Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Application Effects of Modified Coronectomy in Mandibular Third Molars with High-Risk Proximity to the Mandibular Canal and Characteristics of Residual Root Migration

Jianxian Hu
Southwest Hospital，Third Military Medical University (Army Medical University)
Jianguo Xu
Southwest Hospital，Third Military Medical University (Army Medical University)
Mengjie Shen
Southwest Hospital，Third Military Medical University (Army Medical University)
Xiaoyi Liu
Southwest Hospital，Third Military Medical University (Army Medical University)
Ruixue Cheng
Southwest Hospital，Third Military Medical University (Army Medical University)
Yuanyuan Ma
Southwest Hospital，Third Military Medical University (Army Medical University)
Gang Li
ligang@tmmu.edu.cn

Southwest Hospital，Third Military Medical University (Army Medical University)
Yu Xiong
Southwest Hospital，Third Military Medical University (Army Medical University)

Research Article

Keywords: Mandibular third molar, Coronectomy, Inferior alveolar nerve, Residual root migration, Postoperative complications

Posted Date: October 11th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10802709/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License.
Read Full License

Additional Declarations: No competing interests reported.

Abstract

Objective

To evaluate the perioperative outcomes, the protective effect on the inferior alveolar nerve, and the migration characteristics of residual roots within 12 months postoperatively following a modified coronectomy in cases of high-risk contact between the mandibular third molar root and the mandibular canal.

Materials and Methods

The study included 73 patients treated at the Department of Stomatology, First Affiliated Hospital of the Army Medical University, from November 2023 to July 2025. All patients underwent preoperative cone-beam computed tomography (CBCT) scans and were divided into three groups based on the surgical procedure performed: the exodontia group (33 patients), the coronectomy group (5 patients), and the modified coronectomy group (35 patients). The primary outcome was postoperative sensation in the lower lip and chin, secondary outcomes included operative time, intraoperative blood loss, postoperative pain, facial swelling, limited mouth opening, temporomandibular joint clicking, and residual root migration. Clinical and radiographic follow-up lasted up to 12 months.

Results

The operative time in the modified coronectomy group was 51.30 ± 19.63 min, which was longer than the 32.97 ± 13.81 min in the exodontia group ($P < 0.001$); intraoperative blood loss was 15.07 ± 7.03 mL and 10.42 ± 5.88 mL, respectively ($P < 0.05$); Visual Analog Scale (VAS) scores on postoperative day 3 were 2.50 ± 0.75 and 3.09 ± 1.35, respectively ($P < 0.05$). No inferior alveolar nerve injury was observed in the modified coronectomy group, whereas the incidence in the exodontia group was 12.12% ($P < 0.001$); associated sensory abnormalities resolved approximately 3 months postoperatively. Residual root displacement increased with extended follow-up. At 12 months postoperatively, the migration distances for the groups with residual root lengths of ≤ 5 mm, 5–10 mm, and > 10 mm were 4.82 ± 0.59 mm, 3.06 ± 0.81 mm, and 4.13 ± 0.75 mm. After stratification by root morphology, the fusion root group exhibited more pronounced migration in the later stages, while the single-root group showed the lowest migration at 12 months.

Conclusion

In this study, no inferior alveolar nerve injury was observed in the modified coronectomy group, and postoperative pain scores were low. However, this procedure involved a longer operative time and relatively higher intraoperative blood loss. Residual root migration may be related to residual root length

and root morphology, with 5–10 mm residual roots exhibiting relatively better stability during the 12-month follow-up period.

Clinical Implications:

For mandibular third molars where the root is closely associated with the mandibular canal and complete extraction may increase the risk of inferior alveolar nerve injury, modified coronectomy can serve as an alternative treatment strategy. During surgery, attention should be paid to the complete removal of enamel, control of residual root length, and preservation of alveolar bone, and standardized postoperative follow-up should be implemented.

1 Introduction

Inferior alveolar nerve injury (IANI) is one of the common complications of oral and maxillofacial surgery[1]. Clinically, it manifests as numbness or paresthesia of the skin on the affected side, or even neurogenic pain, which significantly impacts patients' quality of life[2–4]. Surgeries such as mandibular implant placement, reduction and fixation of mandibular fractures, orthognathic surgery, and cyst or tumor curettage involving the neural canal region are highly prone to causing injury to the inferior alveolar nerve[5–10]. In particular, the incidence of nerve injury during the extraction of low-positioned impacted mandibular third molars ranges from approximately 0.35% to 8.4%[2, 11–13]. Therefore, accurately identifying high-risk anatomical relationships and selecting an appropriate surgical approach prior to surgery are key to reducing the risk of nerve complications.

