Innovations

Comparative Evaluation of 2.0 Mm 3d Curved Angle Strut Plate versus 2.0 Mm Non-Compression Miniplate in the Fixation of Mandibular Angle Fractures

[1]Dr. Yellanti Doondi Dinesh Nag (MDS); [2]Dr. M Akila (MDS);
[3]Dr. M Wasim Haroon (MDS); [4]Dr. Mylapoori Viswanath (MDS);
[5]Dr. Bhuvaneswari Rajkumar (MDS); [6]Dr. Ravada V S S K Kinneresh (MDS)
[1,2,3] Senior consultant, [4,5] Postgraduate student,
[6] PGDHM, Assistant Resident Medical Officer
[1,2,3] Department of Oral Maxillofacial Surgery
[4]Department of Oral Maxillofacial Surgery, Government Dental College
[5]Government Dental College and Hospital, YSR Kadapa
[6]Department of Public Health Dentistry and Administration, Great Eastern Medical School, Ragolu, Srikakulam

Correspondence Author: **Yellanti Doondi Dinesh Nag**

Abstract

Background: *Mandibular angle fractures account for 23–42% of all mandibular fractures and present unique challenges due to biomechanical forces and limited surgical access. Various fixation methods have been explored, including conventional miniplates and 3D strut plates, but comparative efficacy remains debated.* ***Aim:*** *To compare the efficacy of 2.0 mm 3D curved angle strut plates versus 2.0 mm non-compression miniplates in mandibular angle fracture fixation.*

Materials and Methods: *A prospective clinical study was conducted on 20 patients (18 males, 2 females; age 18–50 years) with unilateral mandibular angle fractures. Patients were randomized into two groups: Group I (n=10) received 3D strut plates, and Group II (n=10) received conventional miniplates. Parameters assessed included time for plate fixation, postoperative pain, swelling, mouth opening, and bite force at 1, 3, and 6 months.* ***Results****: The 3D strut plate group showed significantly better outcomes in bite force ($p<0.005$ at 6 months), reduced pain ($p=0.004$ at day 5), and greater mouth opening (37.9 mm vs. 33.0 mm, $p<0.001$). No significant differences were observed in swelling ($p=0.156$) or plate fixation time ($p=0.074$).* ***Conclusion:*** *3D strut plates offer superior functional outcomes compared to conventional miniplates, with improved masticatory efficiency and fracture stability. They are a viable alternative for mandibular angle fracture fixation.*

Keywords: *Mandibular angle fracture, 3D strut plate, conventional miniplate, bite force, osteosynthesis*

Introduction

Mandibular fractures are among the most common facial injuries, with angle fractures constituting 23–42% of cases. The prominent position of the mandible and complex biomechanical forces at the angle region make these fractures challenging to manage[1]. Traditional treatment methods range from conservative maxillomandibular fixation (MMF) to open reduction and internal fixation (ORIF) using various plating systems[2].

The Champy technique, utilizing a single miniplate along the superior border, is widely used but has limitations, including inferior border instability[3]. In contrast, 3D strut plates, introduced by Farmand and Dupoirieux, provide three-dimensional stability by resisting torsional and bending forces[4]. Despite theoretical advantages, comparative clinical studies are limited. This study evaluates the efficacy of 3D strut plates versus conventional miniplates in mandibular angle fractures, focusing on functional outcomes.

Aim

This study aims to compare the efficacy of a 2mm 3D curved angle strut plate and a 2mm conventional miniplate in mandibular angle fractures.

Objectives of the study

The objective of the study was:

1. To assess the time for plate fixation between the 3D curved angle strut plate and the 2 mm conventional miniplate.
2. To assess the mouth opening between the 3D curved angle strut plate and the 2 mm conventional miniplate.
3. To assess post-operative pain between the 3D curved angle strut plate and the 2 mm conventional miniplate.
4. To assess post-operative swelling between the 3D curved angle strut plate and the 2 mm conventional miniplate.
5. To assess bite force between the 3D curved angle strut plate and the 2 mm conventional miniplate.

