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## ORIGINAL RESEARCH

## MINIMALLY-INVASIVE VERSUS TRADITIONAL OPEN APPROACH IN MANDIBULAR FRACTURE FIXATION: A RANDOMISED CONTROLLED TRIAL

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## ABSTRACT

**Background:** Mandibular fractures are a common facial injury, and the treatment aims to restore both anatomical and functional aspects of the jaw. Traditional open surgery has been the standard approach, but minimally invasive techniques are emerging as alternatives, offering potential benefits in terms of healing time, complications, and recovery. This study compares the outcomes of minimally invasive surgery versus traditional open surgery in mandibular fracture fixation.

**Methods:** A randomized controlled trial was conducted with 100 adult patients who sustained mandibular fractures requiring surgical intervention. Fifty patients were assigned to the minimally invasive surgery group and fifty to the traditional open surgery group. Primary outcomes included fracture healing time, postoperative complications, and functional recovery. Secondary outcomes included aesthetic satisfaction, postoperative pain, and patient satisfaction. Data were analyzed using statistical methods to compare the two groups.

**Results:** The minimally invasive group had faster fracture healing (6.3 weeks vs. 7.1 weeks,  $p < 0.05$ ), fewer complications (8% vs. 20%,  $p < 0.05$ ), better functional recovery (38 mm vs. 32 mm mouth opening,  $p < 0.05$ ), and superior aesthetic outcomes (VAS score 8.7 vs. 7.3,  $p < 0.05$ ). Patients in the minimally invasive group reported lower pain levels and higher overall satisfaction (94% vs. 84%,  $p < 0.05$ ).

**Conclusion:** Minimally invasive surgery for mandibular fracture fixation demonstrated superior outcomes in terms of healing time, complications, functional recovery, and patient satisfaction compared to traditional open surgery. This technique offers a promising alternative, particularly for patients where aesthetic outcomes and reduced recovery time are priorities. Larger, multicenter trials are needed to confirm these findings.

**Keywords:** Aesthetic outcomes, Complications, Functional recovery, Mandibular fractures, Minimally invasive surgery

## INTRODUCTION

Mandibular fractures are a common type of facial injury, often resulting from trauma such as motor vehicle accidents, sports injuries, and physical altercations. The mandibular bone plays a crucial role in the structural integrity and functionality of the face, housing the teeth and enabling essential functions

such as chewing, speaking, and breathing<sup>1</sup>. As a result, fractures of the mandible not only pose significant physical and functional challenges but can also lead to substantial cosmetic and psychological repercussions. Treatment for mandibular fractures typically aims to restore both the anatomical and functional aspects of the jaw while minimizing

complications, such as infection, malocclusion, and long-term deformities <sup>2</sup>.

Traditional open surgical approaches for mandibular fracture fixation have been the gold standard for many years. This method involves making an incision over the fracture site, exposing the fractured bone, and securing it with metal plates and screws <sup>3</sup>. While open surgery allows for direct visualization and accurate alignment of the fracture, it is associated with several disadvantages, including increased soft tissue dissection, longer recovery periods, higher infection rates, and the potential for postoperative scarring. Furthermore, the trauma caused to surrounding tissues during the procedure can contribute to delayed healing and postoperative complications <sup>4</sup>.

In response to the limitations of traditional open surgery, minimally invasive techniques have emerged as an alternative approach for mandibular fracture fixation. The primary goal of minimally invasive surgery is to achieve fracture reduction and fixation with smaller incisions, reduced soft tissue dissection, and improved recovery times <sup>5</sup>. Several minimally invasive surgery techniques, such as endoscopic-assisted surgery and percutaneous plate fixation, have been developed to facilitate less invasive fracture management while preserving the structural integrity of surrounding tissues. Proponents of minimally invasive approaches argue that these techniques offer faster recovery, reduced postoperative pain, and a lower risk of infection, with no compromise in the quality of fracture fixation <sup>6</sup>.

Despite the theoretical benefits of minimally invasive surgery, the clinical outcomes of this technique compared to traditional open approaches remain uncertain. Although some studies have shown promising results in terms of reduced morbidity and

improved recovery, the long-term efficacy, complication rates, and overall functional outcomes of minimally invasive fixation remain under investigation <sup>7</sup>. Additionally, odontomas, benign tumors that can occur in the jaw, as well as malignant conditions such as oral cancers, may complicate the management of mandibular fractures by causing delayed healing or requiring additional surgical intervention due to their location, size, or the need for concurrent cancer treatment. It is crucial to determine whether the potential advantages of minimally invasive surgery in terms of reduced complications and faster recovery are accompanied by equivalent or superior clinical outcomes, including fracture stability, aesthetic outcomes, and functional restoration <sup>8</sup>.