For such high-risk tooth extraction cases, current treatment strategies include orthodontic-assisted traction, staged extraction, and prophylactic pericoronal osteotomy or coronectomy[14–18]. However, their clinical application is severely limited by issues such as long treatment durations, high costs, and complex procedures[19–21]. By removing the crown while preserving the root - which is closely associated with the inferior alveolar nerve - coronectomy reduces direct traction and mechanical damage to the nerve while addressing the local lesion[16]. Consequently, it has gradually become an important alternative surgery for the complete extraction of high-risk mandibular third molars[22]. Therefore, for high-risk cases, after comprehensively considering nerve safety, surgical trauma, and patient tolerance, coronectomy may represent a viable approach to balancing clinical efficacy and medical costs.

Although coronectomy offers potential neuroprotective benefits, its clinical application is still complicated by issues such as root migration, root exposure, pulpitis, infection, delayed healing, and the need for reoperation in a small number of cases[23–26]. At present, there are no uniform standards regarding the crown-truncation plane, residual dentin thickness, residual root length, or the extent of bone support preservation. Preserving a residual root that is too long may increase the risk of subsequent migration and exposure[16], while excessive reduction may compromise residual root stability and increase disturbance to the mandibular canal. Therefore, establishing an operational

strategy for crown truncation that balances nerve safety, residual root stability, and wound healing is of significant clinical importance.

Based on these, this study modified the coronectomy by completely removing the enamel and then further reducing the residual tooth structure under stereoscopic guidance, while preserving the buccal and lingual bone plates and the alveolar ridge morphology as much as possible (Fig. 1). The aim of this study was to compare the perioperative outcomes and incidence of inferior alveolar nerve injury among the modified coronectomy, coronectomy, and exodontia, to describe the migration patterns of residual roots within 12 months postoperatively, and to further analyze the relationship between residual root length, root morphology, and the extent of migration.

2 Materials and Methods

2.1 Study Design and Subjects

This study was a single-center, non-randomized comparative clinical study conducted at the Department of Stomatology, First Affiliated Hospital of the Army Medical University, from November 2023 to July 2025. A total of 73 patients with impacted mandibular third molars were enrolled. All patients underwent preoperative cone-beam computed tomography (CBCT) scans, and the radiographic findings indicated a high-risk contact relationship between the root of the affected tooth and the mandibular canal. The study protocol was approved by the Ethics Committee of the First Affiliated Hospital of the Army Medical University, and all patients signed written informed consent forms. This study has been registered in the China Medical Research Registration Information System NO. MR-50-23-045233.

2.2 Inclusion and Exclusion Criteria

Inclusion Criteria: (1) Met the surgical indications for mandibular third molar extraction; (2) Aged 18–40 years; (3) Scheduled to undergo surgery under local anesthesia; (4) Preoperative cone-beam CT indicated a high-risk contact relationship between the mandibular third molar root and the mandibular canal.[27, 28]

Exclusion Criteria: (1) Contraindications for routine tooth extraction; (2) The affected tooth exhibits severe pathological changes, cysts, tumors, or acute inflammation; (3) The affected tooth has an unusual horizontal relationship along the course of the inferior alveolar nerve and is deemed unsuitable for inclusion based on the surgeon’s assessment;(4) The tooth root is not fully developed, or there is severe distal bone resorption in the adjacent tooth; (5) Patients with severe systemic infections or other major systemic diseases; (6) Pregnant or lactating women; (7) Patients unable to cooperate with treatment and follow-up due to mental or cognitive conditions[28].

2.3 Preoperative Assessment and Grouping

Preoperative records included the patient’s age, sex, type of impaction, depth of impaction, root morphology, and the relationship between the tooth root and the mandibular canal as shown on cone-

beam CT. Assessment was performed using a modified mandibular nerve injury risk scale, which included six indicators such as age, sex, and CBCT contact relationship, with a total score ranging from 0 to 7. A score of ≥ 4 was defined as high risk[29]. Patients were grouped based on the actual surgical procedure they underwent: the exodontia group (33 cases), the coronectomy group (5 cases), and the modified coronectomy group (35 cases). Perioperative outcomes and postoperative complications were primarily compared between the modified coronectomy group and the exodontia group, while the coronectomy group was primarily included in the analysis of residual root length and migration characteristics.