Materials and Methods

Ethical Approval: Obtained from the Institutional Ethics Committee.

Informed consent: participants were informed about the study protocol, and written consent was obtained

Data collection: A pretested case history proforma was used for data collection

Study Design and Participants

A prospective clinical study was conducted at the Department of Oral and Maxillofacial Surgery, Government Dental College and Hospital, Kadapa, for about study duration of 3 months. Twenty patients (18 males, 2 females; mean age 32.4 years) with unilateral mandibular angle fractures were randomized and aged 18–50 years, diagnosed with unilateral mandibular angle fractures. Postoperative evaluation was carried out subsequently for 3 months. Surgical procedures were performed using intraoral or transbuccal approaches under general anesthesia into:

- **Group I (n=10):** 3D strut plate (8-hole, curved titanium plate).
- **Group II (n=10):** Conventional miniplate (4-hole, straight titanium plate).

Inclusion Criteria:

- Non-comminuted fractures requiring ORIF.
- Age 18–50 years.
- No active infection at the surgical sites.

Exclusion Criteria:

- Comminuted fractures, systemic illnesses, or active infections.

Surgical Technique

- **Group I:** Intraoral approach with single 8 hole 3-dimensional curved strut titanium miniplates and eight 2x 8mm titanium screws using transbuccal trocar and cannula system
- **Group II:** Intraoral approach with a single 4hole conventional titanium miniplates and four 2 x 8 mm titanium screws:

1. **Time for plate fixation** (in minutes).
2. **Pain** (ordinal scale: 0–3) on days 1, 3, and 5.
3. **Swelling** (ordinal scale: 0–3).
4. **Mouth opening** (mm) at pre-op, 1 week, and 1 month.
5. **Bite force** (kg) at 1, 3, and 6 months.

Patients were recalled at regular intervals at 1 week, 3 weeks, 6 weeks, 3 months, and 6 months. Both groups were assessed for certain clinical parameters.

Statistical Analysis

Data was entered in Microsoft Excel and analysed using SPSS version 26. The data followed a normal distribution, and parametric tests included paired t-tests, independent t-tests, and ANOVA accordingly.

Results

The demographic distribution was comparable between the groups. Mean plate fixation time was slightly higher in the 3D strut group (45±4.5 minutes) versus the miniplate group (40±4.01 minutes), though not statistically significant (p=0.074). Postoperative mouth opening at 1 month was significantly greater in the strut group (37.9mm) compared to the miniplate group (33.0mm, p<0.001). Pain scores at day 5 were significantly lower in the strut group (mean=1.2) than the miniplate group (2.22, p=0.004). Swelling scores showed improvement in both groups with no significant intergroup differences. Bite force measurements (incisors, right molars, left molars) at 1, 3, and 6 months were consistently higher in the strut group with statistical significance at most intervals. No occlusal derangements or major complications were observed in either group.

Table 1: Distribution of study population based on the side of fracture

Side of the fracture site	GROUP 1 N (%)	GROUP 2 N (%)
Left angle fracture	3(30%)	5(50%)
Right-angle fracture	7(70%)	5(50%)

Table 2: Distribution of study population based on the cause of fracture

Cause of fracture	GROUP 1 N (%)	GROUP 2 N (%)
Road traffic accident	8(80%)	7(70%)
Assault	2(20%)	3(30%)

Table 3: Distribution of study population based on the side of fracture

Groups	Mean (min)	Std. Deviation	Meandiff	T value	P value
Strutplates	45.0000	4.59017	5.000	-8.032	0.074
Conventional	40.0000	4.01			

