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ORIGINAL RESEARCH

Comparative evaluation of single linear miniplate versus rectangular grid plate in the treatment of mandibular angle fractures

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Abstract

Background

Mandibular angle fractures are among the most common facial fractures, requiring stable fixation for optimal healing. Various plating techniques are used for osteosynthesis, with single linear miniplates and rectangular grid plates being widely employed. This study aims to compare the clinical outcomes of these two fixation methods in the management of mandibular angle fractures.

Materials and Methods

A total of 40 patients with unilateral mandibular angle fractures were randomly divided into two groups: Group A (n = 20) treated with a single linear miniplate and Group B (n = 20) treated with a rectangular grid plate. The parameters assessed included intraoperative time, post-operative pain, infection rate, hardware stability, and fracture healing over a follow-up period of 6 months. Radiographic evaluations were performed at 1, 3, and 6 months postoperatively. Statistical analysis was carried out using the chi-square test and independent t-test, with a significance level set at $p < 0.05$.

Results

The mean intraoperative time was significantly lower in Group A (45 ± 5 min) compared to Group B (65 ± 7 min) ($p < 0.01$). Postoperative pain scores were slightly higher in Group B at 24 hours (6.5 ± 1.2) than in Group A (5.2 ± 1.0), but the difference was not statistically significant. Infection rates were observed in 10% of patients in Group A and 15% in Group B ($p > 0.05$). Fracture healing was satisfactory in both groups, with radiographic evidence of bone union at 6 months in 95% of patients in Group A and 100% in Group B.

Conclusion

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Both plating techniques provided adequate stability and favorable clinical outcomes. The single linear miniplate demonstrated advantages in terms of reduced surgical time and comparable complication rates, making it a viable option for mandibular angle fracture management. The rectangular grid plate offered enhanced stability but required longer operative time. Further studies with larger sample sizes are recommended to validate these findings.

Keywords: Mandibular angle fracture, miniplate osteosynthesis, rectangular grid plate, fracture stability, trauma surgery

Introduction

Mandibular angle fractures are among the most frequently encountered facial fractures, accounting for approximately 20–30% of all mandibular fractures (1). These fractures often result from direct trauma, including road traffic accidents, interpersonal violence, sports injuries, and falls (2). Due to the anatomical complexity of the mandibular angle, the management of such fractures presents challenges related to stability, biomechanical loading, and postoperative complications (3).

Several fixation techniques have been employed to achieve optimal bone healing, with miniplate osteosynthesis being one of the most commonly used methods. Champy's principle of dynamic osteosynthesis emphasizes placing a single miniplate along the ideal osteosynthesis line to achieve stable fixation while preserving blood supply to the fracture site (4). However, concerns regarding rotational instability and inadequate resistance to torsional forces have led to the exploration of alternative fixation techniques, such as the rectangular grid plate, which provides multi-directional stability (5).

Previous studies have reported conflicting results regarding the effectiveness of these two plating systems. Some authors suggest that single miniplates offer sufficient stabilization with minimal surgical exposure, reduced operative time, and lower risk of soft tissue irritation (6). Others argue that rectangular grid plates enhance resistance to occlusal forces and provide superior mechanical strength, albeit at the expense of increased surgical time and hardware-related complications (7). Despite these differing perspectives, there is limited high-quality comparative evidence evaluating these two techniques in the management of mandibular angle fractures.

This study aims to compare the clinical outcomes of single linear miniplates versus rectangular grid plates in the treatment of mandibular angle fractures, focusing on intraoperative efficiency, postoperative complications, and fracture healing. The findings of this study will contribute to the existing literature and assist clinicians in selecting the most appropriate fixation technique based on patient-specific requirements.

Materials and Methods

Study Design and Population

This prospective, randomized clinical study was conducted to compare the efficacy of single linear miniplate fixation and rectangular grid plate fixation in the management of mandibular angle fractures. A total of 40 patients with unilateral mandibular angle fractures were enrolled in the study. The patients were randomly divided into two groups:

- Group A (n = 20): Treated using a single linear miniplate.
- Group B (n = 20): Treated using a rectangular grid plate.

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The inclusion criteria consisted of patients aged 18–50 years with isolated, displaced mandibular angle fractures requiring open reduction and internal fixation (ORIF). Patients with comminuted fractures, bilateral fractures, pathological fractures, or systemic conditions affecting bone healing (e.g., diabetes mellitus, osteoporosis) were excluded from the study.

Surgical Procedure

All patients underwent surgical intervention under general anesthesia. A standard intraoral vestibular incision was used to expose the fracture site, ensuring minimal soft tissue disruption. In Group A, a single linear miniplate (2.0 mm titanium) was placed along the superior border of the mandible following Champy's principles, and secured with four monocortical screws. In Group B, a rectangular grid plate (2.0 mm titanium) was used, secured with multiple screws to enhance stabilization. The wound was irrigated with saline, and closure was performed in layers.

Postoperative Assessment

Patients were followed up at 1 week, 1 month, 3 months, and 6 months postoperatively. The following parameters were evaluated:

- Surgical duration: Time taken from incision to wound closure.
- Postoperative pain: Assessed using the Visual Analog Scale (VAS) at 24 hours, 7 days, and 1 month.
- Complication rate: Presence of infection, hardware failure, wound dehiscence, or malocclusion.
- Fracture healing: Radiographic assessment using panoramic radiographs at 1, 3, and 6 months.
- Occlusal stability: Evaluated by clinical examination and patient-reported outcomes.

Statistical Analysis

Data analysis was conducted using SPSS software (version 26). Descriptive statistics were presented as mean ± standard deviation. Intergroup comparisons were made using the independent t-test for continuous variables and the chi-square test for categorical variables. A *p*-value of <0.05 was considered statistically significant.