2.4 Surgical Methods

All surgeries were performed by the same attending physician, assisted by a resident. For the modified coronectomy, inferior alveolar nerve block anesthesia with 2% lidocaine was used, supplemented by local infiltration anesthesia with compound articaine (Primacaine). After making the mucoperiosteal incision, the buccal flap is elevated. If necessary, a relaxation incision is made, and the flap is retracted and secured using a buccal retractor[23]. A splitting drill is used to segment the crown, when removing the crown, prying motions are avoided as much as possible to reduce the risk of root mobility and nerve traction[21].

After crown removal, use a fissure drill under stereoscopic visualization to further remove residual tooth structure, completely removing the enamel and ensuring that the residual root surfaces in all directions are located below the margins of the buccal and lingual bone plates. Thoroughly irrigate the surgical site with saline and gently scrape the bone walls to allow fresh blood to cover the residual root[15]. After completing periosteal release, the wound is tightly closed using single- or multi-stitch interrupted sutures. Both the exodontia group and the coronectomy group underwent the respective procedures in accordance with our center’s established clinical protocols.

2.5 Postoperative Management and Follow-up

All patients received symptomatic treatment postoperatively, including prophylactic antimicrobial therapy with cefuroxime axetil combined with metronidazole and routine analgesia. Imaging examinations included preoperative, immediate postoperative, and postoperative full-mouth panoramic radiographs taken at 1, 3, 6, and 12 months. Clinical follow-up records documented wound healing, root exposure, infection, limited mouth opening, temporomandibular joint crepitus, and recovery of neural sensation.

2.6 Observation Indicators

The primary outcome measure was postoperative sensory function of the inferior alveolar nerve. Sensation in the lower lip and chin was assessed at 1 week postoperatively and at 1, 3, 6, and 12 months postoperatively, with the degree of recovery recorded using the British Medical Research Council Sensory Nerve Recovery Scale (S0–S4)[30].

Secondary outcome measures included: (1) operative time, defined as the duration from the start of flap elevation to the completion of suturing; (2) intraoperative blood loss, estimated using the gauze weighing method, with the difference in weight between blood-soaked and dry gauze approximated as the blood loss volume[31]; (3) pain intensity on postoperative day 3, assessed using a 0-10-point visual analog scale[32]; (4) Postoperative facial swelling, classified as Grade I (< 2 mm), Grade II (2–10 mm), and Grade III (> 10 mm) based on the increase in buccal circumference[33]; (5) limited mouth opening and temporomandibular joint clicking; (6) root exposure, infection, and reoperation; (7) root migration distance.

2.7 Measurement and Classification of Residual Root Migration

A reference line is drawn along the upper margin of the mandibular canal, the intersection of this reference line with the long axis of the tooth root is identified, and the distance from this intersection to the apical point is measured. The change in measurement values at each follow-up time point relative to the immediate postoperative baseline value is defined as the residual root displacement distance. Based on postoperative residual root length, cases were classified into Group A (≤ 5 mm), Group B (5–10 mm), and Group C (> 10 mm). Among these, Groups A and B primarily consisted of cases undergoing modified coronectomy, while Group C comprised cases of coronectomy with longer residual roots.

Cases were classified based on root anatomy into single-rooted teeth, curved-rooted teeth, fused-rooted teeth, and double-rooted teeth. For single-rooted and fused-rooted teeth, the long axis of the root was defined as a straight line passing through the apical foramen and parallel to the long axis of the tooth (Figs. 2A and 2B). For curved-rooted and double-rooted teeth, the measurement axis was defined as a straight line passing through the apical foramen and parallel to the long axis of the root in the apical third region (Figs. 2C and 2D).

2.8 Statistical Analysis

Statistical analysis was performed using SPSS 23.0 software. Continuous variables are expressed as mean ± standard deviation, and categorical variables are expressed as frequency and percentage. Independent samples t-tests were used to compare continuous variables between two groups. Fisher's exact test was used to compare categorical variables, and one-way analysis of variance (ANOVA) was used to compare continuous variables among multiple groups. All tests were two-sided, and a P-value < 0.05 was considered statistically significant.

