

SURGICAL OUTCOMES OF MANDIBULAR FRACTURES TREATED WITH MINIPLATE FIXATION AND MANAGEMENT OF TEETH IN THE LINE OF FRACTURE

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Tooth-bearing mandibular fractures require stable fixation while preserving teeth in the fracture line to restore function and reduce complications. This prospective single-arm interventional study evaluated outcomes of miniplate fixation and tooth management in 37 patients treated with open reduction and internal fixation at two hospitals in Dong Nai from July 2025 to March 2026, with 12 weeks of follow-up. Mean age was 33.1 ± 14.2 years old and 67.6% were male. After 12 weeks, good bone healing was achieved in 94.6% and correct occlusion in 97.3%, with no major complications. Maximum mouth opening improved significantly, with good outcomes increasing from 48.6% to 94.6% ($p = 0.032$). Among 58 teeth in the fracture line, 6 were extracted intraoperatively and 52 were preserved. At 4 and 12 weeks, 1 and 3 teeth required endodontic treatment, and no secondary extraction was needed. Overall, 91.9% of patients had good results, with 97.3%, 94.6%, and 91.9% satisfactory outcomes in anatomical, functional, and aesthetic domains. Miniplate fixation was effective for bone healing, functional recovery, and tooth preservation when appropriately managed.

Keywords: Mandibular fractures, miniplate fixation, teeth in the line of fracture, surgical outcomes.

I. INTRODUCTION

Maxillofacial trauma is a common emergency condition and has shown an increasing trend in recent years, with growing complexity, often involving multiple fracture lines and associated soft tissue, vascular, and nerve injuries. The primary cause is road traffic accidents, particularly motorcycle-related incidents.^{1,2} According to the National Traffic Safety Committee, in 2022, more than 11,400 traffic accidents were reported nationwide, resulting in 6,384 deaths and 7,804 injuries.³ Among maxillofacial injuries, mandibular fractures accounted for the majority of cases presenting

to emergency departments, predominantly affecting males. In the United States, more than 2,500 mandibular fracture cases are reported annually, with traffic accidents being the leading cause.⁴

The mandible is the largest and only movable bone of the facial skeleton, playing a crucial role in mastication and facial aesthetics. Its curved structure, along with anatomical weak points such as the mandibular angle, symphysis, and condylar neck, makes it particularly susceptible to fracture under traumatic forces.⁵ Treatment requires accurate anatomical reduction and restoration of occlusion. Currently, miniplate fixation systems are widely used for mandibular fracture management, providing stable fixation and minimizing secondary displacement.^{1,5,6} In tooth-bearing mandibular fractures, the presence

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of teeth within the fracture line is common, making their management a critical clinical consideration. Despite ongoing controversy and the lack of a clear consensus, earlier approaches often favored extraction to reduce the risk such as infection.^{7,8,9} However, with advances in antibiotic therapy and rigid fixation techniques, tooth preservation is increasingly preferred when no absolute indications for removal are present. The decision to retain or extract a tooth in the fracture line should be based on a comprehensive evaluation of multiple factors, including root integrity, periapical status, tooth position, its contribution to fracture stability and occlusion, as well as the overall treatment plan and timing of intervention.⁷ Based on these clinical context, this study was conducted to evaluate the outcomes of surgical treatment of tooth-bearing mandibular fractures using miniplate fixation and to analyze the role of tooth management in the fracture line in relation to treatment prognosis.

II. MATERIALS AND METHODS

1. Subjects

Patients diagnosed with and treated for mandibular fractures at Thong Nhat General Hospital (Dong Nai) and Long Khanh Regional General Hospital during the study period.

