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# Postoperative Complications Following Intraoral and Extraoral Approaches for Mandibular Angle Fractures: A Retrospective Comparative Study

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## Abstract

### Introduction

Mandibular angle fractures are associated with postoperative morbidity; however, the optimal surgical approach remains controversial. This study compared the postoperative complications and healing outcomes following intraoral and extraoral approaches for open reduction and internal fixation of mandibular angle fractures.

### Materials and methods

This retrospective comparative cohort study included 345 patients with mandibular angle fractures, comprising 225 patients managed through an intraoral approach and 120 patients managed through an extraoral approach. Demographic, clinical, fracture-related, and treatment-related variables were extracted from institutional records. Postoperative complications, functional outcomes, and radiographic healing were compared between groups. Multivariable logistic regression was performed to identify independent predictors of postoperative complications.

### Results

Overall, postoperative complications occurred in 109 (31.6%) patients and were more frequent with the extraoral approach than with the intraoral approach (odds ratio [OR] = 1.79, 95% CI: 1.12-2.86; p = 0.01). Surgical site infection and wound dehiscence were significantly more frequent following extraoral treatment. Facial nerve weakness (p < 0.001) and scar-related complaints (p < 0.001) were significantly more common in the extraoral group. Radiographic union was achieved in 334 (96.8%) patients, with comparable rates between groups (p = 0.91). After adjustment, surgical approach was not an independent predictor of overall complications (adjusted OR = 1.35, 95% CI: 0.89-2.04; p = 0.15). Diabetes mellitus, open fracture, fracture displacement, comminution, multiple-plate fixation, and operative duration >90 minutes remained independent predictors.

### Conclusion

Both approaches achieved high fracture union rates. Although extraoral treatment was associated with more postoperative complications in the unadjusted analysis, fracture complexity and patient- and treatment-related factors appeared to contribute substantially to the overall risk. Extraoral access remains associated with selected wound and facial nerve complications.

**Categories:** Dentistry
**Keywords:** complications, fracture fixation, mandibular fractures, oral surgical procedures, retrospective studies

## Introduction

Mandibular fractures are common maxillofacial injuries, and fractures involving the mandibular angle represent a challenging clinical problem because of the anatomical characteristics of this region and the biomechanical forces acting on it [1]. Managing mandibular angle fractures aims to restore anatomical alignment, occlusion, mandibular function, and fracture healing, while minimizing postoperative complications [2]. Despite advances in fixation techniques and surgical management, complications such as surgical site infection, wound dehiscence, malocclusion, hardware-related problems, neurosensory disturbances, delayed union, and non-union may occur following surgical treatment [3].

Open reduction and internal fixation can be performed using either an intraoral or an extraoral approach. The intraoral approach provides access to the fracture without an external facial incision and therefore avoids a visible extraoral scar. However, the surgical field may be relatively restricted, particularly in severely displaced or comminuted fractures [4]. In contrast, the extraoral approach provides greater surgical exposure and may facilitate reduction and fixation of complex fractures. Nevertheless, extraoral access requires additional soft-tissue dissection and may be associated with complications, such as facial nerve weakness, scar-related concerns, and wound complications [5]. Thus, the choice between intraoral and extraoral approaches involves consideration of both fracture characteristics and potential risks associated with each surgical route.

The reported complication profiles of these approaches vary, and differences in patient characteristics, fracture severity, associated injuries, fixation methods, and timing of surgery may influence the postoperative outcomes [6]. More complex fractures may preferentially require an extraoral approach, making direct comparisons between approaches susceptible to confounding factors [5]. Therefore, evaluating the overall complications together with individual postoperative, functional, and healing outcomes may provide a more clinically meaningful assessment of these surgical approaches.

This study aimed to compare postoperative complications following open reduction and internal fixation of mandibular angle fractures performed through intraoral versus extraoral approaches. The primary objective was to compare the overall incidence of postoperative complications between the two approaches. Secondary objectives were to compare individual complication types, evaluate postoperative functional and radiographic healing outcomes, and identify patient-, fracture-, and treatment-related factors independently associated with overall postoperative complications. We hypothesized that, after adjustment for relevant confounders, surgical approach would not remain independently associated with overall complications.

# Materials And Methods

## Study design and setting

This retrospective comparative cohort study was conducted in the Department of Oral and Maxillofacial Surgery, RKDF Dental College and Research Centre, Bhopal, Madhya Pradesh, India. Patient information was obtained from existing institutional clinical records and operative and postoperative documentation between January 2015 and February 2019. No intervention, modification of treatment, or prospective recruitment was undertaken specifically for this study. The requirement for ethical approval was waived by the Institutional Ethics Committee of the college (Reference no.: RKDF/DC/2019/SS-022 dated March 09, 2019). As this was a retrospective record-based investigation, no additional intervention or alteration of treatment was performed for research purposes. Patient identifiers were excluded from the study database, and the confidentiality of patient information was maintained during data extraction, analysis, and reporting.

