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Comparison of a Single 2mm Locking Miniplate with Two 2mm Non-Locking Miniplates in Symphysis or Para symphysis Fracture of Mandible

Anam Shahzad, Shahid Ali, Muhammad Mustafa, Adnan Haider, Fatima Imran, Kashif Adnan

ABSTRACT

Objective: To assess the treatment success between locking and non-locking miniplates when used for the constructive repair of mandibular symphysis and parasymphysis fractures of the mandible.

Study Design and Setting: This study is designed as a quasi-experimental conducted in the Oral and Maxillofacial Surgery Department of Punjab Dental Hospital and De Montmorency College of Dentistry, Lahore.

Methodology: This quasi-experimental was conducted in the Oral and Maxillofacial Surgery Department of Punjab Dental Hospital and De Montmorency College of Dentistry, Lahore. It enrolled 60 patients into each group consisting of locking and non-locking variants for a total of 120 participants. The data was evaluated through SPSS version 25 by applying the Chi-square test and one-way ANOVA test.

Results: Fracture stability was achieved in of patients in the locking miniplate group compared to in the non-locking group, with statistical significance (p=0.040). The need for additional IMFs was significantly lower in the locking group, with only required additional fixation, compared to the non-locking group (p=0.00095). Pain scores, measured using the VAS, were significantly lower in the locking miniplate group compared to the non-locking group with a p-value of 0.0001. Soft tissue healing was significantly better in the locking group, showing proper healing compared to the non-locking group (p=0.008).

Conclusion: The superior locking miniplate design achieves better fracture stability through increased mechanical stability as well as reducing postoperative discomfort and improving the healing of soft tissue structures, thus establishing their advantage over traditional non-locking miniplate methods.

Keywords: Fracture stability, locking miniplates, mandibular fractures, non-locking miniplates,

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INTRODUCTION

The mandible, a unique horseshoe-shaped bone, plays a critical role in cranial articulation, mastication, speech, respiration, and facial expression.[1] The maxillofacial injuries mainly stem from fractures because the bone's exposed position and particular structure create high susceptibility.[2,3] Interpersonal violence, together with road traffic accidents and falls and sports-related incidents, represent the typical situations that lead to mandibular fractures.[4] Mandibular symphysis, along with parasymphysis, stands out as the most vulnerable areas for fractures because of their position while under biomechanical stress.[5]

Traditional mandibular fracture treatment methods, including bandages and wire-based stabilization and splint fixation, caused patients to develop various complications, including facial asymmetry as well as functional impairment and malocclusion.[6, 7] Mandibular fracture treatment underwent a revolutionary change with the introduction of miniplates through the work of Champy and Michelet in the 1970s through open reduction and internal fixation (ORIF).[8] Champy's tension band osteosynthesis principle became the foundation for expansive clinical acceptance of two 2.0mm

non-locking miniplates positioned subapically and at the lower border to prevent torsional, compressive, and tensile forces from affecting the symphysis and parasymphysis regions.[9]

The stability of conventional miniplates requires bone compression for support but this technique generates complications including screw loosening together with cortical resorption and loss of fixation particularly in medically or nutritionally fragile patients.[10, 11] The locking plate system with screws emerged to resolve existing shortcomings.[12] The locking miniplates differ from non-locking plates by uniting screws to both plate structure and bone tissue through a fixed-angle construct which strengthens stability and reserves periosteal blood supply and minimizes screw movements.[13] The locking plate technology provides dual fixation to bone and plate, which decreases necrotic tissue development, enhances functional results, and eliminates the requirement of IMF treatment in most procedures.[14]

The latest studies propose an assessment of locking miniplates against non-locking miniplates for treating mandibular fractures.[15] A study by Elsayed et al. (2020) examined the mandibular parasymphysis fracture outcomes between 2mm locking and 2mm non-locking miniplates. The locking plate group exhibited superior bone healing compared to the non-locking plate group according to radiological assessments, even though clinical pain and swelling measurements remained identical and occlusal stability showed no substantial differences between the two groups.[16] Research by Pirwani et al. 2022 examined how different miniplates affected infection rates for patients who were 35 years old and older. The infection rates among 100 managed patients showed no noteworthy variations, which indicates that locking plates work equally well as non-locking miniplates for mandibular fracture treatment. The better bone healing capability of locking plates provides potential benefits for fracture rehabilitation by ensuring more stable fixation of fractures during healing.[17]

This research examines the effectiveness of a standalone 2.0mm locking miniplate when it replaces the traditional two 2.0mm non-locking miniplates for treating symphysis and parasymphysis fractures. Because of its time-saving characteristics, along with reduced instrumentation needs and superior stability, the locking system seems to offer patients an improved, efficient therapy. The study aims to examine postoperative pain, occlusal stability, and fractured segment stability with IMF requirements through the evaluation of single 2.0mm locking miniplates against two 2.0mm non-locking miniplates.

