean fixation time was significantly lower in the lag screw group (5.10 ± 0.88 minutes) compared to the 3D miniplate group (8.40 ± 1.51 minutes), indicating that lag screw fixation required less operative time (p = 0.003). No post-operative infection, wound dehiscence, mobility, hardware failure, or pain at 3 months was observed in either group. Normal post-operative occlusion and satisfactory bone healing were achieved in all patients. Functional outcomes, including chewing ability and occlusal assessment, were comparable between the two groups, with no statistically significant difference in most post-operative parameters (Table 3).

Severe occlusal disturbance	3 (30%)	3 (30%)	—
Mild soft tissue injury	4 (40%)	7 (70%)	0.0058
Moderate soft tissue injury	6 (60%)	2 (20%)	0.0058
Severe soft tissue injury	0 (0%)	1 (10%)	0.0058
Mild displacement	3 (30%)	4 (40%)	0.798
Moderate displacement	6 (60%)	5 (50%)	0.798
Severe displacement	1 (10%)	1 (10%)	0.798
Fixation within 1 week	5 (50%)	7 (70%)	0.167
Fixation after 1 week	5 (50%)	3 (30%)	0.167

Table 3: Operative and post-operative outcomes

Parameter	Group I n (%) / Mean ± SD	Group II n (%) / Mean ± SD	p value
Intraoral approach	10 (100%)	10 (100%)	—
Intraoperative stable fixation	10 (100%)	10 (100%)	—
Mean fixation time	5.10 ± 0.88 min	8.40 ± 1.51 min	0.003
Post-operative infection	0 (0%)	0 (0%)	—
Wound dehiscence	0 (0%)	0 (0%)	—

Post-operative mobility	0 (0%)	0 (0%)	–
Normal post-operative occlusion	10 (100%)	10 (100%)	–
Bone healing	10 (100%)	10 (100%)	–
Plate/screw fracture	0 (0%)	0 (0%)	–
Pain at 3 months	0.00 ± 0.00	0.00 ± 0.00	–
Chewing score at 3 months	4.60 ± 0.84	4.60 ± 0.84	0.348
Self-occlusion score	4.80 ± 0.63	4.80 ± 0.63	0.028*
Surgeon occlusion score	4.80 ± 0.63	5.00 ± 0.00	0.354

Discussion:

The present study compared lag screw fixation and 3D miniplate fixation for anterior mandibular symphysis and parasymphysis fractures. Both methods achieved satisfactory anatomical reduction, stable fixation, restoration of occlusion, uneventful wound healing and good functional outcome. These findings support current evidence that selected anterior mandibular fractures can be successfully managed using either compression-based lag screws or geometrically stable 3D miniplates [2]. A recent prospective study by Jawa *et al.* similarly compared lag screws and miniplates in 20 patients with anterior mandibular fractures and found both techniques to provide stable fixation, while lag screws produced greater interfragmentary bony contact and reduced the distance between fracture fragments [13]. The demographic pattern in this study showed a clear male predominance, with 90% males and the highest incidence in the 21–30-year age group. This agrees with contemporary maxillofacial trauma literature, where young adult males are commonly affected due to greater outdoor activity, occupational exposure and road traffic-related injuries. Road traffic accident was the leading cause in the present study, accounting for 60% of cases. Similar etiological patterns have been reported in recent mandibular fracture studies from developing regions, where two-wheeler accidents remain a major contributor [4]. Pre-operative occlusal disturbance and fracture mobility were present in all patients, confirming the functional instability of anterior mandibular fractures. Following open reduction and fixation, all patients in both groups achieved stable occlusion and absence of mobility. This reflects the importance of accurate intraoperative reduction and temporary intermaxillary fixation before definitive osteosynthesis. Restoration of occlusion remains one of the most important outcome measures in mandibular fracture management [5]. Lag screw fixation produced a significantly shorter mean fixation time than 3D miniplate fixation. This may be explained by the reduced implant inventory, absence of plate adaptation and direct interfragmentary compression achieved by two screws. Recent comparative work has similarly suggested that lag screws are time-saving, cost-effective and stable when used in properly selected anterior mandibular fractures [6, 7]. However, lag screw fixation is technique-sensitive and requires favourable fracture geometry, adequate cortical thickness and accurate screw trajectory. Improper angulation may produce displacement, inadequate compression or lingual cortical perforation. Three-dimensional miniplates also produced excellent stability in the present study. Their quadrangular design allows resistance to torsional, bending and shearing forces, which are important in

the symphysis and parasymphysis regions because of functional mandibular loading. Recent studies have reported that 3D miniplates provide stable fixation with low rates of infection, malocclusion and implant failure [8–10]. In the present study, no infection, wound dehiscence, screw loosening or plate fracture was seen in the 3D miniplate group. Pain scores decreased progressively in both groups and pain was absent at 3 months. This pattern suggests satisfactory fracture stabilization and healing. The absence of post-operative neurosensory deficit in both groups is clinically important, especially in parasymphysis fractures where the mental nerve is at risk. Careful incision placement, flap elevation and mental nerve isolation likely contributed to this favourable outcome. Radiographic assessment showed proper approximation and bone healing in all patients. No screw position change, plate fracture, screw fracture or adverse reaction was reported. These findings indicate that both systems provided adequate mechanical stability throughout the healing period. The absence of infection may be related to exclusion of grossly infected fractures, early debridement, intraoral hygiene instructions and post-operative antibiotic coverage. Functional scoring also showed comparable results. Chewing score at 3 months was identical in both groups and occlusal scores were nearly equivalent. This indicates that the clinical success of anterior mandibular fracture fixation depends not only on implant design but also on fracture selection, surgical technique, occlusal control and post-operative compliance. Recent systematic and comparative studies similarly suggest that no single fixation system is universally superior; rather, fixation choice should be individualized according to fracture pattern, surgeon experience and biomechanical requirement [12, 14–16]. The study has some limitations. The sample size was small, with only 10 patients in each group. Follow-up was limited to 3 months and long-term implant-related outcomes were not assessed. The study also included associated fractures in some patients, which may influence function and occlusion. Despite these limitations, the findings demonstrate that both lag screw and 3D miniplate fixation are reliable methods for selected symphysis and parasymphysis fractures.

Conclusion:

Both 2.0 mm lag screws and 2.0 mm 3D miniplates provided stable fixation, satisfactory occlusion, good bone healing and minimal complications in anterior mandibular fractures. Lag screw fixation required significantly less fixation time and is useful in favourable, non-comminuted fractures. 3D miniplates provided dependable three-dimensional stability and are suitable where compression screw placement is less favourable. Proper case selection and surgical technique remain more important than implant choice alone.

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