3 Results

3.1 Study Population and Baseline Characteristics

This study included a total of 73 patients with high-risk contact between the roots of mandibular third molars and the mandibular canal, comprising 33 patients in the exodontia group, 5 in the coronectomy

group, and 35 in the modified coronectomy group. The mean age of the patients was 24.52 ± 3.97 years. There were no statistically significant differences in baseline data - including impaction type, depth of impaction, and root morphology - among the three groups ($P > 0.05$), indicating that the groups were comparable. The mean preoperative mandibular alveolar nerve injury risk scores for cases with different root morphologies were all > 4 points (Figs. 2E and 2F), meeting the inclusion criteria for high-risk cases.

3.2 Perioperative Outcomes

To compare perioperative differences between the modified coronectomy and exodontia procedures, we assessed indicators such as operative time, intraoperative blood loss, and the Visual Analog Scale (VAS) scores. The results showed that the mean operative time was 51.30 ± 19.63 min in the modified coronectomy group and 32.97 ± 13.81 min in the exodontia group, with a significant difference between the groups (Fig. 3A), which was attributed to the precise manipulation required in modified coronectomy. Intraoperative blood loss was 15.07 ± 7.03 mL in the modified coronectomy group and 10.42 ± 5.88 mL in the exodontia group (Fig. 3B). On the third postoperative day, the VAS scores for the modified coronectomy group and the exodontia group were 2.50 ± 0.75 and 3.09 ± 1.35, respectively (Fig. 3C). All quantitative data were in Supplementary Table S1. These results indicate that, compared with exodontia, the modified coronectomy took longer and resulted in greater intraoperative blood loss, but pain scores were lower on the third postoperative day.

3.3 Postoperative Complications and Neurosensory Outcomes

During dental treatment, prolonged wide-mouth opening is highly likely to cause temporomandibular joint symptoms. Therefore, in addition to assessing postoperative complications such as nerve injury and facial swelling following tooth extraction, we further compiled statistics on postoperative complications. The incidence of postoperative TMJ clicking was 7.5% in the modified coronectomy group and 3.0% in the tooth exodontia group (Fig. 4A), which is related to the longer operative time associated with the modified coronectomy. In both groups, symptoms of TMJ clicking resolved spontaneously within one month postoperatively. The incidence of postoperative facial swelling was 12.5% in the modified coronectomy group and 21.2% in the exodontia group (Fig. 4B). Due to less disturbance to the extraction socket during the procedure, the incidence of limited mouth opening was 5.0% in the modified coronectomy group, lower than the 15.2% observed in the exodontia group (Fig. 4C).

The overall incidence of inferior alveolar nerve injury in this study was 5.48%. No nerve injury was observed in the modified coronectomy group, whereas the incidence in the exodontia group was 12.12% (Fig. 4D). This difference was statistically significant, indicating that modified coronectomy can effectively prevent inferior alveolar nerve injury. All four patients in the exodontia group who experienced inferior alveolar nerve injury presented with localized, temporary sensory abnormalities. Symptoms gradually resolved approximately 3 months postoperatively, with no residual permanent neurological dysfunction (Supplementary Table S2).

3.4 Migration Characteristics of Residual Roots of Different Lengths

Uncontrolled movement of residual roots is the most troubling issue following coronectomy, and this is equally true for the modified coronectomy. Therefore, we observed the displacement of residual roots of varying lengths over a 12-month period. After stratifying the groups by postoperative residual root length, the displacement of residual roots in each group increased with extended follow-up time. Group A (≤ 5 mm) exhibited higher overall displacement at all time points, reaching 4.82 ± 0.59 mm at 12 months postoperatively (Fig. 5A). Group B (5–10 mm) showed a relatively gradual increase in displacement, reaching 3.06 ± 0.81 mm at 12 months postoperatively (Fig. 5B). Group C (> 10 mm, the coronectomy group) exhibited relatively slow displacement in the early postoperative period but showed increased displacement later on, reaching 4.13 ± 0.75 mm at 12 months postoperatively (Fig. 5C). The differences between groups showed that the amount of teeth root movement gradually increases over time (Supplementary Figure S1). These results indicate that, there was no simple linear relationship between residual root length and migration, and residual roots measuring 5–10 mm exhibited relatively good stability during the 12-month follow-up period (Fig. 5D–G).

