Original Research Article

USE OF SINGLE MINI-PLATE VERSUS TWO MINIPLATES OSTEOSYNTHESIS FOR LINEAR NON-COMMINUTED FRACTURE OF ANTERIOR MANDIBLE: A PROSPECTIVE RANDOMIZED COMPARATIVE STUDY.

ABSTRACT

Mandibular fractures are the most common fractures within the facial skeleton, occurring two to three times more often than other types of facial fractures. The management of mandibular fractures has evolved from closed techniques such as maxillomandibular fixation (MMF), splints, and external stabilization to rigid internal fixation. This study aims to evaluate and compare the stability and recovery times in anterior mandibular fractures after open reduction with either single or dual miniplate fixation. All patients with anterior mandibular fractures underwent preoperative computed tomography (CT) scans and post-operative radiographic evaluations following open reduction and internal fixation (ORIF). Group 1 included 10 patients who were treated with a 2.5mm single miniplate (comprising 6 holes with a gap), while Group 2, also consisting of 10 patients, received treatment with one 2mm miniplate and one 2.5 mm miniplate, being placed at the lower border (each having 4 holes with a gap). An arch bar was used in the mandibular arch for a duration of 3 weeks in both groups. Patients were assessed at one week, four weeks, and twelve weeks after the procedure as part of a follow-up protocol, focusing on factors such as postoperative occlusion, the stability of the fractured segments, bite force measured with a specific device, neurosensory deficits, wound dehiscence, and damage to the roots of the anterior and bicuspid mandibular teeth. Our study effectively showed that a single miniplate provided stability comparable to that of a two-miniplate system in managing anterior mandibular fractures after open reduction and internal fixation.

Keywords: Mandibular fracture, Symphysis, Parasymphysis, Open Reduction, Internal Fixation, Miniplates.

INTRODUCTION

Mandibular fractures are more prevalent than any other type of fracture in the facial skeleton, occurring 2 to 3 times more frequently than other facial fractures. This prevalence can be linked to various factors such as road traffic incidents, falls, assaults, and even injuries related to sports (1). The rising number of traffic accidents and cases of interpersonal violence has contributed to an uptick in these fractures. Social, cultural, and environmental influences shape the rates and causes of mandibular fractures. Anatomically, the symphysis region of the mandible is one of the most frequently fractured sites in the mandible after the angle and the condyle, making up 18-20 % of the mandibular fractures in adults (2).

The primary objective in treating mandibular fractures is to regain the original shape and function by facilitating a swift healing process of the broken pieces with minimal patient discomfort, restoring pre-injury strength, and avoiding infections at the fracture location. The approach to managing mandibular fractures has progressed from closed methods like maxillomandibular fixation (MMF), splints, and external stabilization to rigid internal fixation (3). This progression has taken place in response to patient needs and advancements in scientific understanding. The Arbeitsgemeinschaft für Osteosynthesefragen (AO)/Association for the Study of Internal Fixation (ASIF) asserts that the primary goal in treating mandibular fractures through open reduction and rigid internal fixation is to promote uninterrupted healing while immediately restoring both form and function without the need for maxillomandibular fixation (MMF) (4).

In the realm of open reduction and internal fixation, two main treatment philosophies surfaced regarding plate and screw fixation of mandibular fractures during the 1970s and 1980s. The first is the AO/ASIF approach, which advocates for enough rigidity at the fracture site to hinder interfragmentary mobility while the mandible experiences functional stresses (5). The second approach, advanced by Champy et al. (6), focuses on "the ideal lines of osteosynthesis" within the mandible, utilizing non-compression monocortical miniplates placed in regions of optimal stress to counteract tension. This principle necessitates the use of two plates for the effective fixation of fractures in the symphysis and parasymphysis regions to ensure an optimal distribution of forces. This plating system has become the favored technique for fixing mandibular fractures and osteotomies due to its straightforward handling, the possibility of intraoral application, reduced risk of nerve damage, the ability to monitor fracture line alignment and occlusal relationships simultaneously, and the removal of the requirement for

maxillomandibular fixation (6) (7). With this in mind, we chose to examine the system and suggested a comparison of the clinical effectiveness and long-term results of using one 2.5 mm (6 holes with gap) miniplate versus two miniplates, one 2mm miniplate and one 2.5 mm miniplate, being placed at the lower border (each having 4 holes with a gap) in treating symphysis/parasymphyseal fractures, with positive outcomes being observed.

AIM AND OBJECTIVES

AIM

Aim of the study is to analyze and compare the stability and rehabilitative periods in anterior mandibular fracture after open reduction with single miniplate and two miniplates fixation.

OBJECTIVES

The objectives of this particular study are as follows:

I. To evaluate and compare the stability of fracture in both the study groups.
II. Assessment of rehabilitative periods using bite force measuring device, in both the study groups.
III. To evaluate the post-operative occlusion in both the study groups.
IV. To evaluate neurosensory deficit, in both the study groups.
V. To evaluate wound dehiscence, in both the study groups.
VI. To evaluate any root damage to mandibular anterior and bicuspid teeth, in both the study groups.

INCLUSION AND EXCLUSION CRITERIA

INCLUSION CRITERIA

I. The age group of the patients is in the range between 18 to 65 years.

II. Fracture in the symphysis or parasymphysis region of the mandible.
III. Fractures amenable to treatment using an intra-oral approach.

EXCLUSION CRITERIA

I. Medically compromised patients who are unfit for the procedure under general anesthesia.
II. Patients with comminuted fracture of the mandible.
III. Patient with additional fractures at other sites of the mandible.
IV. Pan facial trauma.
V. Edentulous and partially edentulous patient.

MATERIALS AND METHODS

SOURCE OF DATA

The study was conducted on subjects reporting to the Department of Facio-maxillary Surgery, SANJAY GANDHI INSTITUTE OF TRAUMA AND ORTHOPEDICS, BANGALORE.

STUDY DESIGN

A prospective study classified patients into two groups: one treated with a single miniplate fixation and the other with two miniplates fixation before the planned procedure. All patients with anterior mandible fractures underwent computed tomography (CT) scans before surgery and radiographic evaluations after open reduction and internal fixation (ORIF). Group 1, made up of 10 patients, received treatment with a 2.5mm single miniplate (6 holes with a gap), while Group 2, consisting of another 10 patients, was treated with two miniplates, one 2mm miniplate and one 2.5 mm miniplate, being placed at the lower border (each having 4 holes with a gap). An arch bar was maintained in the mandibular arch for 3 weeks in both groups. All patients were evaluated as part of a follow-up protocol at one week, four weeks, and twelve weeks post-procedure, focusing on factors such as postoperative occlusion, the stability of fractured segments, bite force measured with a bite force measurement device, neurosensory deficits, wound dehiscence, and root damage to the mandibular anterior and bicuspid teeth.

RESULTS

Our Proposed study consisted of 20 patients, that were randomly divided into 2 groups viz, Group 1 and Group 2. Group 1 consisting of 10 patients, underwent treatment using a 2.5mm single miniplate (6 holes with a gap), whereas group 2 which was composed of another 10 patients underwent treatment using two miniplates, one 2mm miniplate and one 2.5 mm miniplate, being placed at the lower border (each having 4 holes with a gap). Arch bar was applied preoperatively in both groups, which was retained for 3 weeks in both groups. The arch bar was removed as an outpatient department procedure at the second follow-up of the patient after a thorough clinical evaluation. Our research indicated that post-operative occlusion remained stable in both groups throughout all follow-up assessments. The fractured segments demonstrated comparable stability after fixation across both groups. The bite force was somewhat greater in the two plating group compared to the one plating group. No direct link was found between the plating systems and post-operative neurosensory deficits. Notably, significant root damage was observed in the two plating system in contrast to the one plating system. Therefore, our study effectively demonstrated that a single miniplate was as effective as a two miniplate system in preserving stability in anterior mandibular fractures following open reduction and internal fixation.

DISCUSSION

Fractures involving the symphysis and parasymphysis of the mandible are very prevalent injuries. The foundation for effectively managing these fractures lies in understanding the principles of precise fracture reduction, restoration of occlusion, and secure internal fixation (8) (9) (10). The fundamental requirement for rigid fixation is to ensure sufficient stability to prevent interfragmentary motion, even with active movements of the mandible. This stability can be obtained by closely aligning fracture fragments and ensuring larger contact areas in areas subjected to compressive forces (11). Various methods such as bone reconstruction plates, lag screws, geometric bone plates, and miniplates are available to achieve internal fixation for body/symphysis fractures (12). Primary bone healing facilitates the direct extension of osteocytes across the minimal gap that exists between fractured bone segments. This form of bone healing occurs without the formation of an external callus, which consequently reduces the duration needed for remodeling and consolidation (13). Spiessl and Prein and Kellman emphasized the two essential principles necessary for achieving proper rigid internal fixation (14) (15). First, the fixation must be capable of supporting full functional loads (load-bearing osteosynthesis). Second, achieving

absolute stability of the fracture construct is crucial, as it is fundamental for effective healing and minimizing the risk of infection (7). Ellis and Walker (16) observed a significant complication rate (28%) following fracture fixation with two non-compression miniplates. This indicates that various factors may contribute to the occurrence of complications, extending beyond mere biomechanical issues. One possible reason for the less favorable clinical outcomes associated with two plate fixation techniques could be the compromise of blood supply to the lateral mandible due to the stripping of the periosteum for miniplate fixation at the inferior border (16). The use of two plate fixations requires more time, and prolonged surgical procedures increase the risk of bacterial contamination of the bone (17) (18). Effective bone healing relies on a careful equilibrium between adequate rigid internal fixation and the maintenance of the necessary bony and soft tissue environments for successful fracture healing(19) (20). In this research, utilizing a single 2.5 mm bone plate in the neutral zone required less time, caused minimal periosteal stripping, and achieved good anatomical reduction. Champy et al. did not support the use of inter-maxillary fixation (IMF) techniques pre-operatively, intraoperatively, or postoperatively (6). However, some authors argue that employing IMF with arch bars and wires is always the most effective method to ensure occlusal integrity during fracture plating (21). Consequently, many surgeons tend to use some form of inter-maxillary fixation before the open reduction of mandibular fractures, with the placement of arch bars being the most commonly employed technique(6) (9). Additionally, arch bars or dental splints can also act as a tension band in the anterior region. We propose that the installation of a robust, stable lower arch bar could eliminate the necessity for two miniplates in the area of the parasymphysis. The effectiveness of circumferential loop wiring or the use of dental splints can serve as a substitute for split arch bars(22). Employing two miniplates may potentially heighten the risk of injury to the mental nerve, harm to tooth roots, increased likelihood of infection, and exposure to osteosynthesis implants. Rix et al. (23) adhered to Champy's principle but applied a modification specifically for parasymphysis fractures located near the mental nerve. Rather than placing two miniplates, they opted for a single plate above the foramen, supplemented by loop wiring that incorporated two or more teeth on both sides of the fracture line, resulting in satisfactory outcomes. In their in vitro three-dimensional analysis of loads at the fracture site, Tams et al. (24) observed significant torsional moments and 'negative bending' moments. Their results further support the use of a single, stable mini-plate in Group A patients to counteract the forces typically encountered in symphyseal and parasymphyseal fractures. The contemporary techniques for treating fractures enable a swift return to function and a significantly reduced healing time (8)(10). This approach has gained considerable acceptance for addressing various types of mandibular fractures, with numerous plating systems being developed to fulfill this

primary goal(12)(13)(14). The stability of these systems relies on the compression of the screw head that is inserted into the plate against the bone surface. Effective stabilization of a fracture is influenced by at least two factors: the degree of bone contact and the sturdiness of the fixation device. Ideally, the system should remain stable until the fracture heals completely(2)(3). However, there is a considerable risk of resorption occurring in the surrounding bone. Inaccurate adaptation and fixation of the plates may also lead to issues in reduction, potentially resulting in malocclusion and postoperative infection(25).

CONCLUSION

Mandibular fractures are more prevalent than any other type of fracture within the facial skeleton, occurring 2–3 times more frequently than other facial fractures. The management of mandibular fractures has progressed from closed methods such as maxillomandibular fixation (MMF), splints, and external fixation to the adoption of rigid internal fixation, including open reduction and internal fixation with miniplates and screws. In the 1970s and 1980s, two main treatment philosophies for plate and screw fixation of mandibular fractures emerged. The first is based on the AO/ASIF philosophy, while the second, popularized by Champy and colleagues, focuses on "the ideal lines of osteosynthesis" in the mandible, with the latter being the most widely followed approach. The prevailing ideology has been to place two miniplates for internal fixation. We found that using a single 2.5 mm (six holes with a gap) mini-plate offers sufficient stability for symphyseal and parasymphyseal fractures while resulting in a shorter operating time compared to the traditional two-plate fixation method. Although miniplates are typically positioned according to Champy's principle, fractures at the symphysis or parasymphysis can be treated effectively by employing a single, more robust miniplate placed in Champy's neutral zone, alongside arch bars or dental splints that serve as efficient tension bands to counteract forces, thereby reducing the risk of complications such as wound dehiscence and unintentional damage to tooth roots. Therefore, our study effectively demonstrated that a single miniplate was as effective as a two miniplate system in preserving stability in anterior mandibular fractures following open reduction and internal fixation. Conducting a study with a larger sample size could be beneficial in confirming the effectiveness of a single miniplate for managing symphysis and parasymphysis fractures.

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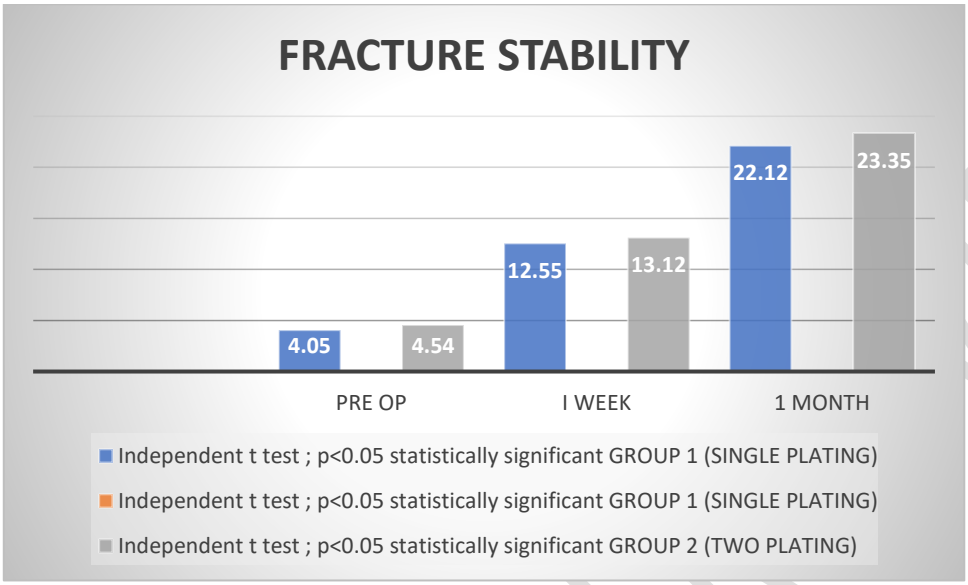

GRAPH 1: GRAPH DENOTING THE FRACTURE STABLITY NOTED AT PRE-OPERATIVE PERIOD, AT ONE WEEK AND AT ONE MONTH IN BOTH THE PLATING SYSTEMS

Bite force

	GROUP 1 (SINGLE PLATING)		**GROUP 2 (TWO PLATING)**		**T value**	**P value**
	Mean	SD	Mean	SD		
Pre-operative	4.05	0.83	4.54	1.45	-0.92	0.36
1 week	12.55	1.94	13.12	3.15	-0.48	0.63
1 month	22.12	2.44	23.35	2.32	-1.51	0.26
3 month	29.49	3.26	30.40	3.01	-0.64	0.52

Independent t test; p<0.05 statistically significant

TABLE 1: TABLE DENOTING THE BITE FORCE IN BOTH THE PLATING GROUPS, AT PRE-OPERATIVE, ONE WEEK, ONE MONTH AND 3 MONTHS FOLLOW UP PERIODS.

Root damage

	GROUP 1 (SINGLE PLATING)		**GROUP 2 (TWO PLATING)**		**Chi-square value**	**P value**
	Absent	Present	Absent	Present		
Pre-operative	9(90)	1(10)	10(100)	0	1.05	0.31
1 week	9(90)	1(10)	6(60)	4(40)	2.40	0.15
1 month	9(90)	1(10)	6(60)	4(40)	2.40	0.15
3 month	9(90)	1(10)	6(60)	4(40)	2.40	0.15

Chi square test; p<0.05 statistically significant

TABLE 2: TABLE DENOTING ROOT DAMAGE IN BOTH THE PLATING GROUPS, AT PRE-OPERATIVE, ONE WEEK, ONE MONTH AND 3 MONTHS FOLLOW UP PERIODS.

IMAGE 1: PICTURE DEPICTING USE OF BITE FORCE DEVICE FOR MEASURING THE BITE FORCE.

IMAGE 2: INTRA-OPERATIVE PICTURE DEPICTING USE OF SINGLE MINIPLATE WITH ARCH BARS IN-SITU.

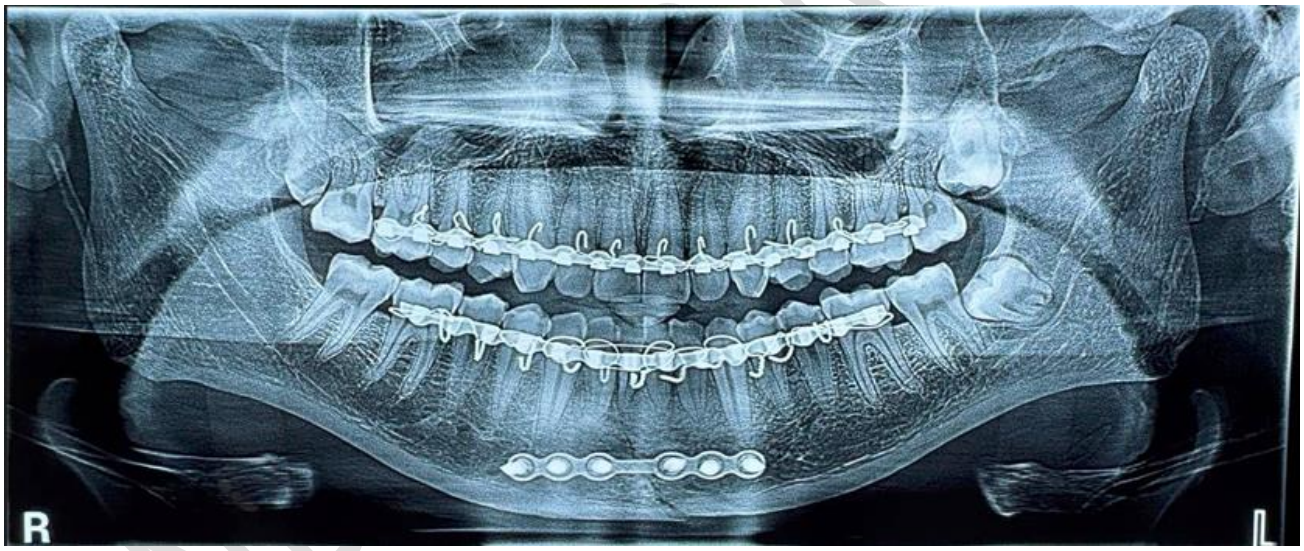

IMAGE 3: AN ORTHOPANTOMOGRAM DEPICTING THE SINGLE MINIPLATE PLACEMENT AT THE SYMPHYSIS REGION.

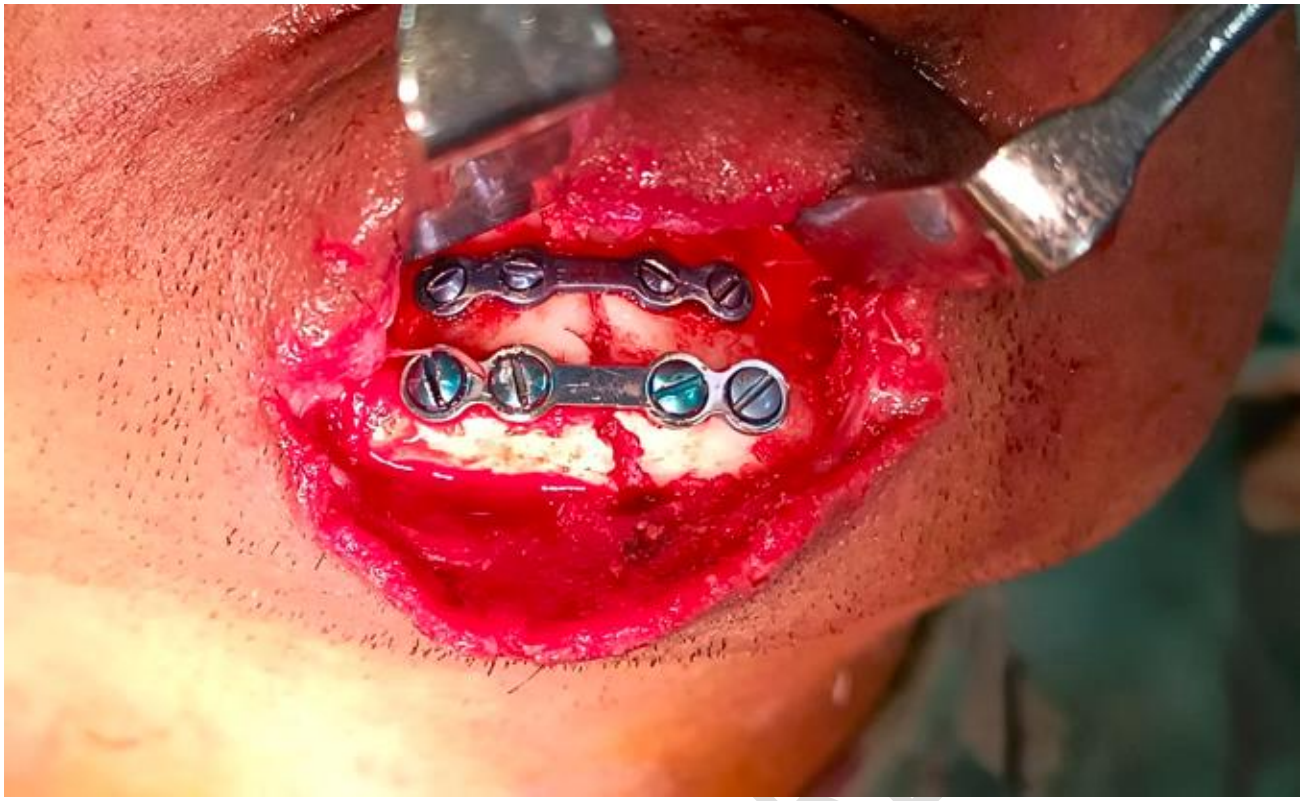

IMAGE 4: INTRA-OPERATIVE PICTURE DEPICTING USE OF TW0 MINIPLATES.

IMAGE 5: AN ORTHOPANTOMOGRAM DEPICTING TWO MINIPLATES PLACED AT THE SYMPHYSIS REGION.