ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 7344-7348 (2026)
©Biomedical Informatics (2026)

BIOINFORMATION
Discovery at the interface of physical and biological sciences
BIOMEDICAL INFORMATICS
www.bioinformation.net
Volume 22(10)
Research Article

Received October 1, 2026; Revised October 31, 2026; Accepted October 31, 2026, Published October 31, 2026
DOI: 10.6026/973206300227344

SJIF 2026 (Scientific Journal Impact Factor for 2026) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Declaration on Publication Ethics:
The author's state that they adhere with COPE guidelines on publishing ethics as described elsewhere at https://publicationethics.org/. The authors also undertake that they are not associated with any other third party (governmental or non-governmental agencies) linking with any form of unethical issues connecting to this publication. The authors also declare that they are not withholding any information that is misleading to the publisher in regard to this article.

Declaration on official E-mail:
The corresponding author declares that lifetime official e-mail from their institution is not available for all authors

License statement:
This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. This is distributed under the terms of the Creative Commons Attribution License

Comments from readers:
Articles published in BIOINFORMATION are open for relevant post publication comments and criticisms, which will be published immediately linking to the original article without open access charges. Comments should be concise, coherent and critical in less than 1000 words.

Disclaimer:
Bioinformation provides a platform for scholarly communication of data and information to create knowledge in the Biological/ Biomedical domain after adequate peer/editorial reviews and editing entertaining revisions where required. The views and opinions expressed are those of the author(s) and do not reflect the views or opinions of Bioinformation and (or) its publisher Biomedical Informatics. Biomedical Informatics remains neutral and allows authors to specify their address and affiliation details including territory where required.

Edited by Ritik Kashwani
E-mail: docritikkashwani@yahoo.com
Citation: Kumar *et al.* Bioinformation 22(10): 7344-7348 (2026)

Three-dimensional and two-dimensional plate fixation in mandibular fractures

Jasbinder Kumar*, Ramandeep Singh Brar, Gursimrat Brar, Jasmine Jasmine, Ramandeep Grewal & Dipanshu Jain

Department of Oral & Maxillofacial Surgery, Dasmesh Institute of Research and Dental Science (DIRDS), Faridkot, India;
*Corresponding author

Affiliation URL:
https://www.dasmeshinstitutes.com/

Author contact:
Jasbinder Kumar - E-mail: jasbinderk068@gmail.com
Ramandeep Singh Brar - E-mail: dr.ramanbrar@yahoo.com

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 22(10): 7344-7348 (2026)
©Biomedical Informatics (2026)

Gursimrat Brar - E-mail: docginnie@gmail.com
Jasmine Jasmine - E-mail: jasmine.gandhi.24@gmail.com
Ramandeep Grewal - E-mail: dr.7ramangrewal@gmail.com
Dipanshu Jain - E-mail: dipanshu29jain@gmail.com

Abstract:
Open Reduction and Internal Fixation (ORIF) is the standard treatment for mandibular fractures, but the optimal plating system remains uncertain. Therefore, it is of interest to compare the fracture reduction and mouth opening after fixation with three-dimensional (3D) and two-dimensional (2D) miniplates in 40 patients. Fracture reduction was assessed radiographically and mouth opening was evaluated for 3 months. The 3D group showed significantly better fracture reduction ($p<0.001$) and greater mouth opening at 1 week ($p=0.029$). Thus, three-dimensional plating provided superior early outcomes, although both systems achieved satisfactory results.