3.5 Displacement Characteristics of Different Root Morphologies

In addition, we examined the displacement of different root morphologies at 12 months postoperatively. The displacement of residual roots increased over time in cases with single roots, curved roots, fusion roots, and double roots, and the differences between groups at each follow-up time point were statistically significant ($P < 0.05$) (Fig. 6E-H). At 1 month postoperatively, the initial displacement was greatest in the curved-root group (1.65 mm) (Fig. 6B) and smallest in the fusion root group (0.70 mm) (Fig. 6C). During the follow-up period, the rate of migration in the fusion root group gradually increased, reaching 3.78 mm at 12 months postoperatively. The single root group exhibited the lowest migration at 12 months postoperatively (3.23 mm) (Fig. 6A), and the displacement in the double-root group was essentially consistent with that of the single root and curved root groups (Fig. 6D). The comparison results between different root groups showed that as time goes on, the amount of root movement gradually increases, while single roots group shows significant stability (Supplementary Figure S2). These results suggest that root morphology may be associated with the early stability and long-term migration patterns of residual roots.

3.6 Follow-up Completion and Reintervention

During the follow-up period, one patient in the coronectomy group developed mild, asymptomatic exposure of the residual root at 6 months postoperatively. After thorough communication, the patient chose not to undergo clinical intervention at that time and continued to be monitored dynamically. In the modified coronectomy, three patients did not complete the full course of radiographic follow-up, one

refused further radiographic examinations due to pregnancy, one did not complete the 6-month postoperative follow-up, and one was lost to follow-up due to a job transfer. All other patients completed the scheduled follow-up.

4 Discussion

This study compared the perioperative outcomes of modified coronectomy and exodontia where cone-beam CT indicated high-risk contact between the roots of the mandibular third molar and the mandibular canal, and conducted a 12-month follow-up on root migration. The main findings were as follows, no inferior alveolar nerve injury occurred in the modified coronectomy group, whereas two patients in the exodontia group experienced transient sensory abnormalities, with a statistically significant difference between the groups. The modified coronectomy group had lower pain scores and a lower incidence of limited mouth opening on the third postoperative day, but the procedure took longer and involved greater intraoperative blood loss. Residual root migration increased over time and may be related to residual root length and root morphology. These findings support the potential value of modified coronectomy in nerve preservation and the mitigation of certain postoperative reactions, but also suggest that clinical application requires balancing surgical complexity with long-term management of the residual root.

Previous randomized controlled trials on high-risk mandibular third molars have generally shown that, compared with complete extraction, successful coronectomy reduces the risk of mandibular nerve sensory deficits. In this study, no inferior alveolar nerve injury was observed in the modified coronectomy group, whereas the incidence in the exodontia group was 12.12%. The difference between the groups was statistically significant. This is consistent with previously published findings and further supports the protective effect of modified coronectomy on the inferior alveolar nerve[34, 35]. The possible mechanism lies in the fact that this procedure preserves the apical portion in close contact with the mandibular canal, avoiding root displacement and instrumental manipulation in the apical region, thereby reducing direct traction, compression, and mechanical injury to the nerve. It should be noted that statistical significance does not equate to a fully established causal effect[24, 36]. As this study employed a non-randomized design and only two cases of nerve injury occurred, the precision and generalizability of the effect size still require further validation through larger-sample, multicenter studies.

Regarding perioperative responses, previous studies generally suggest that coronectomy reduces postoperative pain and dry socket, while other short-term complications, such as infection, are comparable to those of complete extraction. In this study, both the pain scores on the third postoperative day and the incidence of limited mouth opening were significantly lower in the modified coronectomy group than in the exodontia group, consistent with the trend observed in previous studies indicating less tissue trauma and faster postoperative recovery[35, 37, 38]. Coronectomy avoids apical displacement and extensive manipulation around the mandibular canal while preserving alveolar bone structure as much as possible, which may reduce local tissue damage and inflammatory responses[37, 39]. Conversely, the modified coronectomy group had longer operative times and higher intraoperative blood

loss[40], which may be related to additional steps such as complete removal of enamel, further reduction of the residual root, periosteal release, and meticulous wound closure-reflecting the increased technical complexity of the modified procedure used in this study. The incidence of temporomandibular joint clicking was higher in this group, but symptoms resolved spontaneously within 1 month postoperatively, suggesting that the clinical impact was likely transient. However, the prolonged duration of mouth opening during surgery and increased joint loading warrant further attention through process optimization.

Residual root migration is one of the most common radiographic changes following coronectomy. Previous prospective studies have shown that residual root migration primarily occurs in the early postoperative period, particularly within the first 6–12 months, and significantly slows down or tends to stabilize after approximately 24 months. Some cohort studies have reported average migration of approximately 3.3 mm and 5.3 mm at 2 and 6 months postoperatively, while other studies using 3D imaging measurements have reported an average migration of approximately 4.1 mm at 6 months postoperatively. In this study, the migration at 12 months postoperatively across different residual root length subgroups ranged from 3.06 to 4.82 mm, which generally falls within the range reported in previous studies and supports the view that residual root migration occurs primarily in the early stages[23, 39, 41–44]. However, differences exist among studies regarding patient age, crown-cutting depth, radiographic measurement methods, reference points, and follow-up completion rates. Furthermore, this study reports stratified means rather than the overall mean for all cases. Therefore, the comparison of the above values is primarily intended to identify general trends and should not be used to draw direct quantitative conclusions regarding the relative merits of different approaches.

Root remnant migration does not in itself equate to treatment failure. Moderate coronal migration typically allows the root remnant to gradually move away from the mandibular canal and may reduce the risk of nerve injury during subsequent root removal. Previous medium- to long-term follow-up studies have shown that most residual roots migrate within the first 12 months postoperatively, with a small number of cases requiring reoperation due to eruption or exposure of the residual root. Longer-term observations further suggest that long-term residual root exposure and reintervention are generally uncommon, but the associated risks have not completely disappeared. This study observed only one case of mild exposure of an asymptomatic residual root, and the patient did not undergo immediate reoperation, which is consistent with the conclusion from previous studies that ‘the incidence is low but continued monitoring is still necessary[43].’ Therefore, the decision to perform reintervention should be based on a comprehensive clinical assessment of pain, infection, soft tissue laceration, effects on adjacent teeth, and dynamic changes in the relationship between the residual root and the mandibular canal, rather than solely on the radiographic migration distance as an indicator of treatment failure. Compared with the temporal patterns of residual root migration, there is still a lack of consistent evidence regarding the optimal residual root length. Previous studies have focused more on factors such as patient age, gender, depth of impaction, root inclination, available space in the coronal direction, and whether coronal tissues were completely removed, while data on the relationship between residual root length and migration are relatively limited. This study indicates that there may be a nonlinear relationship

between residual root length and migration, with the 5–10 mm group exhibiting the lowest migration at 12 months postoperatively.

Root morphology, depth of impaction, mesio-distal and bucco-lingual inclinations, as well as the adequacy of crown-side tissue removal, may all influence residual root migration. Fusion roots exhibited minimal early migration but increased migration later on, whereas single-root cases showed relatively low migration at 12 months postoperatively, suggesting that root morphology may affect the initial retention of the residual root and subsequent migration patterns. The larger root-bone contact area in fused roots may enhance early stability, while postoperative bone cavity remodeling and reduced local resistance promote late coronal migration of the root[45, 46]. In single-root, the anatomical structure is relatively simple, the extent of bone removal is smaller, and more surrounding bone support is preserved[46]. These factors may be the primary reasons for the smaller displacement of residual roots in both fused -root and single-root teeth.

This study still has several limitations. First, this was a single-center, non-randomized comparative study. Surgical technique selection may have been influenced by anatomical risks and clinical judgment, resulting in selection bias and residual confounding. Second, the sample size was limited, restricting the precision of effect estimates. Future large-sample, multicenter prospective studies are needed, incorporating three-dimensional imaging measurements and standardized neurosensory examinations, while fully adjusting for potential confounding factors, to verify the long-term safety of the modified coronectomy and identify the factors influencing residual root displacement.

5 Conclusions

In this single-center, non-randomized comparative study, no inferior alveolar nerve injury was observed in the modified coronectomy group, and postoperative pain scores and the incidence of limited mouth opening were low. However, this procedure involved a longer operative time and relatively higher intraoperative blood loss. Residual root migration increased over time and may be related to residual root length and root morphology. Specifically, residual roots measuring 5–10 mm exhibited relatively good stability within 12 months postoperatively, and cases involving single roots showed relatively minor long-term migration. Modified coronectomy may serve as an alternative strategy for the extraction of high-risk mandibular third molars. Therefore, its long-term efficacy and standardized operative parameters require further validation in studies with larger sample sizes and longer-term follow-up.

Declarations

Competing interests:

The authors declare no competing interests.

Ethical Approval:

This study was approved by the Ethics Committee of the First Affiliated Hospital of the Army Medical University. All research procedures were conducted with full protection of the participants' rights and privacy.

Consent for publication:

Not applicable.

Informed Consent:

All patients included in the study signed a written informed consent form.

Study Registration:

This study has been registered in the Medical Research Registration Information System NO. MR-50-23-045233.

Funding:

This study was supported by the Natural Science Foundation of Chongqing (CSTB2024NSCQ-KJFZMSX0076), the Post-graduation Medical Education and Teaching Reform Research Project of the First Affiliated Hospital of Army Medical University (2023bjg208), The funders were not involved in the collection, analysis, or interpretation of data or the writing or submitting of this report.

Author Contribution

J.X. Hu and J. G. Xu contributed equally to this work. J.X. Hu, J.G. Xu, M.J. Shen, X.Y. Liu, R.X. Cheng, Y.Y. Ma, Y. Xiong, and G. Li performed the research; M.J. Shen, J.G. Xu, G. Li provided discussions; J.X. Hu, M.J. Shen, X.Y. Liu, and R.X. Cheng analyzed data; J.G. Xu, Y. Xiong, and G. Li wrote the paper. All authors approved the final manuscript.

Data Availability:

Subject to compliance with ethical requirements, protection of patient privacy, and reasonable research purposes, requests for de-identified data supporting the conclusions of this study may be submitted to the corresponding author.

References

1. Kuang S, Liu Y, Zhuang W, Li K, Yang W, Tian Y (2023) The effect of root orientation on inferior alveolar nerve injury after extraction of impacted mandibular third molars based on propensity score-matched analysis: a retrospective cohort study. BMC Oral Health 23:929. https://doi.org/10.1186/s12903-023-03661-0
2. Doh R-M, Shin S, You TM (2018) Delayed paresthesia of inferior alveolar nerve after dental surgery: case report and related pathophysiology. J Dent Anesth pain Med 18:177–182. https://doi.org/10.17245/jdapm.2018.18.3.177
3. Kämmerer PW, Heimes D, Hartmann A, Kesting M, Khoury F, Schiegnitz E, Thiem DG, Wiltfang J, Al-Nawas B, Kämmerer W (2024) Clinical insights into traumatic injury of the inferior alveolar and lingual nerves: a comprehensive approach from diagnosis to therapeutic interventions. Clin Oral Invest 28:216. https://doi.org/10.1007/s00784-024-05615-4
4. Cakir M, Karaca I, Peker E, Ogütlü F (2018) Effects of inferior alveolar nerve neurosensory deficits on quality of life. Niger J Clin Pract 21:206–211. https://doi.org/10.4103/njcp.njcp_408_1
5. Selvi F, Yildirimyan N, Zuniga J (2022) Inferior alveolar and lingual nerve injuries: an overview of diagnosis and management. Front Oral Maxillofacial Med 4. https://doi.org/10.21037/fomm-21-8
6. Peña-Cardelles JF, Markovic J, Akhondi S, Pedrinaci I, Lanis A, Gallucci GO (2025) Inferior alveolar nerve damage related to dental implant placement. A systematic review and meta-analysis. Medicina oral patología oral y cirugía bucal 30:e578. https://doi.org/10.4317/medoral.27125
7. Vinci R, Cosola S, Varkey MK, Gunasekaran S, George J, Covani U (2025) Neurosensory disturbances following inferior alveolar nerve relocation and implant placement: A systematic review and meta-analysis. J Clin Med 14:5741. https://doi.org/10.3390/jcm14165741
8. Logvynenko I, Bursova V (2024) Inferior alveolar nerve injury after sagittal split osteotomy of the mandible: A literature review. Chin J Plast Reconstr Surg 6:219–227. https://doi.org/10.1016/j.cjprs.2024.11.001
9. Phillips C, Essick G (2011) