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Miniplates vs. Microplates in Midface Fracture Fixation: A Randomized Controlled Study for Improved Maxillofacial Trauma Care

[1]Dr. Ritu Lalitbhai Upadhyay, [2]Dr. Amit Kumar Sharma, [3]Dr. Sunil Sharma, [4]Dr. Mridula Trehan, [5]Dr. Henil Parikh, [6]Dr. Shweta Dangi

1PG Resident Department of Oral and Maxillofacial Surgery, NIMS Dental College And Hospital, NIMS University, Rajasthan, India.

2Professor and Head**,** Department of Oral and Maxillofacial Surgery, NIMS Dental College and Hospital, NIMS University, Rajasthan, India.

3Senior Professor, Department of Oral and Maxillofacial Surgery, NIMS Dental College And Hospital, NIMS University, Rajasthan, India.

4Professor, Department of Orthodontics and dentofacial orthopedics, Mahatma Gandhi Dental College and Hospital, Jaipur, Rajasthan, India.

5PG Resident Department of Oral and Maxillofacial Surgery, NIMS Dental College And Hospital, NIMS University, Rajasthan, India.

6PG Resident Department of Public health dentistry, NIMS Dental College And Hospital, NIMS University, Rajasthan, India.

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KEYWORDS

Maxillofacial fractures, miniplates, microplates, open reduction internal fixation (ORIF), plate palpability, neurosensory deficit.

ABSTRACT:

Background:

Facial bone fractures are often associated with head and neck injuries and are primarily caused by road traffic accidents, falls, and assaults. Various implant devices, such as miniplates and microplates, are used for fracture fixation to restore anatomical form and function. This study compares treatment outcomes of maxillofacial fractures fixed with microplates versus miniplates.

Methods:

A total of 68 patients with midface fractures were randomly assigned to two groups: Group 1 (miniplates) and Group 2 (microplates). All patients underwent open reduction internal fixation (ORIF) under general anesthesia. The study assessed preoperative and postoperative occlusion stability, neurosensory deficits, complications, and plate palpability at different follow-up intervals.

Results:

Surgical duration was slightly longer in the miniplate group (92.94 ± 16.97 minutes) compared to the microplate group (86.47 ± 18.24 minutes), though the difference was not statistically significant ($p = 0.135$). Plate palpability was significantly higher in the miniplate group, with 17.6% of patients still reporting it at 12 weeks, whereas none in the microplate group experienced it. Occlusal stability showed no significant difference between groups, with similar rates of intermaxillary fixation (IMF) requirement. Neurosensory deficits were also comparable, with full recovery observed in both groups by 12 weeks.

Conclusion:

Both miniplates and microplates are effective for fracture fixation, but microplates offer superior aesthetic outcomes due to reduced palpability and minimal nerve disruption. They are particularly recommended for use in facial areas with thin soft tissue.

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Introduction

Head and neck injuries may be linked to facial bone fractures, with a wide range of injuries attributed to environmental, socioeconomic, cultural, and traffic-related factors.[1,2] Each year, almost 1.25 million people are killed in automobile accidents,[3-5] with 32% caused by crashes involving all terrain vehicles and motorcyclists, and 8% resulting in craniofacial injuries.[6,7] Traffic accidents are the most frequent cause, accompanied by falls, assaults, and sports-related mishaps. Fracture treatment involves using implant devices like plates and screws to stabilize and align fractured areas.[8] The objective is to restore anatomical form and function, requiring holding broken bone fragments in close proximity for uncomplicated healing.[9] Two philosophies have evolved regarding the use of plates for osteosynthesis: rigid plates fixed with bicortical screws and miniplates and monocortical screws.[10]

The microplate system, introduced by Luhr Microsystern, is transforming the surgical treatment of maxillofacial fractures (MFFs) by minimizing hardware and decreasing the bone plate ratio.[11-13] Microplates are less traumatic to soft tissue, resistant to corrosion, and provide better contouring and thermal conduction.[14-18] Microplates are used for internal fixation of MFFs due to their lower risk of iatrogenic damage and lower cost. Thus, the purpose of our research will be to examine the results of treatment after maxillofacial fractures are fixed using microplates versus miniplates.