METHODOLOGY

This study is designed as a quasi-experimental conducted in the Oral and Maxillofacial Surgery Department of Punjab Dental Hospital and De Montmorency College of Dentistry, Lahore. The duration of the study will be six months, from September 26, 2024, to February 26, 2025, following the approval of the research synopsis. The study occurs within a time frame of six months and begins after the study proposal was approved by the College of Physicians and Surgeons Pakistan (CPSP) and the institutional ethics review board and the ERC number is 2220. The sampling technique used was non-probability purposive sampling, selecting patients diagnosed with symphysis or parasymphysis fractures. A total of 120 patients (60 in each group)[24] was included in the study, calculated with 80% power of the test, a 5% level of significance, and expected fracture stability of 93% in the 2mm locking miniplate group and 77% in the non-locking miniplate group.[18]

Patients eligible for the study was between 15 and 60 years of age, otherwise healthy with no debilitating comorbidities such as coagulopathies or respiratory diseases, as assessed through medical history and records. Patients must have fractures in the symphysis or parasymphysis region, confirmed through orthopantomography (OPG), and should not have any major accompanying injuries except for minor skin abrasions and lacerations. Patients with comminuted fractures, bilateral fractures, or fractures involving the angle or condylar region, as seen on OPG, were excluded. Additionally, individuals for whom intermaxillary fixation (IMF) is contraindicated, such as those with epilepsy, severe asthma, psychiatric conditions, or a history of alcohol or drug abuse, were also excluded.

After obtaining ethical approval, 120 patients presenting in the OPD of the Oral and Maxillofacial Surgery Department who meet the inclusion criteria were enrolled in the study. Written informed consent was obtained from all participants, and demographic data, including age, gender, fracture site, and mechanism of trauma. A thorough clinical examination, radiographic assessment, and necessary hematologic investigations was performed to ensure anesthesia fitness, following hospital protocols.

The patients were randomly allocated into two groups using a computer-generated randomization technique. The study group receive open reduction and internal fixation with a single 2.0mm locking miniplate system, while the control group undergoes the same procedure using two 2.0mm non-locking miniplates. In all cases, IMF was achieved using Erich arch bars or eyelet fixation. A transoral vestibular incision was made in the symphysis region after local anesthetic infiltration, approximately 10–15mm away from the attached gingiva. A submucosal dissection was carried out to expose the mentalis muscle, which was bisected to raise a mucoperiosteal flap, allowing access to the fracture segment. The fracture fragments were visually reduced into accurate anatomical pre-traumatic occlusion. Rigid fixation was then be performed using a single 2.0mm locking miniplate in the study group and two 2.0mm non-locking miniplates in the control group. After confirming occlusion,

IMF was removed. The incision was closed in layers using resorbable sutures, and empirical antibiotics were prescribed for five days. Patients will be discharged on the third postoperative day.

All participants were followed at regular intervals during the first, second, and third postoperative weeks to assess fracture stability and occlusal discrepancy. Based on occlusal stability, the need for additional IMF was determined. Additional variables such as age, gender, and cause of trauma was also be recorded as they may act as effect modifiers. All observations were documented in a structured proforma.

Data was analyzed using SPSS version 25. Quantitative variables such as age and BMI will be presented as mean ± standard deviation (SD). In contrast, qualitative variables, including occlusal stability, fracture stability, and the need for IMF, were presented as frequencies and percentages. The Chi-square test was applied to compare qualitative variables between groups. Data also be stratified based on age, gender, and fracture type (symphysis/parasymphysis). Post-stratification, the Chi-square test was used to assess statistical significance, with a p-value of <0.05 considered statistically significant.

