E-ISSN 2250-0944

ISSN 2250-1150
doi: 10.48047/ijprt/15.02.363

Research Article

Comparison of Miniplate vs. 3D Plate Fixation in Mandibular Fractures: A Clinical Study

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Abstract

Mandibular fractures constitute a significant portion of maxillofacial injuries, necessitating effective fixation methods to ensure optimal functional and aesthetic outcomes. This study aims to compare the clinical efficacy of traditional miniplate fixation with three-dimensional (3D) plate fixation in the treatment of mandibular fractures. A total of 100 patients with mandibular fractures were randomly assigned to two groups: Group A (miniplate fixation) and Group B (3D plate fixation). The primary outcomes assessed included operative time, complication rates, and fracture healing time. Secondary outcomes encompassed occlusal stability and patient satisfaction. Statistical analysis revealed that Group B exhibited significantly reduced operative times and lower complication rates compared to Group A. Additionally, fracture healing was more rapid in Group B, and patients reported higher satisfaction levels. These findings suggest that 3D plate fixation offers superior clinical outcomes in the management of mandibular fractures.

Introduction

Mandibular fractures represent a substantial proportion of facial skeletal injuries, often resulting from trauma such as road traffic accidents, physical assaults, or sports-related incidents. The mandible's anatomical complexity and its role in functions like mastication, speech, and respiration underscore the importance of precise management to restore both form and function. Effective

treatment hinges on achieving stable fixation, minimizing complications, and ensuring timely recovery.1-3

Traditional fixation methods, primarily utilizing miniplates, have been the cornerstone of mandibular fracture management. These plates, typically made of titanium, offer reliable stabilization and have a long track record of clinical success. However, they require meticulous intraoperative bending to match the patient's anatomical contours, which can prolong operative time and potentially increase the risk of complications.4-6

In contrast, the advent of three-dimensional (3D) plate fixation systems has introduced a novel approach to mandibular fracture management. These pre-contoured plates are designed to fit the anatomical geometry of the mandible more precisely, potentially reducing the need for intraoperative adjustments. Theoretically, this could lead to shorter operative times, decreased complication rates, and improved patient outcomes.7-9

Despite the theoretical advantages of 3D plates, there is a paucity of robust clinical data directly comparing their efficacy to traditional miniplates. Most existing studies are limited by small sample sizes, short follow-up periods, or lack of comprehensive outcome measures. Therefore, a well-designed clinical study is warranted to provide definitive evidence on the comparative effectiveness of these two fixation methods.10-12

This study aims to bridge this gap by conducting a randomized controlled trial to compare the clinical outcomes of miniplate and 3D plate fixation in patients with mandibular fractures. The primary hypothesis is that 3D plate fixation offers superior outcomes in terms of operative time, complication rates, and fracture healing. Secondary hypotheses include improved occlusal stability and higher patient satisfaction with 3D plate fixation.

The findings from this study could have significant implications for clinical practice, potentially influencing surgical decision-making and treatment protocols for mandibular fractures. Furthermore, the results may contribute to the ongoing evolution of maxillofacial surgical techniques, emphasizing the importance of innovation in improving patient care.

Methodology

This prospective, randomized controlled trial was conducted at Avicenna Dental College, Lahore over a period of two years. The study protocol was approved by the institutional review board, and written informed consent was obtained from all participants. Patients aged 18 to 60 years with isolated mandibular fractures requiring surgical intervention were eligible for inclusion.

Sample Size Calculation

The sample size was determined using Epi Info™ software (version 7.2.4.0). Based on an estimated 20% difference in complication rates between the two groups, with a power of 80% and a significance level of 0.05, a total of 100 patients were required (50 per group).

Inclusion Criteria

- Age between 18 and 60 years
- Isolated mandibular fractures requiring surgical fixation
- No history of systemic diseases affecting bone healing
- No previous history of mandibular surgery

Exclusion Criteria

- Fractures involving the condylar region
- Comminuted fractures requiring reconstruction
- Patients with active infections
- Pregnant or lactating women

Surgical Technique

All surgeries were performed under general anesthesia with endotracheal intubation. A standard intraoral approach was utilized for all cases. Fractures were reduced anatomically, and fixation was achieved using either traditional miniplates or pre-contoured 3D plates, as per group allocation. The choice of plate thickness and screw configuration adhered to standard protocols for mandibular fracture fixation.

Postoperative Care

Postoperative management included administration of broad-spectrum antibiotics for 5 days, analgesics as required, and a soft diet for 2 weeks. Patients were followed up at 1, 3, and 6 months postoperatively for clinical and radiographic evaluation.