Methodology

The study follows a randomized controlled trial (RCT) design with a parallel-group structure carried out in the department of oral and maxillofacial surgery at NIMS dental college and hospital, Jaipur from July 2023 to November 2024. For this study ethical approval was done by Institutional Ethics committee Nims University Rajasthan, Jaipur and proposal no. IEC/P-265/2023 on 17/06/2023. Study conducted on total of 68 patient who fulfilled the inclusion criteria. Preoperatively, all patients were informed about the surgical procedure, postoperative instructions, possible complications and written consent was taken. Every patient had a CT scan with 3D reconstruction before surgery. Under general anesthesia (GA), all patients had open reduction internal fixation (ORIF). Patients were selected irrespective of gender, caste, socioeconomic status and allocated to groups randomly. Patients included in the study were randomly allocated into two groups: Group 1 (miniplate fixation) and Group 2 (microplate fixation). Randomization was performed using a computer-generated random number table to ensure unbiased allocation. Each patient was assigned a unique identification number upon enrollment. These numbers were then entered into a computer software program, which randomly assigned patients to either group in a 1:1 ratio.

Criteria for selection of patients:

Inclusion Criteria

1.Patients between 18 years to 50 years

2. Both male and female patients

3. Individuals who have been diagnosed with a midface fracture based on clinical and radiological evidence

4.Dentate patient

5.ASA I and II

Exclusion Criteria

1. Immunocompromised patients.

2.ASA III and IV

3.Any undisplaced maxillary fracture

4.Patient age above 50 years.

5. Individuals who declined to sign the consent form

SURGICAL TECHNIQUE:

After intubation, Patients were painted and draped following standard protocol. The surgical sites were infiltrated with 2% lignocaine hydrochloride with 1:80,000 adrenaline. Incisions such as intraoral maxillary vestibular incision, extraoral infraorbital incision and lateral eyebrow incision were used. After exposing the fracture site, fracture segments were reduced either using intermaxillary fixation(IMF) with upper and lower Erich's arch bar/eyelet wiring or by manually approximating the visible fracture segments by holding the dentition in occlusion.

- Internal fixation was done in group A patients using a 1.5mm, 2.0mm miniplates (Figure 2), whereas in group B the fractures were fixed using a 0.4mm, 0.6mm microplate. (Figure 1)

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- After reduction and fixation of the fracture, Normal saline and povidone iodine were used to irrigate the region. The maxillomandibular fixation released in all the patients.
- After achieving adequate hemostasis the 3-0 Vicryl was used for deeper layers of the wound closure, and 4-0 mersilk / Ethicon for skin and mucosa.

Postoperative A-P, Lateral X-ray was taken for assessment. Analgesics, anti-inflammatory medications, and antibiotics were administered intravenously to all patients for a duration of five to seven days.The clinical parameters like Preoperative occlusion, Pre operative neurosensory deficit, Plate palpability , Fracture pattern , Post Operative Occlusion Stability, post operative neurosensory deficit , Other complications such as infection, wound dehiscence and fracture of plate were assessed on postoperative after 1 week, 4 week and 12 week. This study was double-blinded, concealing group assignments from participants, and outcome assessors. Result was analysed with SPSS version 27.

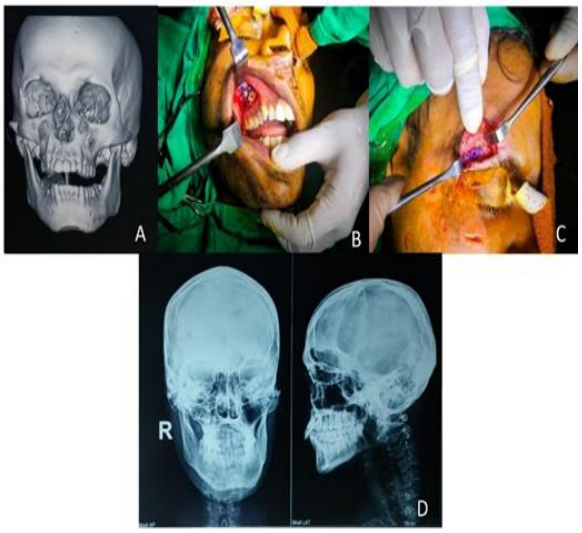

Fig. 1 A. Preoperative CT scan with 3D reconstruction showing multiple midface fracture, B. fixation at left zygomatico-maxillary buttress with 4 holes L-shaped microplate, C. fixation at right zygomatico-maxillary buttress with2 2 holes with gap microplate. D. fixation of fronto zygomatico suture with 2 hole with gap microplate E. post-op A-P, Lateral X-ray—microplate group