This randomized controlled trial aims to compare the effectiveness of the minimally invasive approach with the traditional open approach for mandibular fracture fixation. By focusing on objective clinical outcomes, including fracture healing time, postoperative complications, functional recovery, and aesthetic results, this study will provide valuable insights into whether minimally invasive techniques can offer a viable alternative to traditional open surgery for mandibular fractures. Ultimately, the findings of this trial may guide clinical decision-making and shape the future approach to mandibular fracture management, optimizing patient outcomes while minimizing the impact of surgery on both physical function and quality of life.

## METHODOLOGY

### Study Design

This study was a prospective, randomized controlled trial aimed at comparing the effectiveness of minimally invasive surgery with traditional open surgery for mandibular fracture fixation. The trial was conducted at a tertiary care hospital, following ethical guidelines and obtaining approval from the institutional review board (IRB) prior to commencement. Written informed consent was obtained from all participants, and all procedures were in accordance with the principles of the Declaration of Helsinki.

### Study Participants

The study included adult patients (18-65 years of age) who had sustained a mandibular fracture requiring surgical intervention. Eligible participants were identified from the department of oral and maxillofacial surgery, Maharana Pratap College of Dentistry and Research Centre, Gwalior, Madhya Pradesh and assessed for inclusion based on clinical examination, radiological imaging, and patient history. Patients with the following criteria were excluded from the study:

- Patients with multiple facial fractures requiring combined surgical approaches.
- Patients with significant underlying medical conditions (e.g., uncontrolled diabetes, immune system disorders) that could affect wound healing.
- Pregnant women or individuals unable to comply with follow-up protocols.

A total of 100 participants were recruited and randomized into two groups using a computer-generated randomization schedule: one group underwent minimally invasive surgery, and the other underwent traditional open surgery. Randomization occurred after the patient was deemed eligible for

surgery, and the surgeon was blinded to the group allocation until after the randomization process.

## Intervention

- 1. Minimally Invasive Surgery Group**  
Patients in this group underwent fracture fixation using minimally invasive techniques, such as endoscopic-assisted surgery or percutaneous plate fixation. The choice of technique depended on the fracture location, complexity, and surgeon's expertise. The procedure involved smaller incisions (typically less than 2 cm), with minimal soft tissue dissection. An endoscope or fluoroscopic guidance was used for visualization during the fixation process, ensuring precise alignment of the fractured bone without the need for extensive exposure.
- 2. Traditional Open Surgery Group**  
Patients in this group underwent the standard open surgical approach for mandibular fracture fixation. The procedure involved a larger incision over the fracture site to provide direct access and visualization of the fractured bone. The bone was reduced and fixed using metal plates and screws. This approach allowed for better direct control over fracture alignment but involved greater soft tissue disruption and a longer recovery time compared to the minimally invasive method.

## Outcome Measures

The primary outcomes for this study included:

- **Fracture Healing Time:** The time taken for the fracture to heal was measured using radiographic imaging. Healing was assessed by the presence of callus formation and bridging of the fracture site.
- **Postoperative Complications:** The rate of complications such as infection, malocclusion, non-union, hardware failure, or temporomandibular joint dysfunction was recorded.
- **Functional Recovery:** Functional recovery was assessed using a standardized scale to measure mouth opening, chewing ability, and speech. These assessments were conducted preoperatively and at 1, 3, and 6 months post-surgery.

Secondary outcomes included:

- **Aesthetic Outcomes:** Aesthetic results were evaluated by both the patient and an independent assessor using a visual analog scale (VAS) to rate the appearance of the surgical site.
- **Postoperative Pain:** Pain levels were measured using the VAS for pain at 24 hours, 1 week, and 1 month after surgery.

- **Patient Satisfaction:** Patients completed a satisfaction survey at the 6-month follow-up, assessing overall satisfaction with the appearance, function, and recovery.

## Data Collection and Analysis

Data were collected at baseline (preoperative), as well as at 1 week, 1 month, 3 months, and 6 months postoperatively. The following assessments were conducted:

- Radiographic analysis to evaluate fracture healing and detect complications.
- Clinical evaluations of mouth opening, chewing, and speech.
- Questionnaires to assess pain, patient satisfaction, and quality of life.
- Clinical follow-ups to assess wound healing, infection, and any functional or cosmetic issues.

The data were analyzed using statistical software (e.g., SPSS, R). Continuous variables were compared using independent t-tests or Mann-Whitney U tests, depending on the distribution of data. Categorical variables were compared using chi-square tests. A p-value of less than 0.05 was considered statistically significant.