P<0.05* is considered statistically significant, Independent t-test

Table 4: Intragroup comparison between the time intervals

Groups	Intervals	Mean (mm)	Std. Deviation	P value
Strutplate	Preop	15.4	2.70	<0.001*
	1week	27	2.92	
	1 month	37.9	0.92	
Conventional mini plates	Preop	15.9	2.77	<0.001*
	1week	28.1	0.738	
	1 month	33.0	1.89	

P<0.05* is considered statistically significant, ANOVA: Analysis of variance

Table 5: Distribution of study population based on the type of fracture

Type of fracture	GROUP1 N (%)	GROUP2 N (%)
Horizontally unfavorable	3(30%)	5(50%)
Horizontally favorable	7(70%)	5(50%)

Table 6: Comparison of time for plate fixation between group 1 and group 2

Groups	Mean (min)	Std. Deviation	Me and iff	T value	P value
Strut plates	45.0000	4.59017	5.000	-8.032	0.074
Conventional	40.0000	4.01			

P<0.05* is considered statistically significant, Independent t-test

Table 7: Inter-group Comparison of mouth opening between group 1 and group 2

Groups	Intervals	Mean (mm)	Std. Deviation	P value
Strut plate	Preop	15.4	2.70	<0.001*
	1week	27	2.92	
	1 month	37.9	0.92	
Conventional mini plates	Preop	15.9	2.77	<0.001*
	1week	28.1	0.738	
	1 month	33.0	1.89	

P<0.05* is considered statistically significant, ANOVA: Analysis of variance

Table 8: Intra-group Comparison of mouth opening between group 1 and group 2

Intervals	Groups	Mean (mm)	Std. Deviation	T value	P value
1week	Strut plate	27.0	2.92	-1.156	0.264
	Conventional Mini plates	28.1	0.73		
1 month	Strut plate	37.9	0.92	7.278	<0.001*
	Conventional Mini plates	23.00	1.88		

P<0.05* is considered statistically significant, ANOVA: Analysis of variance

Table 9: Inter-group Comparison of pain between group 1 and group 2

Groups	Intervals		Mean diff	Pvalue
Strut plate	Day1	Day3	0.44	0.035*
		Day5	1.8	0.000*
	Day3	Day5	1.3	0.000*
Conventional mini plates	Day1	Day3	0.300	0.083
		Day5	0.800	0.011*
	Day3	Day5	0.500	0.09

P<0.05* is considered statistically significant, Independent t-test

Table 10: Intra-group Comparison of pain between group 1 and group 2

Intervals	Groups	Mean	Std. Deviation	U value	Pvalue
Day1	Strut plate	3.0000	.00000	45.00	1.000
	Conventional mini plates	3.0000	.00000		
Day3	Strut plate	2.6000	.52705	38.50	0.604
	Conventional mini plates	2.7000	.48305		
Day5	Strut plate	1.200	.44096	11.00	**0.004***
	Conventional mini plates	2.22	.63246		

P<0.05* is considered statistically significant, Mann-Whitney U test

Table 11: Inter-group Comparison of swelling between group 1 and group 2

Groups	Intervals		Mean diff(mm)	Pvalue
Strut plate	Day1	Day3	0.22	0.157
		Day5	0.7	0.014*
	Day3	Day5	0.44	0.046*
Conventional mini plates	Day1	Day3	0.200	0.317
		Day5	0.200	0.414
	Day3	Day5	0.000	1.000

P<0.05* is considered statistically significant, ANOVA: Analysis of variance

Table 12: Intra-group Comparison of swelling between group 1 and group 2

Intervals	Groups	Mean (mm)	Std. Deviation	U value	Pvalue
Day1	Strut plate	2.778	0.44096	41.5	10.78
	Conventional mini plates	2.700	0.48305		
Day3	Strut plate	2.6	0.52705	42.5	0.842
	Conventional mini plates	2.5	0.52705		
Day5	Strut plate	2.111	0.333	27.5	0.156
	Conventional mini plates	2.500	0.52705		