Patients aged ≥ 16 years with confirmed tooth-bearing mandibular fractures diagnosed by panoramic radiography and maxillofacial computed tomography, and indicated for surgical fixation using miniplates, were enrolled. Surgical indications included cases with mild displacement in which conservative reduction

failed or cases eligible for conservative treatment but declined maxillomandibular fixation. Fractures involving tooth-bearing regions of the mandible, including the symphysis, body, and angle, with fracture lines passing through teeth from R37 to R47, were considered. On the other hand, patients with mandibular fractures associated with maxillary fractures affecting occlusion, those with medical contraindications to surgery, contraindications to nasotracheal intubation, incomplete medical records, or withdrawal from the study were excluded.

2. Research methods

Study design

A prospective single-arm interventional study.

Sample size and sampling method

The sample size was calculated using the formula

$$n = Z_{(1-\alpha/2)}^2 \frac{p \cdot (1 - p)}{d^2}$$

With n is the minimum required sample size. Z is the standard normal deviate corresponding to the type I error (α), with $\alpha = 0.05$, thus $Z = 1.96$. p is the success rate of surgical treatment of mandibular fractures using miniplates, according to Tran Minh Triet and Truong Nhut Khue (2018), the overall success rate (good to very good) was approximately 96.0%,⁶ thus $p = 0.96$. d is the absolute precision, set at 0.07. Based on this formula, the estimated minimum sample size was $n = 31$ patients. In practice, 37 patients were enrolled using consecutive sampling, including all eligible patients who met the inclusion criteria during the study period.

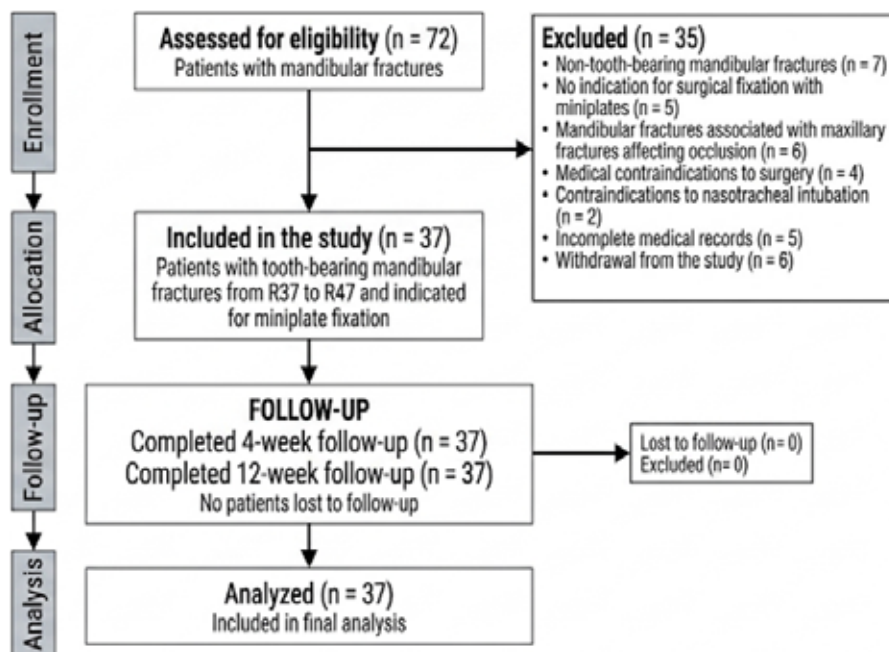


Figure 1. Flowchart of study participants

Study variables:

General characteristics: Age (16-18, 19-39, 40-59, ≥ 60 , mean \pm standard deviation) and gender (male, female).

Treatment outcomes of mandibular fractures:

- Surgical site infection condition: None, mild (erythema at suture line, managed conservatively with outpatient wound care), moderate (infection with pus formation and suture dehiscence requiring incision and drainage plus antibiotics), severe (extensive infection with pus, wound dehiscence and plate exposure requiring surgery and systemic antibiotics).

- Occlusion condition: Normal (uniform tooth contact in maximal intercuspation), mildly altered (uneven contact with at least three contact points), severely altered (only one or a few contacting tooth pairs).