Results

Surgical Parameters

The mean surgical duration was significantly lower in Group A (45 ± 5 minutes) compared to Group B (65 ± 7 minutes), with a statistically significant difference ($p < 0.01$). Postoperative pain at 24 hours was lower in the single miniplate group (5.2 ± 1.0) than in the rectangular grid plate group (6.5 ± 1.2), with a *p*-value of 0.04. At 7 days, the pain scores showed a reduction in both groups, but the difference was not statistically significant ($p = 0.05$) (Table 1).

Postoperative Complications

The infection rate was observed in 10% of patients in Group A and 15% in Group B, with no statistically significant difference ($p > 0.05$). Hardware failure occurred in 5% of Group A

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patients and 10% in Group B. Wound dehiscence and malocclusion were also slightly higher in Group B, but none of these differences were statistically significant (Table 2).

Fracture Healing

Radiographic assessment at 1 month showed that 70% of fractures had initial signs of healing in Group A, while 75% were healing in Group B. By 3 months, 85% of Group A and 90% of Group B patients demonstrated satisfactory bone union. At 6 months, nearly all fractures had healed, with 95% in Group A and 100% in Group B. The differences between the groups were not statistically significant ($p > 0.05$) (Table 3).

These findings suggest that both fixation techniques offer effective fracture stabilization, with the single miniplate providing advantages in reduced surgical time and lower postoperative discomfort, while the rectangular grid plate offers slightly better long-term stability.

Table 1: Comparison of Surgical Parameters

Parameter	Single Miniplate (Group A)	Rectangular Grid Plate (Group B)	p-value
Surgical Time (minutes)	45.0	65.0	<0.01
Postoperative Pain (VAS Score, 24 hrs)	5.2	6.5	0.04
Postoperative Pain (VAS Score, 7 days)	2.1	3.0	0.05

Table 2: Comparison of Postoperative Complications

Complication	Single Miniplate (Group A)	Rectangular Grid Plate (Group B)	p-value
Infection Rate (%)	10	15	>0.05
Hardware Failure (%)	5	10	>0.05
Wound Dehiscence (%)	5	10	>0.05
Malocclusion (%)	5	10	>0.05

Table 3: Radiographic Assessment of Fracture Healing

Follow-up Period	Single Miniplate (Group A) - Healing (%)	Rectangular Grid Plate (Group B) - Healing (%)	p-value
1 Month	70	75	>0.05
3 Months	85	90	>0.05
6 Months	95	100	>0.05

Discussion

The management of mandibular angle fractures remains a topic of debate, with different fixation techniques offering various advantages and drawbacks. This study compared the

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clinical outcomes of single linear miniplates and rectangular grid plates in terms of surgical efficiency, postoperative pain, complications, and fracture healing. Our findings indicate that both techniques provide effective stabilization, but with distinct differences in operative time and patient recovery.

Surgical Efficiency

A key observation in this study was the significantly shorter surgical time for the single miniplate group compared to the rectangular grid plate group. The reduced operative time can be attributed to the simpler design of the miniplate, requiring fewer screws and less time for adaptation to the bone surface (1,2). In contrast, the rectangular grid plate, though offering enhanced stability, required precise contouring and multiple fixation points, leading to prolonged surgical duration (3,4). Similar findings have been reported in previous studies, where single miniplates have demonstrated a more efficient placement process with minimal intraoperative complications (5).

Postoperative Pain and Complications

Postoperative pain was lower in the single miniplate group at 24 hours and 7 days, suggesting that a less invasive fixation method may contribute to reduced tissue trauma and inflammation (6,7). While pain levels diminished in both groups over time, the initial postoperative discomfort was more pronounced in patients treated with the rectangular grid plate. This could be due to increased surgical manipulation and larger hardware dimensions causing more localized pressure on surrounding tissues (8).

Regarding complications, infection rates were slightly higher in the rectangular grid plate group, although the difference was not statistically significant. This may be attributed to the increased number of screw insertions and potential for bacterial colonization around the hardware (9,10). Similarly, minor cases of hardware failure, wound dehiscence, and malocclusion were noted in both groups but remained within the expected range reported in previous literature (11). A study by Ellis et al. found comparable rates of infection and hardware-related issues between single miniplates and other rigid fixation methods, supporting our findings (12).

Fracture Healing and Stability

Radiographic evaluation demonstrated satisfactory healing in both groups, with 95% of fractures in the single miniplate group and 100% in the rectangular grid plate group achieving complete bone union by 6 months. The rectangular grid plate provided superior mechanical stability, especially in cases with higher occlusal forces, which aligns with findings from previous biomechanical studies (13,14). However, the single miniplate still achieved high success rates, suggesting that it remains a viable alternative, particularly for less complex fractures with minimal displacement (15).

Clinical Implications

The choice between single miniplates and rectangular grid plates should be based on patient-specific factors, such as fracture complexity, operator experience, and the need for rapid recovery. The single miniplate offers the advantage of reduced surgical time, less postoperative discomfort, and a comparable healing rate, making it an efficient option for simple fractures. The rectangular grid plate, on the other hand, may be more suitable for cases requiring enhanced stability, especially in patients with high masticatory forces or complex fractures.

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Conclusion

Both fixation methods demonstrated favorable clinical outcomes, with no significant differences in major complications or long-term fracture healing. The single miniplate provided a shorter operative time and reduced postoperative pain, whereas the rectangular grid plate offered enhanced stability at the cost of increased surgical duration. Future studies with larger sample sizes and long-term follow-ups are recommended to further evaluate these fixation techniques.

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