## Study population

The study population comprised patients diagnosed with mandibular angle fractures who underwent surgical management with open reduction and internal fixation during the study period. The patients were classified into two groups according to the surgical approach documented in their operative records. Patients treated using an intraoral approach constituted the intraoral group, whereas those treated using an extraoral approach constituted the extraoral group. A total of 345 eligible patients were included, comprising 225 in the intraoral group and 120 in the extraoral group (Figure *1*).

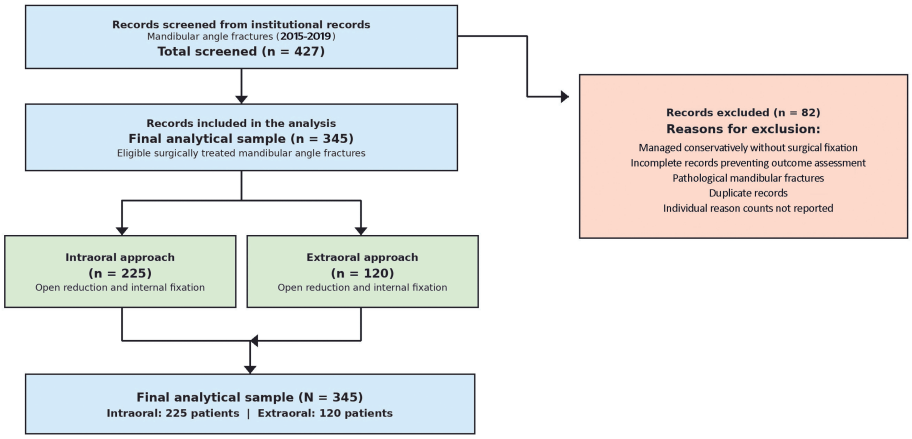



**FIGURE 1: Flowchart of the study.**

Figure created by the authors using Canva (Canva Pty Ltd, Surry Hills, Sydney, New South Wales, Australia), without the use of artificial intelligence features.

## Eligibility criteria

Patients were eligible for inclusion if they had a documented mandibular angle fracture, underwent open reduction and internal fixation through either an intraoral or extraoral approach during the study period, and had adequate medical records containing information regarding the surgical procedure and postoperative follow-up. Patients managed conservatively without surgical fixation, those with incomplete records that did not permit assessment of the surgical approach or postoperative outcome, those with pathological mandibular fractures, and those with duplicate records were excluded from the analysis.

## Sampling and sample size

Consecutive sampling was used to identify all eligible records during the study period (2015-2019). Because of the retrospective design, the final sample comprised every patient who met the inclusion criteria and had adequate documentation (N = 345; 225 intraoral, 120 extraoral). No a priori sample-size calculation was performed. Instead, the precision of the principal between-group comparisons is conveyed through the reported 95% confidence intervals. For the primary outcome (any postoperative complication), the unadjusted odds ratio was 1.79 (95% CI 1.12-2.86); after multivariable adjustment, the interval widened to 0.89-2.04, indicating that the data are compatible with both a modest residual effect and no independent effect of surgical approach.

## Data collection

Demographic variables included age, sex, smoking status, alcohol use, and documented systemic comorbidities, including diabetes mellitus and hypertension. Clinical and injury-related variables included the etiology of the fracture, time from injury to surgery, delayed surgery, fracture displacement, fracture pattern, open or closed status, fracture laterality, unilateral or bilateral involvement, associated mandibular or maxillofacial fractures, associated soft tissue injury, and the presence of a third molar at the fracture site. Treatment-related variables included surgical approach, fixation characteristics, number of plates used, tooth extraction when documented, and operative duration. The duration of the hospital stay was also recorded when available. Radiographic union and time to union were extracted from available follow-up records. The exact timing of postoperative imaging, formal criteria used to declare union, and whether assessments were performed by independent reviewers with reported inter-rater reliability were not standardized and were not consistently documented.

## Assessment of postoperative complications

The primary outcome was the occurrence of at least one documented postoperative complication after surgical fixation. Complications were identified from the postoperative clinical notes, discharge summaries, operative records, and follow-up documentation. The assessed complications included surgical site infection, intraoral wound infection, extraoral wound infection, wound dehiscence, plate exposure, plate loosening, screw loosening, malocclusion, delayed union, non-union, malunion, refracture, trismus, facial nerve weakness, inferior alveolar nerve symptoms, persistent pain, scar-related complaints, and need for secondary surgery. Only complications explicitly documented in the available clinical records were considered as study outcomes. When follow-up documentation was insufficient, the absence of a documented complication was not automatically interpreted as evidence that the complication had not occurred.

### Functional and radiographic outcomes

Postoperative functional and healing outcomes were evaluated using the available follow-up records. Radiographic outcomes included time to radiographic union, achievement of radiographic union, delayed union, and non-union. Functional outcomes included malocclusion, persistent trismus, and neurosensory deficits. Requirements for secondary surgery and plate removal were also recorded. These outcomes were compared between the intraoral and extraoral approaches.