- Maximum mouth opening: Good (> 4 cm),

fair (2-4 cm), poor (< 2 cm).

- Other postoperative complications: including wound infection, osteomyelitis, sensory disturbance.

- Bone healing at 12 weeks: assessed clinically and radiographically.

Characteristics and course of tooth management in the fracture line:

- Number of teeth involved in the fracture line.

- Initial management (extraction or preservation).

- Course during follow-up (preservation, endodontic treatment, or extraction).

- Tooth status at 12 weeks (retained or lost).

Overall treatment outcomes (at 12 weeks): Evaluated across three domains: anatomical, functional, and aesthetic. Detailed criteria are presented in Table 1.

Table 1. Post-treatment evaluation criteria^{1,10}

Outcome	Anatomical	Functional	Aesthetic
Good	Good bone healing, no deformity, no displacement, normal occlusion	Normal chewing, speaking, and swallowing, mouth opening > 4 cm	Symmetrical face, faint scar, aesthetically pleasing
Fair	Bone healed, mild deformity, slight displacement, minor occlusal discrepancy	Able to chew, mouth opening 2-4 cm	Mild facial deformity, noticeable scar but correctable
Poor	Poor or non-union, deformity, significant occlusal discrepancy	Difficulty chewing or unable to chew, mouth opening < 2 cm	Obvious facial deformity, requires reoperation

Overall treatment outcome:

Good: when all three criteria (anatomical, functional, and aesthetic) are good.

Fair: when at least one criterion is fair.

Poor: when at least one criterion is poor.

Intervention protocol

Surgery was performed under nasotracheal general anesthesia. The fracture site was approached intraorally for most symphyseal, body, and angle fractures, through the traumatic wound for open fractures with soft tissue injury, or via a Risdon approach when wider exposure of the mandibular angle and ramus was required. After exposure, interposed inflammatory and fibrous tissue was removed, the fracture segments were anatomically reduced, and occlusion was restored before fixation. Internal fixation was achieved using miniplates and screws according to AO principles, with plate configuration tailored to fracture location to ensure stable fixation and restoration of mandibular continuity. Occlusion was repeatedly checked throughout fixation. Postoperative outcomes were evaluated during hospitalization and at 4 and 12 weeks after surgery. Teeth within the fracture line

were assessed intraoperatively, teeth meeting extraction criteria, including vertical root fracture, interference with fracture reduction, acute infection at the fracture site, extensive periapical lesions, severe periodontal involvement, or loss of alveolar bone integrity, were removed, whereas the remainder were preserved for follow-up.⁷ Preserved teeth were re-evaluated at 1, 4, and 12 weeks by clinical examination, pulp vitality testing, and periapical radiography, and were subsequently maintained, treated endodontically, or extracted as indicated.

Data analysis

Data were coded and analyzed using SPSS software version 27.0. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as mean \pm standard deviation (mean \pm SD). Fisher's Exact Test was used to assess associations between categorical

variables. The Friedman test was applied to evaluate statistically significant differences in variables across multiple time points. Statistical significance was set at $p < 0.05$. Results were presented in tables and illustrated with figures.

3. Ethical considerations

The study was reviewed and approved by the Institutional Ethics Committee of Can Tho University of Medicine and Pharmacy (Approval No. 25.532/PCT-HĐĐĐ, dated June 30, 2025). All study procedures complied with ethical

principles for biomedical research and ensured the rights and safety of participants.

III. RESULTS

A total of 37 patients with tooth-bearing mandibular fractures were enrolled in this study. All patients underwent open reduction and internal fixation using miniplates at Thong Nhat General Hospital (Dong Nai) and Long Khanh Regional General Hospital from May 2025 to February 2026.