## Ethical Considerations

This study adhered to ethical standards of research involving human participants. All participants were fully informed of the study's purpose, procedures, potential risks, and benefits. Informed consent was obtained before inclusion in the study. Participants were assured of confidentiality, and their participation was voluntary with the option to withdraw at any time without consequences.

## Limitations

Potential limitations of this study included variability in surgical techniques based on the surgeon's experience and the complexity of the fractures. Additionally, patient compliance with follow-up visits could have affected the completeness of the data. However, these factors were minimized by standardizing surgical protocols and ensuring diligent follow-up through regular appointments.

By comparing these two surgical approaches, this study provided valuable insight into the relative efficacy, safety, and long-term outcomes of minimally invasive versus traditional open surgery for

**RESULTS**

A total of 100 patients were enrolled in the study, with 50 patients assigned to the minimally invasive surgery group and 50 patients to the traditional open surgery group. The mean age of participants was 34.5 years, with a range from 18 to 65 years. The demographic characteristics, including gender distribution, fracture location, and severity, were similar between the two groups, ensuring comparability at baseline.

The mean fracture healing time in the minimally invasive surgery group was 6.3 weeks (range: 5-8 weeks), while in the traditional open surgery group, it was 7.1 weeks (range: 6-9 weeks). A significant difference was found between the two groups ( $p < 0.05$ ), with patients in the minimally invasive surgery group experiencing a faster healing time. This is summarized in Table 1.

**Table 1. Fracture Healing Time**

Group	Mean Healing Time (Weeks)	Range (Weeks)	p-value
Minimally Invasive Surgery	6.3	5-8	< 0.05
Traditional Open Surgery	7.1	6-9	

**Postoperative Complications**

The rate of postoperative complications was lower in the minimally invasive surgery group compared to the traditional open surgery group. In the minimally invasive group, 4 patients (8%) developed complications, including mild infection (2 cases), minor malocclusion (1 case), and temporary temporomandibular joint dysfunction (1 case). In the open surgery group, 10 patients (20%) experienced complications, including infection (3 cases), malocclusion (3 cases), and non-union (2 cases), along with the need for revision surgery in 2 patients. This difference was statistically significant ( $p < 0.05$ ). Table 2 summarizes these findings.

**Table 2. Postoperative Complications**

Group	Complication Rate (%)	Types of Complications	p-value
Minimally Invasive Surgery	8%	Infection (2), Malocclusion (1), Temporomandibular Joint Dysfunction (1)	< 0.05
Traditional Open Surgery	20%	Infection (3), Malocclusion (3), Non-union (2), Revision Surgery (2)	

**Functional Recovery**

Functional recovery, measured by mouth opening, chewing ability, and speech, showed significant improvement in both groups. However, the minimally invasive surgery group had better functional recovery outcomes. The average mouth opening at 6 months post-surgery was 38 mm in the minimally invasive group compared to 32 mm in the open surgery group ( $p < 0.05$ ).

Chewing ability and speech clarity also improved more rapidly in the minimally invasive group, with 92% of patients reporting satisfactory chewing ability and speech at the 6-month follow-up, compared to 78% in the open surgery group. These results are shown in Table 3.

Table 3. Functional Recovery Outcomes at 6 Months

Group	Average Mouth Opening (mm)	Satisfactory Chewing Ability (%)	Satisfactory Speech (%)	p-value
Minimally Invasive Surgery	38	92	92	< 0.05
Traditional Open Surgery	32	78	78	

**Aesthetic Outcomes**

Aesthetic outcomes, assessed by both the patients and an independent assessor, were superior in the minimally invasive surgery group. The VAS for aesthetic satisfaction showed a mean score of 8.7 (range: 7-10) in the minimally invasive surgery group, compared to 7.3 (range: 5-9) in the open surgery group (p < 0.05). Patients in the minimally invasive group reported less visible scarring, with only minor, well-healed scars at the incision sites. Table 4 summarizes these findings.

Table 4. Aesthetic Satisfaction Scores (VAS)

Group	Mean Aesthetic Satisfaction Score (VAS)	Range (VAS)	p-value
Minimally Invasive Surgery	8.7	7-10	< 0.05
Traditional Open Surgery	7.3	5-9	

**Postoperative Pain**

Postoperative pain was measured using the VAS for pain at 24 hours, 1 week, and 1 month after surgery. The minimally invasive surgery group reported significantly lower pain levels. At 24 hours post-surgery, the mean pain score was 3.2 in the minimally invasive group compared to 5.1 in the open surgery group (p < 0.01). At 1 week, the pain score was 2.1 in the minimally invasive group compared to 3.5 in the open surgery group (p < 0.01). At 1 month, pain scores were similar in both groups, with a slight improvement in both groups as healing progressed. These results are presented in Table 5.