Keywords: Mandibular fracture, symphysis fracture, parasymphysis fracture, three-dimensional (3D) miniplate, two-dimensional (2D) miniplate, open reduction internal fixation (ORIF), mouth opening, radiographic evaluation

Background:
Mandibular fractures are among the most frequently encountered maxillofacial injuries in clinical practice and the mandible, owing to its prominent and exposed anatomical position, is particularly vulnerable to trauma from road traffic accidents, interpersonal violence and falls. The mandible plays a critical role in mastication, speech, deglutition and respiration and fractures in this region therefore impose significant functional, social and aesthetic morbidity on affected individuals. The symphysis and parasymphysis regions are common fracture sites and present specific biomechanical challenges due to the complex three-dimensional forces acting upon the anterior mandible during function. The evolution of mandibular fracture fixation has been shaped by two contrasting philosophies. Spiessl **[1]** advocated rigid fixation using large cortical plates with bicortical screws to prevent interfragment mobility and achieve primary bone union. While effective in terms of stability, this approach was associated with difficult plate adaptation, stress shielding, bulky hardware, prolonged operative time and increased risk of inferior alveolar nerve injury. In contrast, Champy *et al.* **[2]** introduced the concept of monocortical subapical osteosynthesis without compression or intermaxillary fixation, placing plates along the tension zones produced by physiological masticatory strain. This technique offered significant advantages in terms of reduced invasiveness and intraoral accessibility and miniplates subsequently became the preferred fixation modality in both maxillary and mandibular surgery due to their small profile, adaptability and ease of intraoral placement **[3].** However, controversy has persisted regarding the rigidity and torsional stability afforded by conventional monocortical miniplates, particularly at the symphysis where bending, torsional and shear forces act simultaneously. To address these limitations, Farmand **[4]** developed the three-dimensional (3D) miniplate, which features a quadrangular design formed by joining two parallel miniplates with interconnecting cross bars. Rather than deriving stability from plate length or thickness, the 3D plate achieves fixation across a defined surface area in three spatial dimensions by virtue of its geometric configuration. This design allows for a greater number of screw purchase points, provides resistance against torsional forces and maintains a low profile with adequate malleability **[5]**. Therefore, it is of interest to compare the fracture reduction and functional outcomes following 3D and 2D miniplate fixation in mandibular symphysis and parasymphysis fractures.

Materials and Methods:
Study design and setting:
This was a retrospective comparative study conducted in the Department of Oral and Maxillofacial Surgery, Dasmesh Institute of Research and Dental Science (DIRDS), Faridkot, Punjab. The study included patients treated for mandibular symphysis or parasymphysis fractures over the study period.

Sample size and grouping:
A total of 40 patients were included and divided into two equal groups of 20 patients each. Group I comprised patients treated with 3D miniplates and Group II comprised patients treated with 2D miniplates (conventional miniplates). Groups were matched for fracture type (symphysis or parasymphysis).

Inclusion criteria:
[1] Patients aged 15–60 years.
[2] Unilateral or bilateral mandibular symphysis or parasymphysis fracture.
[3] Patients with controlled systemic conditions.

Exclusion criteria:
[1] Infected fractures at the time of treatment.
[2] Comminuted fractures.
[3] Pathologic fractures.

Pre-operative assessment:
Pre-operative records included documentation of occlusion, interincisal mouth opening measurement and panoramic (OPG) and periapical radiographs to evaluate anatomical displacement. Antibiotics were prescribed pre-operatively and Erich arch bars or Ivy eyelets were placed for arch stabilisation.

Surgical procedure:

All procedures were performed under local or general anaesthesia following thorough pre-anaesthetic evaluation. Fracture site exposure was achieved via an intraoral vestibular approach. No post-operative intermaxillary fixation was applied in any patient. Post-operative medications included antibiotics, analgesics, antacids and antiemetics.

Parameters assessed:

Radiographic evaluation:

Fracture gap was measured at four defined points on pre- and post-operative OPG radiographs. A line was drawn along the fracture line, divided into three equal parts and perpendicular projections were made at the resulting four points (A, B, C and D). Gap width at each point was measured using a digital calliper.

Mouth opening:

Interincisal distance was measured using a ruler and compared between groups at immediate post-operative, 1-week, 1-month and 3-month follow-up intervals.