Table 2. General characteristics of patients (n = 37)

Characteristics		Frequency (n)	Percentage (%)
Age	16-18	6	16.2
	19-39	20	54.1
	40-59	10	27.0
	≥ 60	1	2.7
	Mean ± SD	33.1 ± 14.2	
Gender	Male	25	67.6
	Female	12	32.4

The mean age of the study population was 33.1 ± 14.2 years old, with the 19-39 age group accounting for the majority (54.1%). Most patients were male (67.6%).

Table 3. Treatment outcomes at admission, at 4 weeks and 12 weeks after treatment (n = 37)

Characteristics	At admission n (%)	At 4 weeks n (%)	At 12 weeks n (%)	p-value ^a
Infection condition				
No infection	35 (94.6)	36 (97.3)	37 (100)	0.317
Mild infection	2 (5.4)	1 (2.7)	0 (0)	
Occlusion condition				
Normal	35 (94.6)	36 (97.3)	36 (97.3)	0.875
Slight malocclusion	2 (5.4)	1 (2.7)	1 (2.7)	

Characteristics	At admission n (%)	At 4 weeks n (%)	At 12 weeks n (%)	p-value ^a
Maximum mouth opening (mandible)				
Good	18 (48.6)	32 (86.5)	35 (94.6)	0.032*
Fair	17 (45.9)	4 (10.8)	2 (5.4)	
Poor	2 (5.4)	1 (2.7)	0 (0)	

Friedman test

*Post-hoc pairwise comparisons with Bonferroni correction showed significant differences between admission and 4 weeks ($p = 0.041$), and between admission and 12 weeks ($p = 0.018$), while no significant difference was found between 4 and 12 weeks ($p = 0.317$)

Postoperatively, infection was well controlled, with the rate of no infection increasing from 94.6% at admission to 100% at 12 weeks. Correct occlusion remained high throughout follow-up (94.6-97.3%), with no statistically significant difference ($p = 0.875$).

Maximum mouth opening improved significantly over time, with the proportion of good outcomes increasing from 48.6% at admission to 94.6% at 12 weeks ($p = 0.032$). No case of osteomyelitis or major complications was observed.

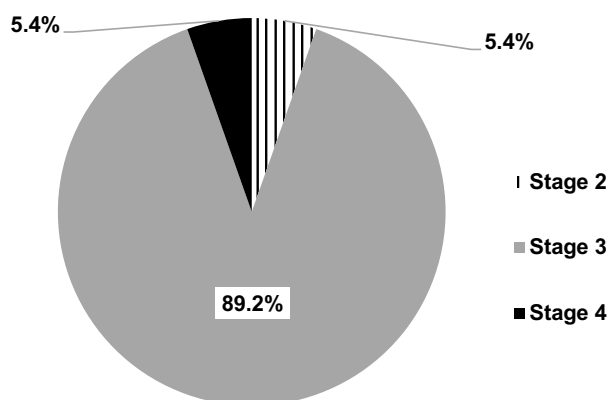


Figure 2. Radiographic assessment of bone healing at 12 weeks (n = 37)

After 12 weeks, most patients demonstrated good bone healing. Radiographic findings showed that 62.2% reached stage 4 (complete

union), 32.4% were at stage 3, and 5.4% at stage 2, with no cases at stage 1.