### Definition of delayed surgery

The interval between the injury and definitive surgical treatment was recorded in days. Surgery performed more than seven days after the injury was categorized as delayed surgery. A seven-day cut-off was chosen because it is a commonly applied conventional threshold in the maxillofacial trauma literature when evaluating the influence of surgical delay on infection and other complications [3]. The median interval from injury to surgery and the proportion of patients who underwent delayed surgery were compared between the two surgical approach groups.

### Definition and assessment of fracture characteristics

Fracture displacement was categorized as nondisplaced, minimally displaced, moderately displaced, or severely displaced, according to the documentation available in the clinical records. For regression analysis, moderate and severe displacements were subsequently combined into a displaced fracture category. Fracture patterns were categorized as simple or comminuted, whereas fractures were classified as open or closed. The side of the mandibular angle fracture was classified as right, left, or bilateral. Additional mandibular and maxillofacial fractures and associated soft tissue injuries were also documented.

### Statistical analysis

Statistical analyses were performed using SPSS Statistics Version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality with the Shapiro-Wilk test. Normally distributed continuous variables are presented as mean ± standard deviation and compared between groups with the independent-samples t-test. Non-normally distributed continuous variables are presented as median (interquartile range) and compared with the Mann-Whitney U test. Categorical variables are summarized as frequencies and percentages and compared with Pearson's $\chi^2$ test or Fisher's exact test, as appropriate. A two-sided p-value of $<0.05$ was considered statistically significant.

Univariable logistic regression was first used to examine the association of each demographic, clinical, fracture-related, and treatment-related variable with the binary outcome of any postoperative complication. Variables with $p < 0.10$ in the univariable analysis were entered into a multivariable binary logistic regression model. Forward stepwise selection based on the likelihood-ratio statistic was applied. All estimates are odds ratios (not risk ratios). Adjusted odds ratios with 95% confidence intervals are reported; $p < 0.05$ was considered statistically significant in the multivariable model. Reference categories are stated in the tables. Model fit was assessed with the Hosmer-Lemeshow goodness-of-fit test, and Nagelkerke $R^2$ was used to describe explanatory capacity.

## Results

A total of 345 patients with mandibular angle fractures were included, comprising 120 patients treated using an extraoral approach and 225 patients treated using an intraoral approach. The mean age of the study population was 32.0 ± 10.9 years, with 286 (82.9%) males. Baseline demographic characteristics, including age, sex, smoking status, alcohol use, and systemic comorbidities, were comparable between the two groups. However, the mechanism of injury and timing of surgery differed significantly between the groups, with road traffic accidents being more frequently associated with the extraoral approach. The detailed demographic and clinical characteristics are presented in Table *1*.

| Variable | | Extraoral approach (n = 120) | Intraoral approach (n = 225) | Total (N = 345) | Test value | p-value |
|---|---|---|---|---|---|---|
| Age, mean ± SD | Years | 32.4 ± 11.2 | 31.8 ± 10.8 | 32.0 ± 10.9 | t = 0.49 | 0.62 |
| Sex, n (%) | Male | 102 (85.0) | 184 (81.8) | 286 (82.9) | $\chi^2 = 0.52$ | 0.47 |
| | Female | 18 (15.0) | 41 (18.2) | 59 (17.1) | | |
| Smoking status, n (%) | Smoker | 54 (45.0) | 95 (42.2) | 149 (43.2) | $\chi^2 = 0.30$ | 0.58 |
| | Nonsmoker | 66 (55.0) | 130 (57.8) | 196 (56.8) | | |
| Alcohol use, n (%) | Yes | 48 (40.0) | 86 (38.2) | 134 (38.8) | $\chi^2 = 0.14$ | 0.71 |
| | No | 72 (60.0) | 139 (61.8) | 211 (61.2) | | |
| Systemic comorbidity, n (%) | Diabetes mellitus | 10 (8.3) | 16 (7.1) | 26 (7.5) | $\chi^2 = 0.17$ | 0.68 |
| | Hypertension | 14 (11.7) | 26 (11.6) | 40 (11.6) | $\chi^2 = 0.001$ | 0.98 |
| | Other | 8 (6.7) | 12 (5.3) | 20 (5.8) | $\chi^2 = 0.27$ | 0.60 |
| Etiology of fracture, n (%) | Road traffic accident | 72 (60.0) | 101 (44.9) | 173 (50.1) | $\chi^2 = 10.21$ | 0.04* |
| | Assault | 24 (20.0) | 79 (35.1) | 103 (29.9) | | |
| | Fall | 12 (10.0) | 27 (12.0) | 39 (11.3) | | |
| | Occupational injury | 6 (5.0) | 11 (4.9) | 17 (4.9) | | |
| | Other | 6 (5.0) | 7 (3.1) | 13 (3.8) | | |
| Time from injury to surgery, median (IQR) | Days | 3.0 (2.0–5.0) | 2.5 (1.0–4.0) | 3.0 (1.0–4.0) | U = 11,842 | 0.04* |
| Delayed surgery, n (%) | >7 days | 18 (15.0) | 18 (8.0) | 36 (10.4) | $\chi^2 = 4.10$ | 0.04* |

**TABLE 1: Demographic and clinical characteristics of patients according to surgical approach.**

Data are presented as mean ± SD for normally distributed continuous variables, median (IQR) for non-normally distributed continuous variables, and n (%) for categorical variables. Continuous variables were compared using the independent-samples t-test or Mann–Whitney U test, as appropriate, while categorical variables were compared using Pearson's chi-square test. *p < 0.05 was considered statistically significant.