Statistical analysis:

Data were entered in Microsoft Excel 2007 and analysed using SPSS version 23.0. Descriptive statistics included mean and standard deviation. The Shapiro–Wilk test was used to assess data normality and Levene's test to explore homogeneity of variance. Intergroup comparisons were performed using the independent samples t-test. Intragroup comparisons across time points were conducted using the paired t-test and repeated measures ANOVA. A p-value < 0.05 was considered statistically significant.

Results:

As shown in **Table 1**, the overall mean age of the study population was 29.28 ± 4.69 years. The 3D plating group had a mean age of 30.40 ± 4.74 years and the 2D plating group had a mean age of 28.15 ± 4.44 years. The largest age cohort across the entire sample was 26–30 years (35.0%), with the 3D group predominantly represented in this range (40.0%), while the 2D group was most represented in the 20–25 year group (45.0%). No patients in the 2D plating group were above 35 years of age. As shown in **Table 2**, males constituted the overwhelming majority of the study population, with 33 of 40 participants (82.5%) being male and 7 (17.5%) female. This male predominance was consistent across both groups: 80.0% in the 3D plating group and 85.0% in the 2D plating group. Intergroup comparison of mouth opening **(Tables 3 and 4) Table 3** presents the intergroup comparison of absolute mouth opening at each follow-up interval. In the immediate post-operative period, mean mouth opening was 24.00 ± 2.85 mm in the 3D group and 23.00 ± 2.96 mm in the 2D group, with no statistically significant difference (p = 0.284). At 1-week follow-up, the 3D group showed a significantly greater mean mouth opening of 29.00 ± 2.74 mm compared to 27.00 ± 2.88 mm in the 2D group (p = 0.029), indicating superior early functional recovery with the 3D plate. At 1 month and 3 months, both groups continued to improve, reaching 33.00 and 38.00 mm (3D) versus 32.00 and 37.00 mm (2D) respectively, with no statistically significant intergroup differences at these later time points (p = 0.214 and p = 0.176). **Table 4** presents the mean improvement in mouth opening from the immediate post-operative baseline. The 3D plating group demonstrated significantly greater improvement at 1 week (5.00 ± 1.42 mm vs 4.00 ± 1.56 mm; p = 0.036). By 1 month and 3 months, both groups achieved identical mean improvements of 9.00 mm and 14.00 mm respectively, with no statistically significant difference (p = 1.000 for both), confirming comparable long-term functional recovery despite the earlier advantage of the 3D plate. Repeated measures ANOVA revealed statistically significant improvement in mouth opening within both groups across all time intervals (p < 0.001 for all pairwise comparisons), as shown in **Table 5**. In the 3D plating group, mouth opening improved by 5.00 mm from post-operative to 1 week, a further 4.00 mm from 1 week to 1 month and a further 5.00 mm from 1 month to 3 months. In the 2D plating group, corresponding improvements were 4.00 mm, 5.00 mm and 5.00 mm respectively. All intragroup time-interval comparisons were highly statistically significant in groups (p < 0.001), confirming sustained and progressive functional recovery following both fixation methods. Radiographic evaluation of fracture reduction **(Table 6)** summarises the pre- and post-operative radiographic measurements at all four fracture gap measurement points (A, B, C and D). Pre-operatively, no statistically significant differences were observed between the two groups at any measurement point (Point A: p = 0.299; Point B: p = 1.000; Point C: p = 0.062; Point D: p = 0.167), confirming comparable baseline fracture characteristics. Post-operatively, however, highly significant differences were observed at all four points in favour of the 3D plating group (p < 0.001 for all). At Point A, the mean post-operative fracture gap was 1.18 ± 0.37 mm in the 3D group versus 2.30 ± 0.66 mm in the 2D group. At Point B: 1.08 ± 0.34 mm versus 1.78 ± 0.41 mm. At Point C: 0.88 ± 0.36 mm versus 1.78 ± 0.41 mm. At Point D: 0.68 ± 0.24 mm versus 1.20 ± 0.50 mm. These findings collectively show that the 3D plating system achieved significantly superior fracture reduction across the entire extent of the fracture line.

Table 1: Age distribution of study participants across 3D and 2D plating groups

Age Group (Years)	3D Plating Group (n=20)	Total (n=40)
20–25	4 (20.0%)	13 (32.5%)
26–30	8 (40.0%)	14 (35.0%)
31–35	4 (20.0%)	9 (22.5%)
36–40	4 (20.0%)	4 (10.0%)
Mean ± SD	30.40 ± 4.74	29.28 ± 4.69

Table 2: Gender distribution of study participants

Gender	3D Plating Group (n=20)	Total (n=40)
Male	16 (80.0%)	33 (82.5%)
Female	4 (20.0%)	7 (17.5%)
Total	20 (100%)	40 (100%)

Table 3: intergroup comparison of mean mouth opening (mm) between 3D and 2D plating groups at each follow-up interval.

Time Interval	Group	n	Mean (mm)	SD	SE	Mean Diff.	p-value

Post-Op	3D Plating	20	24	2.85	0.64	1	0.284 (NS)
	2D Plating	20	23	2.96	0.66		
1 Week	3D Plating	20	29	2.74	0.61	2	0.029*
	2D Plating	20	27	2.88	0.64		
1 Month	3D Plating	20	33	2.52	0.56	1	0.214 (NS)
	2D Plating	20	32	2.63	0.59		
3 Months	3D Plating	20	38	2.31	0.52	1	0.176 (NS)
	2D Plating	20	37	2.4	0.54		

**p < 0.05 (significant); NS = not significant*

Table 4: Intergroup comparison of improvement in mouth opening (mm) from post-operative baseline

Time Interval	Group	n	SD	p-value
1 Week	3D Plating	20	1.42	0.036*
	2D Plating	20	1.56	
1 Month	3D Plating	20	1.74	1.000 (NS)
	2D Plating	20	1.68	
3 Months	3D Plating	20	1.95	1.000 (NS)
	2D Plating	20	2.02	

**p < 0.05 (significant); NS = not significant*

Table 5: Intragroup comparison of mouth opening across time intervals using repeated measures ANOVA

Group	Comparison	Mean Diff. (mm)	SE
3D Plating	Post-Op vs 1 Week	5	0.32
	Post-Op vs 1 Month	9	0.39
	Post-Op vs 3 Months	14	0.44
	1 Week vs 1 Month	4	0.3
	1 Week vs 3 Months	9	0.41
	1 Month vs 3 Months	5	0.33
2D Plating	Post-Op vs 1 Week	4	0.35
	Post-Op vs 1 Month	9	0.38
	Post-Op vs 3 Months	14	0.45
	1 Week vs 1 Month	5	0.32
	1 Week vs 3 Months	10	0.42
	1 Month vs 3 Months	5	0.34

**p < 0.001 (highly significant)*

Table 6: Pre- and post-operative radiographic fracture gap (mm) at measurement points A, B, C and D

Measurement Point	Group	Mean (mm)	SE	p-value	Significance
Pre-op Point A	3D Plating	3.08	0.16	0.299	Non-Significant
	2D Plating	3.3	0.15		
Post-op Point A	3D Plating	1.18	0.08	<0.001*	Significant
	2D Plating	2.3	0.15		
Pre-op Point B	3D Plating	2.75	0.12	1	Non-Significant
	2D Plating	2.75	0.1		
Post-op Point B	3D Plating	1.08	0.08	<0.001*	Significant
	2D Plating	1.78	0.09		
Pre-op Point C	3D Plating	2.4	0.13	0.062	Non-Significant
	2D Plating	2.75	0.1		
Post-op Point C	3D Plating	0.88	0.08	<0.001*	Significant
	2D Plating	1.78	0.09		
Pre-op Point D	3D Plating	1.93	0.09	0.167	Non-Significant
	2D Plating	2.15	0.13		
Post-op Point D	3D Plating	0.68	0.05	<0.001*	Significant
	2D Plating	1.2	0.11		

**p < 0.001 (highly significant); NS = not significant.*

Discussion:

The present study compared the clinical and radiographic outcomes of 3D miniplate fixation versus conventional 2D miniplate fixation in patients with mandibular symphysis and parasymphysis fractures. The principal findings were that both systems produced progressive and statistically significant improvement in mouth opening over the three-month follow-up period, while the 3D plating group showed significantly superior early functional recovery at one week and markedly better post-operative fracture reduction at all four radiographic measurement points. These results are discussed below in the context of the available literature. The demographic profile of the study population is consistent with established epidemiological patterns for mandibular fractures globally. The mean age of 29.28 ± 4.69 years reflects the well-documented predilection of maxillofacial trauma for young adults in the peak productive years of life. The marked male predominance-82.5% in the present series -aligns with data reported by Kryeziu *et al.* **[6]** and Cirignaco *et al.* **[7],** both of whom described a substantially higher incidence of facial fractures in males attributable to greater exposure to road traffic accidents and interpersonal violence. Mittal *et al.* **[8]** and Khemka *et al.* **[9]** similarly identified young males as the highest-risk demographic for motor vehicle-related maxillofacial injuries, corroborating the patient profile observed in the current study. With respect to mouth opening, the 3D plating group demonstrated statistically significant superior early recovery at one week compared to the 2D plating group (29.00 vs 27.00 mm; p = 0.029) and a significantly greater mean improvement from baseline at this interval (5.00 vs 4.00 mm; p = 0.036). This early advantage may be attributed to the intrinsic biomechanical design of the 3D plate: its quadrangular geometry provides simultaneous fixation in three spatial dimensions and greater resistance to torsional and bending forces than a single monocortical miniplate**,** thereby enabling earlier and more confident mobilisation of the mandible. By one month and three months, both groups achieved comparable improvement in mouth opening (9.00 mm and 14.00 mm respectively; p = 1.000), indicating that while the 3D plate conferred an early functional advantage, long-term mouth opening recovery was equivalent between the two systems. These findings are consistent with those of Lee *et al.* **[10]** and Bohner *et al.* **[11],** who similarly reported superior early mouth opening outcomes with 3D miniplates compared to 2D plates in mandibular fracture fixation. The radiographic findings constitute the most compelling evidence in favour of 3D miniplate fixation. Pre-operatively, the two groups were radiographically comparable at all four measurement points (p ≥ 0.062), confirming absence of selection bias in fracture severity. Post-operatively, the 3D plating group achieved significantly smaller residual fracture gaps at all four points (A, B, C, D; p < 0.001 for all). The absolute gap reductions-particularly at Point D (0.68 vs 1.20 mm) and Point C (0.88 vs 1.78 mm) -suggest that the 3D plate's geometric design provides more uniform compression across the entire fracture line, including the inferior border, which is mechanically the most challenging region in symphysis fixation due to the compressive forces generated during mastication. Tigraniya *et al.* **[12]** reported analogous findings, demonstrating that 3D miniplates provided superior anatomical reduction compared to conventional 2.0 mm miniplates in a prospective mandibular fracture cohort. The biomechanical basis for this

superiority was explored by Sadhwani and Anchlia **[13],** who showed that locking plate geometries with multiple fixation points distributed across a defined surface area resist interfragment micro-movement more effectively than linear plate designs under physiological loading conditions. Not all comparative studies, however, have found statistically significant differences between 3D and 2D fixation systems. Philip *et al.* **[14]** evaluated pain, sensory response, post-operative infection, occlusion and fracture segment mobility between conventional and 3D miniplate groups and found no statistically significant differences in any of these parameters-a finding that contrasts with the present study, possibly reflecting differences in study design, fracture location, measurement technique or follow-up duration. It is also noteworthy that did not perform quantitative radiographic fracture gap analysis, which may explain the absence of a detected difference. Mishra *et al.* **[15],** in a retrospective analysis of a miniplate fixation cohort, reported fewer complications in the 3D miniplate group compared to 2D fixation, which aligns with the present study's observation that both groups demonstrated low complication rates, with no adverse events necessitating plate removal or re-operation during the three-month follow-up period **[16, 17]**. The low complication rate in both groups further supports the safety of intraoral miniplate fixation as the standard of care for symphysis and parasymphysis fractures, regardless of the specific plate geometry employed. Several limitations of the present study should be acknowledged. The retrospective design introduces inherent selection bias and the relatively small sample size of 20 patients per group limits the statistical power of some subgroup comparisons. The three-month follow-up period, while adequate to capture early and mid-term outcomes, is insufficient to assess long-term stability, hardware-related complications or bone remodelling. The radiographic measurements were performed on two-dimensional OPG images, which may underestimate three-dimensional fracture displacement. Future prospective randomised controlled trials with larger sample sizes, longer follow-up periods and three-dimensional cone beam CT-based radiographic analysis would provide more definitive evidence for clinical guidelines on plate selection in mandibular symphysis fractures.

Conclusion:

The 3D miniplate demonstrated significantly superior radiographic fracture reduction and better mouth opening recovery at one week than the conventional 2D miniplate.Both fixation systems showed comparable long-term functional outcomes and low postoperative complication rates, supporting their clinical safety and reliability. The 3D miniplate may be preferred for mandibular symphysis and parasymphysis fractures when improved anatomical reduction and early functional recovery are priorities.

References:

[1] Thumari JMMR *et al. J Pharm Bioallied Sci.* 2025 **17**:S3707. [PMID: 41846788]
[2] Kanala S *et al. Ann R Coll Surg Engl.* 2021 **103**:18. [PMID: 32808805]
[3] Kim YG *et al. Arch Craniofac Surg. 2022* **23**:23. [PMID: 35255592]
[4] Sweta S *et al. J Pharm Bioallied Sci.* 2022 **14**:S131. [PMID: 36110774]
[5] Mancilla MJ *et al. Med Oral Patol Oral Cir Bucal.* 2025 **30**:e814. [PMID: 40421991]
[6] Kryeziu K *et al. Heliyon.* 2023 **9**:e15024. [PMID: 37096003]
[7] Cirignaco G *et al. Medicina (Kaunas).* 2025 **61**:1443. [PMID: 40870488]
[8] Mittal G *et al. Ann Maxillofac Surg*. 2020 **10**:31. [PMID: 32855911]
[9] Khemka G *et al. Natl J Maxillofac Surg*. 2025 **16**:347. [PMID: 41019680]
[10] Lee SW *et al. Life (Basel).* 2025 **15**:845. [PMID: 40566499]
[11] Bohner L *et al. J Clin Med.* 2020 **9**:2922. [PMID: 32927782]
[12] Tigraniya D *et al. J Oral Biol Craniofac Res.* 2025 **15**:992. [PMID: 40687861]
[13] Sadhwani BS & Anchlia S. *Ann Maxillofac Surg*. 2013 **3**:154. [PMID: 24205475]
[14] Philip LMN *et al. Ann Maxillofac Surg*. 2025 **15**:137. [PMID: 41726195]
[15] Mishra N *et al. J Maxillofac Oral Surg.* 2019 **18**:65. [PMID: 30728695]
[16] Sarepally G *et al. Cureus.* 2022 **14**:e21325. [PMID: 35186584]
[17] BlessmannWeber JB *et al. J Dent Child (Chic).* 2023 **90**:102. [PMID: 37621042]

Caveat Emptor is applicable among the literate community where required and possible. The publisher, its journal, editors and the internal/external reviewers take adequate steps to check, evaluate, correct, edit, revise and improve content where possible and required.