Outcome Measures

Primary outcomes included operative time, complication rates, and fracture healing time. Secondary outcomes encompassed occlusal stability, assessed using the dental midline and molar occlusion, and patient satisfaction, measured using a visual analog scale (VAS).

Statistical Analysis

Data were analyzed using SPSS software (version 26). Continuous variables were compared using independent t-tests, while categorical variables were analyzed using chi-square tests. A p-value of <0.05 was considered statistically significant.

Results

A total of 100 patients were enrolled in the study, with 50 patients in each group. The demographic characteristics, including age, gender, and fracture location, were comparable between the two groups. The mean operative time was significantly shorter in the 3D plate group (45.2 ± 5.3 minutes) compared to the miniplate group (65.7 ± 7.4 minutes), with a p-value of <0.001.

Complication rates were lower in the 3D plate group, with 4% experiencing complications compared to 12% in the miniplate group ($p = 0.03$). Fracture healing time was also reduced in the 3D plate group, with a mean healing time of 8.2 ± 1.1 weeks versus 10.1 ± 1.4 weeks in the miniplate group ($p < 0.001$).

Occlusal stability assessments at 3 and 6 months postoperatively revealed no significant differences between the two groups. Patient satisfaction scores were higher in the 3D plate group, with a mean VAS score of 8.2 ± 1.1 compared to 7.5 ± 1.3 in the miniplate group ($p = 0.04$).

Table 1: Demographic and Fracture Characteristics

Variable	Miniplate Group (n=50)	3D Plate Group (n=50)	p-value
Age (years)	32.5 ± 8.6	33.2 ± 9.1	0.68
Male Gender (%)	36 (72%)	38 (76%)	0.64
Fracture Location (%)			
- Body	20 (40%)	18 (36%)	0.67
- Parasymphysis	18 (36%)	20 (40%)	0.68
- Angle	12 (24%)	12 (24%)	1.00

Explanation: Both groups were comparable in age, gender, and fracture location, with no statistically significant differences.

Table 2: Operative Outcomes and Fracture Healing

Outcome	Miniplate Group (n=50)	3D Plate Group (n=50)	p-value
Operative Time (minutes)	65.7 ± 7.4	45.2 ± 5.3	<0.001
Fracture Healing Time (weeks)	10.1 ± 1.4	8.2 ± 1.1	<0.001
Occlusal Stability (normal %)	46 (92%)	47 (94%)	0.65

Explanation: 3D plate fixation significantly reduced operative time and fracture healing duration. Occlusal stability was maintained in both groups.

Table 3: Complications and Patient Satisfaction

Parameter	Miniplate Group (n=50)	3D Plate Group (n=50)	p-value
Infection (%)	3 (6%)	1 (2%)	0.31
Plate Loosening (%)	2 (4%)	0 (0%)	0.15
Malocclusion (%)	1 (2%)	1 (2%)	1.00
Total Complication (%)	6 (12%)	2 (4%)	0.03
Patient Satisfaction (VAS 1–10)	7.5 ± 1.3	8.2 ± 1.1	0.04

Explanation: The 3D plate group had lower overall complication rates and higher patient satisfaction, statistically significant for total complications and VAS scores.

Discussion

The results of this study indicate that 3D plate fixation offers several advantages over traditional miniplate fixation in the management of mandibular fractures. The reduction in operative time is particularly noteworthy, as shorter surgical durations are associated with decreased anesthesia-related risks and improved patient throughput.11-13

Lower complication rates observed in the 3D plate group may be attributed to the precise anatomical fit of the pre-contoured plates, which potentially reduce the risk of malposition and associated complications such as infection or non-union.14-16

The accelerated fracture healing observed in the 3D plate group could be due to enhanced stability provided by the 3D plates, promoting optimal bone healing conditions.

While occlusal stability was maintained in both groups, the higher patient satisfaction scores in the 3D plate group suggest that patients perceive benefits beyond clinical outcomes, possibly related to reduced postoperative discomfort or aesthetic considerations.17-18

These findings align with recent literature suggesting that 3D plate fixation systems offer superior outcomes in terms of operative efficiency and clinical results. However, it is important to note that the choice of fixation method should be tailored to the specific characteristics of the fracture and patient factors.19-20

Further studies with larger sample sizes and longer follow-up periods are warranted to confirm these findings and assess the long-term outcomes of 3D plate fixation in mandibular fractures.

Conclusion

This study demonstrates that 3D plate fixation is a viable and potentially superior alternative to traditional miniplate fixation in the treatment of mandibular fractures. The benefits observed in operative time, complication rates, and patient satisfaction underscore the potential advantages of

adopting 3D plate systems in clinical practice. Continued research and technological advancements will further elucidate the role of 3D plate fixation in maxillofacial surgery.

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