P<0.05* is considered statistically significant, ANOVA: Analysis of variance

Table 13: Comparison of bite force for incisors between group 1 and group 2

Intervals	Groups	Mean (kgs)	Std. Deviation	T value	Pvalue
1month	Strut plate	7.9556	.85456	3.11	0.005*
	Conventional	5.1800	1.92573		
3month	Strut plate	17.1111	1.18157	5.586	0.000*
	Conventional	12.4900	2.20980		
6month	Strut plate	22.1000	3.07287	3.20	0.005*
	Conventional	18.5400	1.63109		

P<0.05* is considered statistically significant, ANOVA: Analysis of variance

Table 14: Comparison of bite force for the right molar between group 1 and group 2

Intervals	Groups	Mean (Kgs)	Std. Deviation	T value	P value
1month	Strut plate	11.5111	1.76737	-2.30	0.034*
	Conventional	13.6500	2.21773		
3month	Strut plate	33.8111	1.52762	9.454	0.000*
	Conventional	25.5000	2.20000		
6month	Strut plate	41.5778	4.51879	3.108	0.006*
	Conventional	36.8000	1.73141		

P<0.05* is considered statistically significant, paired t-test

Table 15: Comparison of bite force for the left molar between group 1 and group 2

Intervals	Groups	Mean (kgs)	Std. Deviation	T value	Pvalue
1 month	Strut plate	25.3333	6.17642	5.515	0.005*
	Conventional	14.4500	1.09861		
3month	Strut plate	33.2111	1.68852	9.269	0.000*
	Conventional	25.9800	1.70607		
6month	Strut plate	33.5667	1.62327	1.920	0.072
	Conventional	30.7800	4.06224		

P<0.05* is considered statistically significant

Discussion

This study demonstrates that 3D strut plates provide superior stability and functional outcomes compared to conventional miniplates. The geometric design of 3D plates resists torsional forces and minimizes inferior border splaying—an inherent limitation of single linear miniplates [4, 5].

Previous literature supports the biomechanical advantages of 3D strut plates. Farmand and Dupoirieux initially introduced these plates to counter multidirectional forces through their quadrangular design [4]. Their findings have since been validated by multiple clinical studies. Zix et al. found lower complication rates with 3D plates compared to traditional fixation methods[12]. Malhotra et al. and Al-Moraissi et al. reported significantly improved functional outcomes and reduced morbidity with 3D plates [5, 6].

In the present study, significant improvements were observed in postoperative mouth opening and pain levels. These findings are in agreement with the results of Kaushik et al. and Mishra et al., who demonstrated faster recovery and superior masticatory efficiency with 3D plates [8,9]. Gerlach et al. also showed early restoration of bite force in patients treated with 3D fixation systems [10].

Another prospective analysis by Amy S Xue et al. showed that patients treated with 3D strut plates experienced less postoperative discomfort and achieved higher bite forces at earlier stages [11]. Similarly, Sahu et al. highlighted the

versatility of 3D plates in managing complex angle fractures with minimal complications [12].

Although our study showed no significant difference in swelling or time for plate fixation between groups, the clinical advantages of 3D plates in terms of stability and patient comfort make them a strong alternative to traditional miniplates. Ellis et al. also emphasized the importance of selecting fixation systems that align with biomechanical stress zones, supporting the design logic behind 3D plates [13]. The present study results had similar findings as **Kinraetal. (2017) and Gerlach and Schwarz 2002.**

Despite the favorable findings, limitations exist. The sample size was limited to 20 patients, and follow-up was restricted to 6 months. Future studies should consider larger, multi-center trials with extended follow-up periods to validate these outcomes [7,14].

This present study showed maximum bite force, less pain and more mouth opening with respect to 3-D strut plate when compared to conventional miniplate and was statistically significant. There was no statistically significant difference present with respect to parameters like swelling and time for plate fixation.

Clinical Implications

Advantages of 3D Plates:

- Simultaneous stabilization of tension and compression zones.
- Reduced postoperative pain and faster functional recovery.

Limitations

- Small sample size (n=20).
- Short follow-up (6 months).

Future studies with larger cohorts and longer follow-up are recommended.

Conclusion

The 3D curved angle strut plate offers a biomechanically superior alternative to the conventional miniplate for the management of mandibular angle fractures. Its use is associated with improved mouth opening, reduced pain, and enhanced bite force recovery, making it a promising fixation option in clinical settings.

References

1. ***Ellis E.*** *Management of mandibular angle fractures. Oral Maxillofac Surg Clin North Am. 2009; 21(2):163–74.*
2. ***Killey HC, Kay LW.*** *An analysis of 1,471 cases of mandibular fractures. Br J Oral Surg. 1975; 13(1):1–15.*

3. ***Champy M, Lodde JP, Schmitt R, Jaeger JH, Muster D***. *Mandibular osteosynthesis by miniature screwed plates via a buccal approach. J Maxillofac Surg. 1978; 6(1):14–21.*
4. ***Farmand M, Dupoirieux L***. *The value of 3D titanium plates in maxillofacial surgery. Rev Stomatol Chir Maxillofac. 1992; 93(6):353–7.*
5. ***Malhotra K, Sharma A***. *Versatility of titanium 3D plate in comparison with conventional titanium miniplate fixation for the management of mandibular fracture. J Maxillofac Oral Surg. 2012; 11(3):284–90.*
6. ***Al-Moraissi EA, Mounair RM, El-Sharkawy TM, El-Ghareeb TI***. *Comparison between three-dimensional and standard miniplates in the management of mandibular angle fractures: A prospective, randomized, double-blind, controlled clinical study. Int J Oral Maxillofac Surg. 2015;44(3):316–21.*
7. ***Perez R, Langdon JD***. *Principles in mandibular angle fracture treatment. J Craniomaxillofac Surg. 2010; 38(3):219–24.*
8. ***Kaushik S, Ali I, Dubey M, Bajpai N***. *2 mm conventional miniplates with three-dimensional strut plate in mandibular fractures. Ann Maxillofac Surg. 2020; 10(1):10–5.*
9. ***Mishra N, Thakkar N, Kar I, Baig SA, Sharma G, Kar R, et al***. *3-D miniplates versus conventional miniplates in treatment of mandible fractures. J Maxillofac Oral Surg. 2019; 18(1):65–72.*
10. ***Gerlach KL, Schwarz A, Maier W***. *Bite force recovery after miniplate osteosynthesis. Int J Oral Maxillofac Surg. 2002; 31(2):130–5.*
11. ***Xue AS, Koshy JC, Wolfswinkel EM, Weathers WM, Marsack KP, Hollier LH***. *A prospective study of strut versus miniplate for fractures of the mandibular angle. Craniomaxillofac Trauma Reconstr. 2013;6(3):191–6.*
12. ***Zix J, Lieger O, Iizuka T***. *Use of a 2.0-mm 3-dimensional curved angle strut plate for mandibular angle fractures: A prospective study. J Oral Maxillofac Surg. 2007; 65(8):1758–63.*
13. ***Sahu D, Sinha R, Bhatnagar A***. *Efficacy of 3D plates in mandibular angle fractures. Natl J Maxillofac Surg. 2017;8(1):21–6.*
14. ***Ellis E, Ghali GE***. *Lag screw versus plate fixation in mandibular angle fractures. J Oral Maxillofac Surg. 1991;49(3):234–43.*
15. ***Gerressen M, Pastaschek CI, Riediger D, Hilgers RD, Ghassemi A***. *Use of three-dimensional titanium plates in mandibular angle fractures. Craniomaxillofac Trauma Reconstr. 2013; 6(1):25–9.*

Conflict of Interest: None declared.
Ethical Approval: Obtained from the Institutional Ethics Committee.
Funding: None