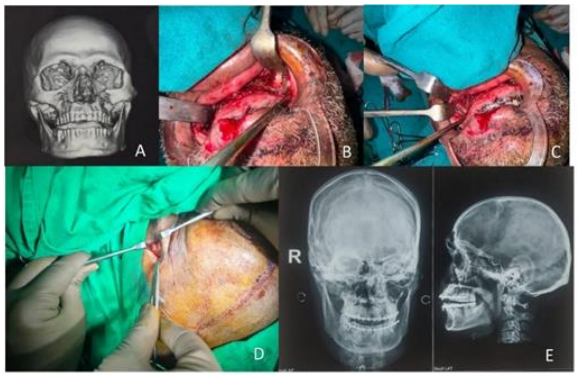

Fig. 2 A. Preoperative CT scan with 3D reconstruction showing multiple midface fractures, B. fixation at right zygomatico-maxillary buttress with2 3 holes with gap miniplate. C. fixation of fronto zygomatico suture with 3 hole miniplate, D. post-op A-P , Lateral X-ray—miniplate group

RESULTS

The study divided the subjects into two groups of 34. The mean age in Group 1 (Miniplate) was 34.47 years, and in Group 2 (Microplate), it was 32.97 years; There was no statistically noteworthy difference ($p = 0.871$) (Table 1). Both groups contained a large proportion of male participants: Group 1 had 32 males (94.1%) and 2 females (5.9%), whereas Group 2 had 31 males (91.2%) and 3 females (8.8%), with no significant difference in gender distribution ($p = 0.642$) (Table 1). Automobile accidents were the main cause of injury in both categories, accounting for 85.3% of cases in each, followed by self-fall occurrences (14.7%). The etiology was not significantly different between the groups ($p = 1.000$) (Table 1).

The surgical features and postoperative complications were comparable in the two groups. Group 1 (Miniplate) had a slightly longer mean operation length (92.94 ± 16.97 minutes) than Group 2 (Microplate) (86.47 ± 18.24 minutes), but There was no statistically noteworthy difference ($p = 0.135$) (Table 1). Regarding preoperative occlusion, 67.6% of participants in both groups had normal occlusion, whereas 32.4% had disordered occlusion, indicating no significant difference between the groups ($p = 1.000$) (Table 1). Furthermore, complications after surgery were reported in 91.2% of participants in both groups, with only 8.8% reporting no issues, showing no statistically significant difference in complication rates ($p = 1.000$). Furthermore, analysing

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fracture patterns and postoperative occlusion stability with intermaxillary fixation (IMF). In both groups, LeFort I fractures occurred in 5 patients (14.7%), whereas LeFort II in Group 1 in 2 (5.9%) patient and in group 2 in 3 (8.8%) patient, LeFort III in group 1 in 2 (5.9%) patient and in group 2 in 3 (8.8%) patient, ZMC fractures in group 1 in 18 (52.9%) patient and in group 2 in 15 (44.1%) patient, and combination fractures in group 1 in 7 (20.6%) patient and in group 2 in 8 (23.5%) patient, respectively (Table 1). Postoperatively, IMF was required in 6 (17.6%) patients in group 1 and in group 2, 7 (20.6%) patient required IMF postoperatively. The p-values for both fracture patterns (0.946) and IMF requirement (0.758) indicate There was no statistically noteworthy difference (Table 1).

The presence of neurosensory impairment or paraesthesia was observed in group1 and 2 at various time zones throughout the trial. Preoperatively, 11.8% of individuals in Group 1 (Miniplate) and 14.7% in Group 2 (Microplate) had neurosensory impairments, although the difference was not statistically significant ($p = 0.128$). At 1-week postoperative, 11.8% of patients in each group still had neurosensory impairments, whereas 88.2% were free of these symptoms, indicating no significant difference between the groups ($p = 1.000$). At the 4-week follow-up, neurosensory impairments were detected in 5.9% of Group 1 individuals and 8.8% of Group 2, with no statistically significant difference ($p = 0.642$). At the 12-week follow-up, no neurosensory impairments were found in either group, with all patients demonstrating complete sensory function ($p = 1.000$) (Table 2).