SD, standard deviation; IQR, interquartile range

Fracture characteristics differed significantly according to the surgical approach. The extraoral group had a greater proportion of severely displaced and comminuted fractures as well as open fractures and associated soft tissue injuries (all $p < 0.05$). These findings indicate a greater fracture complexity among patients managed using the extraoral approach. The distribution of the fracture side and the presence of a third molar at the fracture site were comparable between the groups (Table *2*).

| Fracture characteristic | | Extraoral approach (n = 120), n (%) | Intraoral approach (n = 225), n (%) | Total (N = 345), N (%) | Test statistics | p-value |
|---|---|---|---|---|---|---|
| Fracture displacement | Nondisplaced | 6 (5.0) | 34 (15.1) | 40 (11.6) | $\chi^2 = 38.71$ | <0.001* |
| | Minimally displaced | 18 (15.0) | 68 (30.2) | 86 (24.9) | | |
| | Moderately displaced | 36 (30.0) | 78 (34.7) | 114 (33.0) | | |
| | Severely displaced | 60 (50.0) | 45 (20.0) | 105 (30.4) | | |
| Fracture pattern | Simple | 66 (55.0) | 169 (75.1) | 235 (68.1) | $\chi^2 = 20.68$ | <0.001* |
| | Comminuted | 54 (45.0) | 56 (24.9) | 110 (31.9) | | |
| Open/closed fracture | Closed | 90 (75.0) | 202 (89.8) | 292 (84.6) | $\chi^2 = 13.90$ | <0.001* |
| | Open | 30 (25.0) | 23 (10.2) | 53 (15.4) | | |
| Angle fracture side | Right | 48 (40.0) | 94 (41.8) | 142 (41.2) | $\chi^2 = 0.51$ | 0.770 |
| | Left | 54 (45.0) | 92 (40.9) | 146 (42.3) | | |
| | Bilateral | 18 (15.0) | 39 (17.3) | 57 (16.5) | | |
| Unilateral/bilateral fracture | Unilateral | 102 (85.0) | 186 (82.7) | 288 (83.5) | $\chi^2 = 0.310$ | 0.570 |
| | Bilateral | 18 (15.0) | 39 (17.3) | 57 (16.5) | | |
| Associated fractures | Mandibular fracture | 24 (20.0) | 27 (12.0) | 51 (14.8) | $\chi^2 = 3.94$ | 0.047* |
| | Maxillofacial fracture | 20 (16.7) | 25 (11.1) | 45 (13.0) | $\chi^2 = 2.13$ | 0.140 |
| | Soft-tissue injury | 36 (30.0) | 34 (15.1) | 70 (20.3) | $\chi^2 = 10.81$ | 0.001* |
| Third molar at fracture site | Present | 48 (40.0) | 79 (35.1) | 127 (36.8) | $\chi^2 = 0.87$ | 0.350 |

**TABLE 2: Fracture-related characteristics of patients according to surgical approach.**

Data are presented as n (%); categorical variables were compared using Pearson's chi-square. *p < 0.05 was considered statistically significant.

For associated injuries, percentages are also calculated using the total number of patients in each treatment group (extraoral, n = 120; intraoral, n = 225; total, N = 345); these categories are not mutually exclusive, and a patient may have more than one associated injury.

Among 345 patients, any postoperative complication occurred in 109 (31.6%), more often after extraoral than intraoral procedures (48 [40.0%] vs. 61 [27.1%]; p = 0.014), as did wound dehiscence (12 [10.0%] vs. 10 [4.4%]; p = 0.044). Intraoral wound infection occurred only intraorally (16 [7.1%] vs. 0; p = 0.006), whereas extraoral wound infection (12 [10.0%] vs. 0; p < 0.001), facial nerve weakness (15 [12.5%] vs. 0; p < 0.001), and scar-related complaints (18 [15.0%] vs. 0; p < 0.001) occurred only extraorally. Surgical-site infection, plate exposure, plate loosening, screw loosening, malocclusion, delayed union, non-union, malunion, refracture, trismus, inferior alveolar nerve symptoms, persistent pain, and secondary surgery did not differ significantly (Table 3).