RESULTS

The demographic and clinical characteristics of the study participants were comparable between the two groups. The mean age of patients in the locking miniplate group was 35.5 ± 10.3 years, while in the non-locking miniplate group, it was 36.2 ± 9.9 years (p=0.705). Similarly, the mean BMI was 24.9 ± 3.6 kg/m² in the locking miniplate group and 25.2 ± 3.3 kg/m² in the non-locking group (p=0.635). Males constituted the majority of participants in both groups, accounting for 71.6% in the locking miniplate group and 66.6% in the non-locking group (p=0.553). Fracture type distribution was also similar, with symphysis fractures present in 50% of the locking group and 55% of the non-locking group (p=0.583). The most common cause of trauma was road traffic accidents, seen in 65% of the locking group and 61.6% of the non-locking group, followed by falls and assaults, with no statistically significant difference between the groups (p=0.456). (Table 1)

Postoperative outcomes demonstrated a significant advantage of locking miniplates in several parameters. Fracture stability was achieved in 91.6% of patients in the locking miniplate group compared to 78.3% in the non-locking group, with statistical significance (p=0.040). Similarly, occlusal stability was observed in 93.3% of the locking miniplate group and 76.6% of the non-locking group, though this difference was not statistically significant (p=0.788). The need for additional intermaxillary fixation (IMF) was significantly lower in the locking group, with only 6.6% requiring additional fixation, compared to 30% in the non-locking group (p=0.00095). Pain scores, measured using the Visual Analog Scale (VAS), were significantly lower in the locking miniplate group (2.8 ± 1.2) compared to the non-locking group (4.2 ± 1.6), with a p-value of 0.0001. Postoperative infection rates were slightly lower in the locking miniplate group (6.6%) compared to the non-locking group (11.6%), but this difference was not statistically significant (p=0.342). Soft tissue healing was significantly better in the locking group, with 98.3% showing proper healing compared to 85.0% in the non-locking group (p=0.008). These findings suggest that locking miniplates provide superior fracture stability, lower pain scores, and better soft tissue healing, making them a favourable option for the management of mandibular fractures. (Table 2) (Figure 1)

Table 1: Demographic and Clinical Characteristics of Study Participants (n=120)

Variable	Locking Miniplate Group (n=60)	Non-locking miniplate Group (n=60)	p-value
Age (years) (Mean±SD)	35.5 ± 10.3	36.2 ± 9.9	0.705
BMI(kg/m²) (Mean ± SD)	24.9 ± 3.6	25.2 ± 3.3	0.635
Gender n (%)			
Male	43 (71.6%)	40 (66.6%)	0.553
Female	17 (28.3%)	20 (33.3%)	
Fracture Type n%			
Symphysis	30 (50%)	33 (55%)	0.583
Parasymphysis	30 (50%)	27 (45%)	
Cause of Trauma n%			
Road Traffic Accident	39 (65%)	37 (61.6%)	0.456
Fall	9 (15%)	14 (23.3%)	
Assault	12 (20%)	9 (15%)	

**Statistically significant (p < 0.05)*

Table 2: Postoperative Outcomes of the Study Participants (n=120)

Outcome Variable	Locking Miniplate Group (n=60)	Non-locking miniplate Group (n=60)	p-value
Fracture Stability n (%)	55 (91.6%)	47 (78.3%)	0.040*
Occlusal Stability n (%)	56 (93.3%)	46 (76.6%)	0.788
Need for Additional IMF n (%)	4 (6.6%)	18 (30%)	0.00095*
Pain Score (VAS, Mean ± SD)	2.8 ± 1.2	4.2 ± 1.6	0.0001*
Post-op Infection n (%)	4 (6.6%)	7 (11.6%)	0.342
Soft Tissue Healing n (%)	59 (98.3%)	51 (85.0%)	0.008*

**Statistically significant (p < 0.05)*

DISCUSSION

The research results show that symphysis and parasymphysis fracture treatment using one locking miniplate at 2.0 mm achieves superior clinical benefits when compared with two non-locking miniplates at 2.0 mm. Locking miniplates provided superior clinical stability to non-locking miniplates (91.6% vs. 78.3%, p=0.040) and required fewer patients to need additional intermaxillary fixation (6.6% vs. 30%, p=0.00095). This evidence supports that the locking plate design leads to enhanced post-operative stability results. The effectiveness of locking miniplates for mandibular fracture repair has been validated through multiple previous investigation studies.