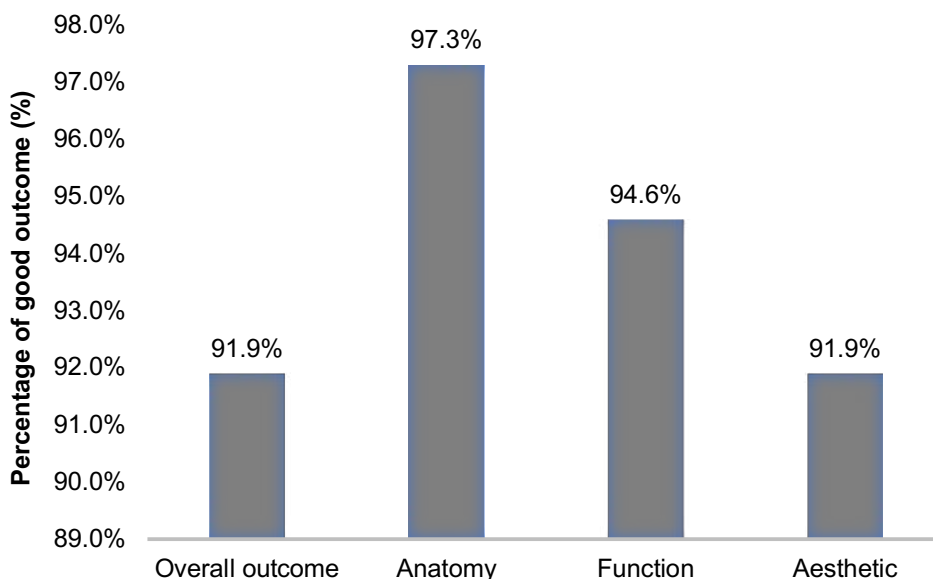


Figure 3. Overall treatment outcomes at 12-week follow-up (n = 37)

Overall, 91.9% of patients achieved good outcomes at 12 weeks. By domain, good results were highest in anatomical outcomes (97.3%),

followed by functional (94.6%) and aesthetic outcomes (91.9%).

Table 4. Management of teeth in the fracture line over time (n = 58 teeth)

Management	In surgery n (%)	At 1 week n (%)	At 4 weeks n (%)	At 12 weeks n (%)	p-value
Tooth preservation	52 (89.7)	52 (89.7)	51 (87.9)	48 (82.8)	0.32
Endodontic treatment	0 (0)	0 (0)	1 (1.8)	4 (6.9)	
Tooth extraction	6 (10.3)	6 (10.3)	6 (10.3)	6 (10.3)	

Friedman test

A total of 58 teeth were identified in the fracture line, of which 6 (10.3%) were extracted and 52 (89.7%) were preserved. No endodontic treatment was recorded at 1 week. At 4 weeks, 1 tooth (1.8%) required endodontic treatment, and by 12 weeks, an additional 3 teeth were treated, resulting in a total of 4 teeth (6.9%). The proportion of preserved teeth slightly decreased over time (from 89.7% to 82.8%), while the extraction rate remained unchanged.

No statistically significant difference was observed (p = 0.32).

IV. DISCUSSION

Mandibular fractures are among the most common maxillofacial injuries, and open reduction and internal fixation using miniplates is currently considered the standard treatment due to its ability to provide stable fixation and enable early functional recovery. In this study, after

12 weeks of follow-up, the outcomes showed a high rate of good bone healing (94.6%), correct occlusion (97.3%), good mouth opening (94.6%), and 91.9% of patients achieving overall good results. In addition, most teeth in the fracture line were successfully preserved (89.7%), demonstrating the effectiveness and safety of miniplate fixation in managing tooth-bearing mandibular fractures.

The mean age of patients was 33.1 ± 14.2 years old, with the majority aged 16-39 years old. This finding is consistent with previous studies by Le Duy Tan (31.6 ± 14.9 years old), Tran Minh Triet (28.96 ± 9.45 years old), and Truong Viet Hung (29.3 ± 8.4 years old).^{1,2,11} This age group is more actively involved in social activities, labor, and traffic participation. Regarding sex distribution, males predominated, approximately twice as many as females. Similar findings have been reported by Le Duy Tan (70.0%), Tran Kieu Hoa (80.6%), and Tran Minh Triet (91.1%).^{1,6,12} This disparity may be attributed to differences in traffic behavior, alcohol consumption, and the tendency to operate high-speed or large-displacement vehicles, which are more common among males.