The frequency distribution of plate palpability for the miniplate and microplate groups at various time periods. All patients in both groups (100%) had perceptible plates at one week, and there was no discernible difference between the groups ($p = 1.00$). By four weeks, however, a significant difference had shown ($p = 0.01$), with patients in the miniplate group (17.6%) continuing to report palpability, whereas 0% of patients in the microplate group report palpable plates. This pattern persisted after 12 weeks, when 17.6% of the miniplate group and 0% of the microplate group, respectively, still had plate palpability ($p = 0.01$) (Table 2). These results reveal a difference in their long-term detectability since they show that palpability remained consistently high in the miniplate group, even while it declined over time in the microplate group.

		GROUP 1 (Miniplate) (n=34)	GROUP 2 (Microplate) (n=34)	p value
Mean Age (in years)		34.47	32.97	0.871 NS
Duration of surgery (in minutes) (Mean±SD)		92.94±16.972	86.47±18.238	0.135 NS
Gender	Male	32 (94.1%)	31 (91.2%)	0.642 NS
	Female	2 (5.9%)	3 (8.8%)	
Etiology	Road Traffic Accident	29 (85.3%)	29 (85.3%)	1.000 NS
	Self Fall	5 (14.7%)	5 (14.7%)	
PreOperative Occlusion	Normal	23 (67.6%)	23 (67.6%)	1.000 NS
	Deranged	11 (32.4%)	11 (32.4%)	
Other Complications	Absent	31 (91.2%)	31 (91.2%)	1.000 NS
	Present	3 (8.8%)	3 (8.8%)	
Fracture Pattern (Graph 1)	LeFort I	5 (14.7%)	5 (14.7%)	0.946 NS
	LeFort II	2 (5.9%)	3 (8.8%)	
	LeFort III	2 (5.9%)	3 (8.8%)	
	ZMC	18 (52.9%)	15 (44.1%)	
	Combination	7 (20.6%)	8 (23.5%)	
Post operative	IMF Required	6 (17.6%)	7 (20.6%)	

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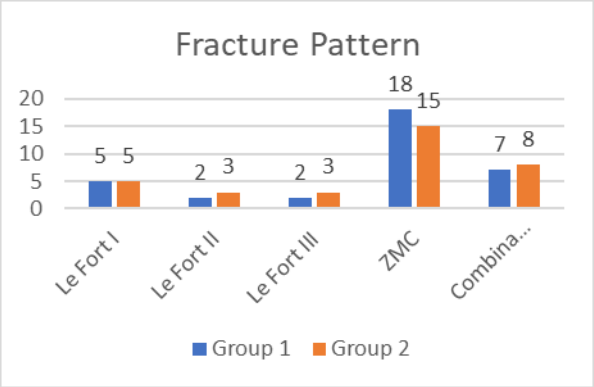
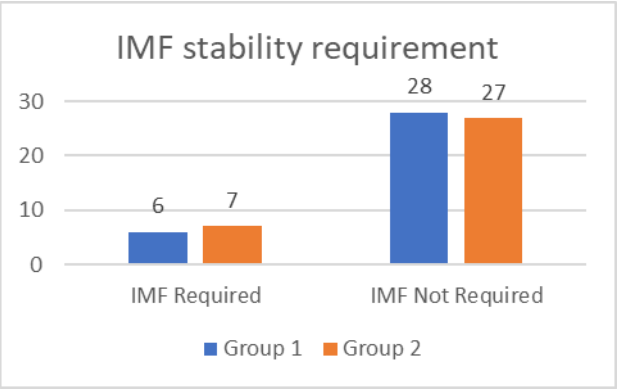
Occlusion Stability with IMF (Graph 2)	IMF Not Required	28 (82.4%)	27 (79.4%)	0.758 NS

Table 1 Demographic, characteristics of the surgery performed and other complications seen after surgery, type of fracture pattern and IMF stability requirement for both miniplate and microplate groups

Graph 1 depicts the type of fracture pattern in both the miniplate and microplate groups



Graph 2 depicts the IMF stability requirement in both the miniplate and microplate groups



Neurosensory Deficit / Paraesthesia (Graph 3)	GROUP 1 (Miniplate) (n=34)	GROUP 2 (Microplate) (n=34)	p value
Pre Operative	Present	4 (11.8%)	5 (14.7%)	0.128 NS
	Absent	30 (88.2%)	29 (85.3%)	
At 1 week	Present	4 (11.8%)	4 (11.8%)	1.00 NS
	Absent	30 (88.2%)	30 (88.2%)	
At 4 week	Present	2 (5.9%)	3 (8.8%)	0.642 NS
	Absent	32 (94.1%)	31(91.2%)	
At 12 week	Present	0 (0%)	0 (0%)	1.00 NS
	Absent	34 (100%)	34 (100%)	
Plate Palapability (Graph 4) At 1 week	Absent	34 (100%)	34 (100%)	1.00 NS
	Present	0 (0%)	0 (0%)	
At 4 weeks	Absent	28 (82.4%)	34 (100%)	0.01 *
	Present	6 (17.6%)	0 (0%)	
At 12 weeks	Absent	28 (82.4%)	34 (100%)	0.01 *
	Present	6 (17.6%)	0 (0%)	
Plate Palpability (Time 1- Time 2) (Cochrane Q test) At 4 week- At 1 week		0.003*	Not able to calculate as all the values are same i.e in all the cases the	
At 12 weeks - At 1 week		0.003*		

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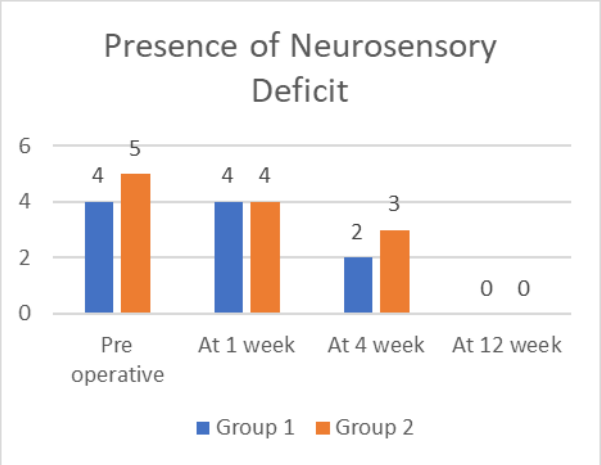
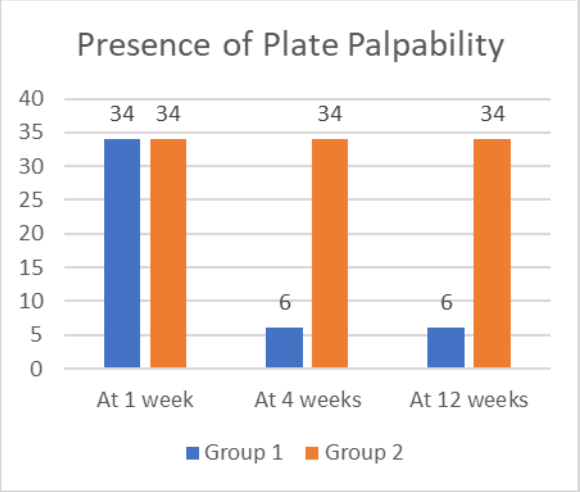
At 4 weeks – At 12 weeks	1.000 NS	plate is not palpable	

* p value is significant

Table 2 Neurosensory deficit/paraesthesia, plate palpability and its comparison at various points of time for both miniplate and microplate groups



Graph 3 depicts the presence of neurosensory deficit in both the miniplate and microplate groups



Graph 4 depicts the presence of plate palpability in both the miniplate and microplate groups

Discussion

Our eyes are focused on the midface. In terms of anatomy, the midface lies between the occlusal plane inferiorly and the cranium superiorly [19]. Midface fractures have the potential to be disfiguring. As a result, treating midface fractures becomes essential and difficult for oral and maxillofacial surgeons.

Two groups of 68 patients were randomly assigned to the current investigation and were treated for midface fracture using miniplate (Group 1) and microplate (Group 2).

The age of the patients ranges from 18 to 50 years in all groups. The average age of groups 1 and 2 was 34.47 and 32.97 years, respectively. There was no significant difference of age between the study groups, means the samples of all 2 groups are similar at the base line.

Out of total 68 patients, 32 (94.1%) patients were male whereas only 2(5.9%) patient was female in group 1 whereas 31 (91.2%) patients were male whereas only 3(8.8%) patient was female in group 2. This male predominance was also reported by previous study in their retrospective analysis of facial fractures [20].

The cause of the road traffic collision was midface fracture in 29 cases (85.3%), in group 1 and 2 whereas self-fall accounted for midface fractures in 5(14.7%) patients in group 1 and 2**.** The fast-paced lifestyle, the growing number of cars, and the lax enforcement of traffic safety regulations are all factors contributing to the increased frequency of traffic accidents.