| Complication | Extraoral (n = 120), n (%) | Intraoral (n = 225), n (%) | Total (n = 345), n (%) | $\chi^2$ (df=1) | OR (95% CI) | p-value |
|---|---|---|---|---|---|---|
| Any complication | 48 (40.0) | 61 (27.1) | 109 (31.6) | 6.02 | 1.79 (1.12–2.87) | 0.014* |
| Surgical site infection | 12 (10.0) | 16 (7.1) | 28 (8.1) | 0.88 | 1.45 (0.66–3.18) | 0.349 |
| Wound dehiscence | 12 (10.0) | 10 (4.4) | 22 (6.4) | 4.05 | 2.39 (1.00–5.70) | 0.044* |
| Intraoral wound infection | 0 (0.0) | 16 (7.1) | 16 (4.6) | 7.41† | 0.05 (0.003–0.89)† | 0.006* |
| Extraoral wound infection | 12 (10.0) | 0 (0.0) | 12 (3.5) | 22.68† | 51.96 (3.05–885.6)† | <0.001* |
| Plate exposure | 5 (4.2) | 6 (2.7) | 11 (3.2) | 0.57 | 1.59 (0.47–5.31) | 0.450 |
| Plate loosening | 4 (3.3) | 5 (2.2) | 9 (2.6) | 0.38 | 1.52 (0.40–5.76) | 0.537 |
| Screw loosening | 6 (5.0) | 8 (3.6) | 14 (4.1) | 0.42 | 1.43 (0.48–4.22) | 0.517 |
| Malocclusion | 6 (5.0) | 24 (10.7) | 30 (8.7) | 3.17 | 0.44 (0.18–1.11) | 0.075 |
| Delayed union | 4 (3.3) | 6 (2.7) | 10 (2.9) | 0.12 | 1.26 (0.35–4.55) | 0.725 |
| Non-union | 2 (1.7) | 3 (1.3) | 5 (1.4) | Fisher | 1.25 (0.21–7.61) | 0.805† |
| Malunion | 3 (2.5) | 4 (1.8) | 7 (2.0) | Fisher | 1.42 (0.31–6.44) | 0.698† |
| Refracture | 1 (0.8) | 2 (0.9) | 3 (0.9) | Fisher | 0.94 (0.08–10.4) | 1.000† |
| Trismus | 10 (8.3) | 13 (5.8) | 23 (6.7) | 0.82 | 1.48 (0.63–3.49) | 0.365 |
| Facial nerve weakness | 15 (12.5) | 0 (0.0) | 15 (4.3) | 26.47† | 66.26 (3.93–1118)† | <0.001* |
| Inferior alveolar nerve symptoms | 8 (6.7) | 15 (6.7) | 23 (6.7) | 0.00 | 1.00 (0.41–2.43) | 1.000 |
| Persistent pain | 6 (5.0) | 10 (4.4) | 16 (4.6) | 0.05 | 1.13 (0.40–3.19) | 0.815 |
| Scar-related complaint | 18 (15.0) | 0 (0.0) | 18 (5.2) | 36.55† | 81.40 (4.86–1365)† | <0.001* |
| Secondary surgery | 14 (11.7) | 18 (8.0) | 32 (9.3) | 1.25 | 1.52 (0.73–3.17) | 0.263 |

**TABLE 3: Postoperative complications according to surgical approach.**

Data are presented as n (%). Categorical outcomes were compared using Pearson's chi-square test or Fisher's exact test as appropriate. *p < 0.05 was considered statistically significant.

The intraoral approach was considered the reference category for calculation of ORs; ORs represent the odds of each postoperative complication in the extraoral approach compared with the intraoral approach and are reported with 95% CIs. †Haldane–Anscombe correction for the zero cell. Yate's correction applied for 2x2 contingency tables.

CI, confidence interval; OR, odds ratio

Radiographic union was achieved in 334 (96.8%) patients, with no significant difference between the extraoral and intraoral groups (p = 0.91). Although the mean time to radiographic union was slightly shorter in the extraoral group (45.2 ± 12.1 vs. 48.3 ± 14.0 days, p = 0.04), rates of delayed union and non-union were comparable. Persistent neurosensory deficits were significantly more frequent in the extraoral group (p = 0.008). The secondary surgery and plate removal rates were not significantly different between the groups (Table *4*). No formal adjustment for multiplicity (Bonferroni or false-discovery rate) was applied. Consequently, the p-values for time to radiographic union (p = 0.040) and persistent neurosensory deficit (p = 0.008) should be interpreted cautiously and are regarded as hypothesis-generating rather than confirmatory.