The main findings of the present study are consistent with several studies. Throughout the follow-up period, treatment with miniplate fixation demonstrated clear improvements in infection control, occlusion, and mouth opening, with minimal postoperative complications. It should be noted that functional outcomes such as occlusion and maximum mouth opening may be influenced by baseline fracture characteristics and surgical indication. Although miniplate fixation is applicable to fractures with varying degrees of displacement, cases selected for this approach are generally amenable to anatomical reduction and stable fixation, which may partly contribute to the

favorable functional outcomes observed. These results indicate that miniplate fixation is a safe and reliable method with a low complication rate. This is in agreement with previous studies by Le Duy Tan (2025), Truong Viet Hung (2021), Tran Minh Triet (2018), and Al-Moraissi (2014), which reported a low risk of infection when proper aseptic techniques and appropriate indications are followed.^{1,6,11,13} The bone healing rate observed in this study (94.6%) is also consistent with international data. Bohner et al. (2020), in a study of 336 patients with 391 mandibular fractures treated with miniplates, reported that 89.3% of cases showed no displacement on postoperative radiographs and that the complication rate was below 10.0%.¹⁴ These findings suggest that miniplate systems effectively maintain fracture stability and facilitate bone healing.

Regarding the management of teeth in the fracture line, most of teeth in our study were preserved. After 12 weeks, 52/58 teeth were maintained, including 4 requiring endodontic treatment, with no secondary extraction. These findings support the current paradigm favoring tooth preservation. Although extraction was historically advocated to prevent infection, evidence shows that with modern antibiotic prophylaxis and stable fixation, retention does not increase the risk of infection or non-union and is now considered the standard of care.¹⁵ This approach is supported by previous studies. Bohner et al. reported that most teeth can be retained without compromising bone healing, while Walker et al. (2023) found low complication rates when intact teeth are preserved.^{9,14} Similarly, Hosgor et al. (2021) demonstrated a pulp survival rate of 69.8% at one year.⁷ Prognosis depends more on factors such as fracture displacement and pulp status rather than the mere presence of a tooth in the fracture line. Overall evaluation after 12 weeks

showed that most patients achieved good outcomes across anatomical, functional, and aesthetic domains. Compared with previous studies by Le Duy Tan (2025), Truong Viet Hung (2021), Tran Minh Triet (2018), and Chrcanovic (2013), the rates of good outcome in our study are comparable or even higher.

1,6,11,15

The findings of this study provide additional real-world evidence supporting the effectiveness and safety of miniplate fixation in the management of tooth-bearing mandibular fractures, particularly in the local clinical setting where data remain limited. The high rate of tooth preservation observed also supports a conservative approach to teeth within the fracture line when no clear indication for extraction exists. However, several limitations should be acknowledged. This was a prospective single-arm study, limiting comparison with alternative treatments. Although consecutive sampling was applied, the single-center design may still introduce selection bias and limit generalizability. The study was primarily descriptive, and no multivariable analysis was performed; thus, potential confounders were not controlled. In addition, the relatively small sample size and low number of extraction cases limited subgroup analyses. Some outcome measures, particularly aesthetic and functional assessments, are inherently subjective, although they reflect routine clinical practice. Post-hoc analyses were only conducted for variables with significant overall differences. Furthermore, the predominance of minimally displaced fractures may have reduced the discriminatory value of certain functional outcomes, and the 12-week follow-up may not capture late complications. Further studies with larger sample sizes, longer follow-up, and comparative or analytical designs are warranted.

V. CONCLUSION

Surgical management of mandibular fractures using miniplate fixation at two healthcare facilities in Dong Nai demonstrated favorable and consistent clinical outcomes. The findings confirm high rates of bone healing, satisfactory functional recovery, and a low incidence of complications, in line with the established effectiveness of this technique in clinical practice. In addition, most teeth located within the fracture line were successfully preserved when no clear indication for extraction was present. These results further support the routine use of miniplate fixation in the management of tooth-bearing mandibular fractures in appropriate clinical settings.

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