Pre op occlusion was normal for 23(67.6%) patient in both group where as deranged in 11(32.4%) patient in both groups. In our study, we observed other complication like infection present in 3(8.8%) patient in both groups where as absent in 31(91.2%). Sadove and Eppley,[21] Gupta et.al.,[22] Xie et.al.,[23] Huston and Stassen; [24] Abdullah, Ozkan and Cil, and Anand et.al.[25] found that the groups they examined for fractures treated with microplates did not significantly differ in terms of plate exposure or infection.

More often, majority of the midface fractures occur in combination and rarely isolated Le Fort fractures are seen. We observed lefort I fracture in 5(14.7%) patient in both groups , Lefort II fracture in group 1 in 2(5.9%) patient and 3(8.8%) patient in group 2 , lefort III fracture in 2(5.9%) patient in group 1 and in group 2 3(8.8%) patient , ZMC fracture in group 1 in 18(52.9%) patient and in group 2 15(44.1%) patient , combination of fracture seen in 7(20.6%) in group 1 and in group 2

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8(23.5%) patient. These results ran counter to the research of P Satish et al. [26] and RS Patil et al. [27].

Occlusion is indicator of postreduction stability [19]. In our study we observed that IMF required in group 1 in 6(17.6%) patient, where as in group 2 IMF needed in 7(20.6%) patient.

A common postoperative finding is paresthesia in the infraorbital region, which is caused by compression of the infraorbital nerve. In our study, Preoperatively, 11.8% of individuals in Group 1 (Miniplate) and 14.7% in Group 2 (Microplate) had neurosensory impairments. which led to the administration of vitamin B6 and B12 supplements. Within three months, the paresthesia progressively went away. At 1-week postoperative, 11.8% of patients in each group still had neurosensory impairments, whereas 88.2% were free of these symptoms. At the 4-week follow-up, neurosensory impairments were detected in 5.9% of Group 1 individuals and 8.8% of Group 2. These findings were comparable to those of Sridhar and colleagues [28]. Due to their reduced size, microplates can be placed through smaller incisions, resulting in less compression on the surrounding soft tissues and a decreased chance of temporary nerve damage.

In our research, we observed that 6(17.6%) patient complaints of plate palpability in miniplate while no patient complaint about plate palpability with microplate. Compared to fractures treated with miniplate, we found that maxillary fractures treated with microplate had significantly better palpability. The use of microplates reduces palpability, according to the findings of Sadove and Eppley Lee et al. and Schortinghuis et al., because to their close adaptation at the fracture site. According to Xie et al. and Mccleod (1992), microplates facilitate the making of small incisions, hence reducing the danger of nerve damage.

In the area of facial aesthetics, plate palpability is a significant concern. Campbell and Lin estimate that the plate palpability with miniplates is between 0.5 and 3% [29].

When fixing ZMC fractures, Ozkan et al. [30] advise using a combination of miniplates and microplates, with a miniplate in the zygomatico-maxillary buttress region and a microplate at the fronto-zygomatic suture and infraorbital region (if necessary). The infraorbital rim, nasomaxillary process, fronto-nasal, and fronto-zygomatic suture region are among the facial regions where the soft tissue layering over the fracture is thin and delicate. Based on our experience treating midface fractures, microplates are less palpable and more aesthetically pleasing than miniplates in these areas.

Limitations:

- The sample size was relatively small, limiting the generalizability of the findings.
- There was a significant gender imbalance, with a predominance of male patients.
- Follow-up was short-term, which may not capture long-term outcomes or complications.
- The study was likely conducted at a single center, reducing external validity.
- Functional outcomes and patient-reported measures were not extensively evaluated.
- Inclusion of varied fracture types may have introduced confounding variables.
- Economic analysis comparing the cost-effectiveness of miniplates and microplates was not conducted.

Conclusion

This study evaluates the effectiveness of microplates versus miniplates in the management of midface fractures. Both treatment modalities were assessed on different parameters. Overall, the findings of our study suggest that microplates are preferred over miniplates, especially in areas with thin soft tissue, due to their better aesthetic outcomes, reduced palpability, and minimal nerve disruption. Both systems, however, demonstrate similar efficacy in fracture fixation, with a slightly more favorable outcome for microplates in terms of aesthetics and complication rates. Therefore, microplates may be the ideal choice for treating midface fractures, particularly in regions where minimizing visible hardware and preserving nerve function are crucial.

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- **No conflict of interest**

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