| Outcome | Extraoral approach (n = 120) | Intraoral approach (n = 225) | Test value | p-value |
|---|---|---|---|---|
| Time to radiographic union (days), mean ± SD | 45.2 ± 12.1 | 48.3 ± 14.0 | t = –2.08 | 0.040* |
| Radiographic union achieved, n (%) | 116 (96.7) | 218 (96.9) | $\chi^2$ = 0.01 | 0.910 |
| Delayed union, n (%) | 4 (3.3) | 6 (2.7) | Fisher’s exact | 0.750 |
| Non-union, n (%) | 2 (1.7) | 3 (1.3) | Fisher’s exact | 1.000 |
| Malocclusion, n (%) | 6 (5.0) | 24 (10.7) | $\chi^2$ = 3.20 | 0.080 |
| Persistent trismus, n (%) | 8 (6.7) | 10 (4.4) | $\chi^2$ = 0.81 | 0.370 |
| Persistent neurosensory deficit, n (%) | 18 (15.0) | 14 (6.2) | $\chi^2$ = 7.02 | 0.008* |
| Secondary surgery, n (%) | 14 (11.7) | 18 (8.0) | $\chi^2$ = 1.27 | 0.260 |
| Plate removal, n (%) | 12 (10.0) | 16 (7.1) | $\chi^2$ = 0.87 | 0.350 |

**TABLE 4: Postoperative functional and radiographic healing outcomes according to surgical approach.**

Data are presented as mean ± SD for continuous variables and as n (%) for categorical variables. Normally distributed continuous variables were compared using the independent-samples t-test, whereas categorical variables were compared using Pearson's chi-square test or Fisher's exact test, as appropriate. *p < 0.05 was considered statistically significant.

SD, standard deviation

In univariable binary logistic regression, the extraoral approach, smoking, diabetes mellitus, open fracture, fracture displacement, comminution, associated mandibular fracture, multiple plates, operative duration >90 minutes, and delayed surgery were associated with postoperative complications (Table 5).

| Potential predictor | No complication (n = 236), n (%) | Complication (n = 109), n (%) | Crude OR | 95% CI | p-value |
|---|---|---|---|---|---|
| Extraoral (ref: intraoral) | 72 (60.0) | 48 (40.0) | 1.79 | 1.12–2.86 | 0.015* |
| ≥30 years (ref: <30 years) | 108 (65.1) | 58 (34.9) | 1.35 | 0.87–2.09 | 0.180 |
| Male (ref: female) | 196 (68.5) | 90 (31.5) | 1.20 | 0.72–2.00 | 0.480 |
| Smoking (ref: no smoking) | 94 (63.1) | 55 (36.9) | 1.65 | 1.08–2.52 | 0.020* |
| Alcohol (ref: no alcohol) | 88 (65.7) | 46 (34.3) | 1.45 | 0.95–2.21 | 0.080 |
| Diabetes mellitus (ref: no comorbidity) | 14 (53.8) | 12 (46.2) | 2.10 | 1.12–3.95 | 0.020* |
| Other comorbidity (ref: no comorbidity) | 12 (60.0) | 8 (40.0) | 1.46 | 0.57–3.75 | 0.430 |
| Open fracture (ref: closed) | 30 (56.6) | 23 (43.4) | 1.84 | 1.01–3.34 | 0.044* |
| Displaced fracture (ref: non-displaced) | 128 (58.4) | 91 (41.6) | 2.80 | 1.60–4.90 | <0.001* |
| Comminuted (ref: simple) | 66 (60.0) | 44 (40.0) | 2.30 | 1.50–3.52 | <0.001* |
| Associated mandibular fracture (ref: no associated fracture) | 30 (58.8) | 21 (41.2) | 1.80 | 1.05–3.10 | 0.030* |
| Associated facial fracture (ref: no associated fracture) | 28 (62.2) | 17 (37.8) | 1.50 | 0.90–2.50 | 0.120 |
| Third molar present (ref: absent) | 84 (66.1) | 43 (33.9) | 1.20 | 0.78–1.85 | 0.400 |
| Tooth extraction present (ref: absent) | 42 (60.0) | 28 (40.0) | 1.40 | 0.85–2.30 | 0.180 |
| Multiple plates (ref: single plate) | 52 (56.5) | 40 (43.5) | 2.10 | 1.35–3.27 | 0.001* |
| Operative duration >90 min (ref: ≤90 min) | 48 (57.8) | 35 (42.2) | 2.20 | 1.40–3.45 | 0.001* |
| Delayed surgery >7 days (ref: ≤7 days) | 18 (50.0) | 18 (50.0) | 2.00 | 1.15–3.48 | 0.010* |

**TABLE 5: Univariate binary logistic regression analysis of factors associated with postoperative complications.**

Data are presented as n (%) for categorical variables. Crude ORs and 95% CIs were obtained from univariable binary logistic regression. The intraoral surgical approach was used as the reference category for surgical approach. Variables with $p < 0.10$ in the univariable analysis were considered for inclusion in the multivariable logistic regression model. *$p < 0.05$ was considered statistically significant.