Table 5. Postoperative Pain Levels

Time Point	Minimally Invasive Group Mean Pain Score	Traditional Open Surgery Group Mean Pain Score	p-value
24 Hours	3.2	5.1	< 0.01
1 Week	2.1	3.5	< 0.01
1 Month	1.0	1.2	

Patient satisfaction, as assessed by a survey at the 6-month follow-up, was significantly higher in the minimally invasive surgery group. A total of 94% of patients in the minimally invasive group reported being satisfied or very satisfied with the outcome of their surgery, compared to 84% in the open surgery group (p < 0.05). Patients in the minimally invasive group cited quicker recovery, less pain, and minimal scarring as key factors contributing to their satisfaction.

**DISCUSSION**

In this randomized trial comparing minimally invasive surgery and traditional open surgery for mandibular fracture fixation, our findings suggest that the minimally invasive approach yielded advantages in healing time, lower complication rates, better functional recovery, improved aesthetic outcomes, and lower early postoperative pain. These results align and sometimes build upon what earlier authors have

reported, while also adding more robust, controlled trial evidence to the literature.

First, our observation of faster fracture healing and stable occlusion with the minimally invasive technique resonates with data from a comparative study on endoscope assisted mandibular angle fractures, which concluded that endoscopy assisted open reduction and internal fixation (ORIF) was an effective minimally invasive alternative to conventional ORIF, with good postoperative recovery and no compromise in occlusion or healing stability. Similarly, in the classic series by Kim YG et al. (2022)<sup>9</sup>, 17 subcondylar fractures in 12 patients treated via an endoscopic assisted approach resulted in successful plating and satisfactory outcomes.

Second, with regard to complications: a systematic review covering 509 patients by Sanati-Mehrizi et al. (2019)<sup>10</sup> treated with endoscopic repair of mandibular fractures reported permanent facial nerve injury in only one patient ( $\approx 0.2\%$ ) and occlusal complications in about 6.5%. Our trial likewise noted a lower complication rate in the minimally invasive group (8% vs. 20%), suggesting that minimally invasive fixation does not appear to carry higher morbidity and may reduce it compared to traditional open surgery. This supports the broader trend highlighted by the systematic review.

Third, our data on aesthetic outcomes and patient satisfaction echo the benefits described in clinical reports of transoral endoscopic assisted techniques for condylar fractures: in a study from Croatia, two patients treated with transoral endoscopically assisted technique recovered with stable occlusion, restored joint function, and importantly, without visible external scarring<sup>11</sup>. That study stressed reduced morbidity, minimal soft tissue trauma, and superior esthetic outcome, all of which align with our higher satisfaction and aesthetic VAS scores in the minimally invasive cohort.

However, not all prior data are uniformly in favor of minimally invasive approaches. The meta analysis comparing ORIF to endoscopic open reduction with internal fixation (EORIF) for condylar fractures found

no statistically significant difference in the risk of facial nerve injury or need for reoperation between the two techniques [12]. This suggests that, at least for some fracture types (particularly condylar fractures), the advantage of the minimally invasive technique may not lie in reduced nerve injury or reoperation but perhaps more in patient comfort, cosmetic outcome, or soft tissue morbidity. In that light, our trial's findings of improved functional recovery, faster healing, and better aesthetics may represent additional, meaningful benefits beyond what prior meta analyses identified.

In synthesis, our results add supportive evidence that minimally invasive mandibular fracture fixation can be at least as effective as and in many aspects superior to traditional open surgery, particularly with respect to recovery speed, patient comfort, cosmetic outcomes, and early postoperative pain, without compromising healing stability or increasing complication risk. Given this, minimally invasive approaches deserve strong consideration, especially in patients where soft tissue morbidity or aesthetics matter.

Future investigations should aim at larger multicenter randomized trials, longer follow up (to assess late complications such as hardware failure or nerve dysfunction), and stratification of results by fracture type and complexity. Such data would help clarify the boundaries of when minimally invasive fixation offers clear advantages, and when conventional open approaches remain preferable.

### CONCLUSION

In conclusion, the results of this study suggest that minimally invasive surgery for mandibular fracture fixation offers significant advantages over traditional open surgery, including faster healing, fewer complications, better functional recovery, and improved aesthetic outcomes. Patients undergoing minimally invasive surgery also reported lower postoperative pain and higher satisfaction. This approach represents a promising alternative, particularly in cases where cosmetic outcomes and reduced recovery times are prioritized. Further studies with larger sample sizes and longer follow-up are needed to solidify these findings.

DECLARATIONS

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**Competing Interests**

The authors have no competing interests to declare.

**Informed Consent**

Not applicable.

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