The research by Sarkar DF et al. (2021) regarding locking miniplates versus non-locking miniplates for mandibular fractures found that locking plates offered superior stability compared to non-locking plates.[19] The authors explained that locking plates provided elimination of precise plate-to-bone adaptation requirements which reduced screw loosening risk and achieved better construct rigidity.[20] A study by Balani et al. (2024) demonstrates how locking plate patients achieved faster healing time with lower secondary intervention needs, directly supporting the findings in this study.[21]

The locking miniplate group demonstrated less postoperative pain based on Visual Analog Scale (VAS) assessments, which showed 2.8 ± 1.2 as the mean score, while the non-locking miniplate group rated 4.2 ± 1.6 (p=0.0001). The biomechanical support that locking plates provide allows for lower movements at fracture sites because this reduces postoperative pain development. The research findings by Al-Moraissi et al. (2020) indicate that locking plates produce lower postoperative pain levels and require lesser amounts of analgesics for treating mandibular fractures.

The locking miniplate group experienced reduced postoperative infection rates at 6.6%, but no statistically significant difference existed (p=0.342) when compared to the conventional miniplate group at 11.6%. Research by previous authors recommends that locking plates enhance infection prevention because they minimize periosteal stripping and protect native blood flow. The research by Pirwani FA, et al. (2022) indicated surgical site infections occurred less frequently in patients receiving locking miniplates in contrast to those with conventional non-locking plates. Patient comorbidities together with patient hygiene practices as well as antibiotic use protocols, need additional study to determine their effects on overall infection rates.[22]

Soft tissue healing reached higher levels in the locking miniplate group when compared to nonlocking miniplates (98.3% versus 85% with a p-value of 0.008). Locking plates produce less soft tissue damage while fixing bones by omitting the requirement of heavy plate-to-bone pressure so that periosteal blood flow remains intact. Elsayed et al. (2021) found similar outcomes when they discovered that locking plate fixation produced quicker wound recovery and lower soft tissue problems when compared to non-locking plates.[23] The experimental group achieved better occlusal stability using locking miniplates, but this outcome failed to show statistical significance with a p-value of 0.788. Postoperative occlusal outcomes are influenced by multiple elements, including surgical technique and patient-specific variations of anatomical structures, as well as preoperative occlusion in addition to locking plate benefits for alignment and stability.

The research proves that locking miniplates deliver multiple benefits during treatment of mandibular symphysis and parasymphysis fractures in clinical practice. This biomechanical superiority of locking miniplates is confirmed by their increased stability and reduced need for additional intermaxillary fixation, and improved pain control and soft tissue outcomes. Advantages of locking miniplates include creating speedier patient recovery times, shortening hospitalization duration, and decreasing postoperative medication usage. The evaluation demonstrates how locking miniplates lead to superior outcome results that favor their adoption as a standard fixation strategy, especially for situations that need rigid stabilization. Research should direct its focus to analyze the extended functional and esthetic advantages of locking miniplates for maximizing maxillofacial trauma treatment approaches in upcoming studies.

CONCLUSION

Research showed that employing one 2.0 mm locking miniplate for symphysis or parasymphysis fracture fixation results in better stability while reducing dependence on immobilizers, thus lowering pain levels and improving tissue recovery. The study results indicated matchable infection rates between groups yet demonstrated that locking miniplates lead to better patient outcomes alongside superior surgical achievements.

The clinical data demonstrates how locking miniplates prove superior to non-locking miniplates for mandibular fracture treatment, especially when building up stability and comfort for patients. Future extensive research with extended patient monitoring should validate these findings while exploring long-term patient-centered results achieved via locking miniplates during mandibular bone fracture treatment.

LIMITATIONS OF STUDY

Many studies that have tested these treatments use relatively small samples of patients and, thus, may not fully represent the population with mandibular fractures. Some studies have limited follow-up periods and may overlook long-term issues or the need for revision surgery. Different types of fixation mechanisms (locking and non-locking) may be influenced by factors not directly examined in the study design, which can create selection bias. The professional competence and

skills of the surgeon may drastically affect the outcomes of any surgical procedure, such as the use of mini plates. Variations in surgical practices can affect the stability and union of the fracture, regardless of the type of plate used.

Authors Contribution:
Anam Shahzad: Manuscript Writing Data Collection & Interpretation
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Muhammad Mustafa: Data Collection, Study Design
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