CI, confidence interval; OR, odds ratio

Alcohol, open fracture, and associated mandibular fracture met the entry criterion but were not retained, as their effects attenuated or proved collinear with stronger predictors on likelihood-ratio testing. However, after adjusting for potential confounders, the surgical approach was an independent predictor of overall postoperative complications (adjusted OR = 1.60, 95% CI: 1.04-2.46; p = 0.031). Diabetes mellitus, fracture displacement, comminution, multiple plates, operative duration >90 minutes, delayed surgery, and smoking

remained as independent predictors (Table 6).

| Predictor | Reference category | β | SE | AOR | 95% CI | Wald $\chi^2$ | p-value |
|---|---|---|---|---|---|---|---|
| Diabetes mellitus | Yes vs. no (Ref) | 0.69 | 0.331 | 1.99 | 1.04–3.81 | 4.34 | 0.037* |
| Displaced fracture (moderate/severe) | Moderate/severe vs. non-displaced (Ref) | 0.92 | 0.291 | 2.51 | 1.42–4.44 | 9.99 | 0.002* |
| Comminuted fracture | Comminuted vs. simple (Ref) | 0.72 | 0.228 | 2.05 | 1.31–3.21 | 9.97 | 0.002* |
| Multiple plates | Multiple vs. single plate (Ref) | 0.63 | 0.234 | 1.88 | 1.19–2.97 | 7.25 | 0.007* |
| Operative duration (>90 min) | >90 vs. ≤90 min (Ref) | 0.71 | 0.236 | 2.03 | 1.28–3.23 | 9.05 | 0.003* |
| Delayed surgery (>7 days) | >7 vs. ≤7 days (Ref) | 0.61 | 0.292 | 1.84 | 1.04–3.26 | 4.37 | 0.037* |
| Smoking | Yes vs. no (Ref) | 0.48 | 0.225 | 1.62 | 1.04–2.52 | 4.55 | 0.033* |
| Surgical approach: extraoral vs intraoral | Extraoral vs. intraoral (Ref) | 0.47 | 0.218 | 1.60 | 1.04–2.46 | 4.65 | 0.031* |

**TABLE 6: Multivariable logistic regression analysis of factors independently associated with postoperative complications (n = 345).**

AORs with 95% CIs are shown. The table presents the final model obtained by forward stepwise binary logistic regression (likelihood-ratio method). Variables with p < 0.10 on univariable analysis were eligible for entry. Reference category for surgical approach = intraoral; for binary predictors = absence of the factor.

*p < 0.05 was considered statistically significant. The β coefficient is the estimated regression coefficient on the log-odds scale, and SE is its standard error. For categorical predictors, β is the change in log odds relative to the reference category; for continuous predictors, β is the change in log odds per one-unit increase. AOR = exp(β).

Model performance: C-statistic (AUC) = 0.791 (95% CI 0.736–0.846); Nagelkerke $R^2$ = 0.278; Hosmer–Lemeshow $\chi^2$ = 6.92, df = 8, P = 0.546; model $\chi^2$ = 76.4, df = 8, p < 0.001; −2 log likelihood = 352.1.

AOR, adjusted odds ratio; CI, confidence interval

## Discussion

The present study evaluated the postoperative outcomes following intraoral and extraoral approaches for the surgical management of mandibular angle fractures. The principal finding was that the extraoral approach was associated with a greater overall burden of postoperative complications in the unadjusted analysis; however, this association was not retained after adjustment for patient-, fracture-, and treatment-related factors. This distinction is important because patients treated through the extraoral approach have more complex fracture characteristics, including greater displacement, comminution, open fractures, and associated soft tissue injuries. Thus, the higher crude complication burden may partly reflect the greater severity of fractures for which extraoral exposure was selected, rather than an independent adverse effect of the surgical approach itself.

The association between fracture complexity and the surgical approach is clinically plausible. Extraoral access provides wider exposure and may facilitate direct visualization, reduction, and fixation when fractures are severely displaced or comminuted [5,7]. In contrast, intraoral access avoids an external incision and may be particularly suitable when adequate reduction and fixation can be achieved through the oral cavity [5]. Previous comparative studies have emphasized that the selection of the approach is influenced by the fracture location, displacement, number of fracture segments, accessibility, and the surgeon's ability to obtain stable anatomical reduction [5,8,9]. Therefore, the apparent difference in overall complications between approaches should be interpreted in the context of the clinical indications for selecting each approach.

Surgical site infection and wound dehiscence were more strongly associated with the extraoral approach in the present study. Greater soft tissue dissection associated with an external approach may contribute to wound-related complications through increased tissue manipulation and disruption of the local blood supply [10]. However, the literature regarding infection and surgical approaches is inconsistent. A systematic review comparing transbuccal and extraoral approaches reported a tendency toward fewer infections with less invasive access, whereas a more recent systematic review and meta-analysis found no significant overall difference in infection risk between intraoral and extraoral approaches [5,11]. The discrepancy between these findings and those of the present study may be explained by differences in fracture severity, fixation techniques, patient characteristics, and study design. Importantly, the present analysis demonstrated that open fractures and other measures of fracture complexity were independently

associated with postoperative complications, supporting the contribution of injury-related factors to infection risk.

Facial nerve weakness is another complication that is specifically associated with the extraoral approach. This finding is consistent with previous literature identifying facial nerve dysfunction as an important potential complication of external mandibular approaches [12]. The likely mechanism is related to soft-tissue dissection, retraction, and proximity of the marginal mandibular branch of the facial nerve to the commonly used submandibular approaches. The clinical implication is that extraoral exposure should be undertaken with meticulous identification and protection of the relevant anatomical structures, particularly when extensive exposure is required.

Scar-related complaints were also more frequent after extraoral treatment. This finding is expected because the extraoral approach requires a cutaneous incision and consequently introduces a potential aesthetic concern that is absent with the complete intraoral approach. Previous comparative evidence has similarly identified visible or unsatisfactory scarring as an important disadvantage of extraoral access [5,13,14]. Therefore, when the two approaches provide comparable access and stable fixation, avoidance of an external scar may be an important consideration, particularly in patients for whom facial aesthetics are a major concern.

Radiographic healing was generally favorable with both approaches, and the rates of union, delayed union, and non-union did not demonstrate meaningful differences. This finding suggests that the surgical approach itself may be less important for fracture healing than achieving adequate reduction, stable fixation, and appropriate postoperative care [15]. Likewise, previous clinical studies have reported satisfactory healing following different approaches to mandibular angle fractures [1,16]. The slightly shorter healing interval observed with the extraoral approach should be interpreted cautiously because it may reflect differences in fracture characteristics and fixation rather than the direct biological advantage of extraoral access.

A multivariate analysis provides an important clinical perspective. Diabetes mellitus, open fractures, greater fracture displacement, comminution, multiple plate fixation, and prolonged operative duration remained independently associated with postoperative complications, whereas the overall surgical approach did not. These findings indicate that the postoperative risk is multifactorial. Diabetes may adversely affect wound healing [17], whereas open, displaced, and comminuted fractures represent greater biological and mechanical challenges [18]. Similarly, multiple-plate fixation and prolonged surgery may act as markers of fracture complexity and technical difficulty [19]. Consequently, risk assessment should extend beyond the choice of incision and incorporate the patient's systemic status, fracture characteristics, and anticipated fixation complexity. The statistically significant but small difference in mean time to radiographic union is unlikely to be clinically meaningful. Because imaging modality, follow-up intervals, and radiographic criteria for union were not standardized, and independent dual review with reliability assessment was not performed, this difference should be interpreted cautiously and may partly reflect measurement variability or differences in scheduling rather than a true biological effect of the surgical approach.

## Clinical implications and limitations

These findings support an individualized approach for mandibular angle fracture management. An intraoral approach may be advantageous when adequate reduction and stable fixation can be achieved while avoiding an external scar and potential facial nerve morbidity. Nevertheless, extraoral access remains clinically valuable for selected complex fractures, in which wider exposure facilitates safe and accurate fixation. Therefore, the decision should be based on fracture displacement, comminution, open injury, associated injuries, patient-related risk factors, and anticipated requirements for fixation rather than on a presumed difference in overall complication risk. The retrospective design, dependence on existing medical documentation, potential selection bias, unequal group sizes, and differences in fracture severity between the groups limit causal inference. In addition, a standardized objective assessment of scar aesthetics and facial symmetry was not performed.

In addition, several technical and surgeon-related variables that may influence wound healing and infection risk, including fixation type (lag screw, miniplate or reconstruction plate), plate material, thickness and profile, screw characteristics, use of maxillomandibular fixation, drains, antibiotic prophylaxis and postoperative antibiotic protocols, perioperative steroids, and individual surgeon experience, were not systematically recorded in the available clinical documentation and therefore could not be adjusted for. These unmeasured factors constitute residual confounding.

Outcome ascertainment relied entirely on chart review and was therefore susceptible to under-reporting and misclassification. Standardized operational definitions were not applied, and assessors were not blinded to the surgical approach, raising the possibility of differential misclassification. The number of patients with insufficient follow-up was not quantified, and missing outcome data were not imputed. Analyses therefore relied on documented events only. Differential completeness of follow-up between groups cannot be excluded and may have biased the observed complication rates. The multivariable model was constructed by forward stepwise selection. With 109 outcome events and multiple candidate predictors, the events-per-variable ratio in the final model was approximately 7, below the commonly recommended threshold of 10.

No internal validation (bootstrap or cross-validation) was performed. Consequently, the adjusted odds ratios may be optimistic and should be interpreted cautiously. Future prospective studies using standardized fracture classification, treatment protocols, and patient-reported esthetic and functional outcomes would strengthen this evidence.

## Conclusions

Both the intraoral and extraoral approaches were associated with high rates of radiographic union in the management of mandibular angle fractures. Although the extraoral approach was associated with a greater overall complication burden on unadjusted analysis, it was not independently associated with overall postoperative complications after adjustment for measured covariates. This finding represents an absence of a statistically significant independent association rather than evidence that the two approaches are equivalent. Extraoral access remained associated with specific complications, particularly wound-related complications and facial nerve weakness. Fracture complexity and patient- and treatment-related factors appeared to exert a greater influence on overall postoperative risk, supporting individualized selection of the surgical approach.

## Additional Information

### Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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### Disclosures

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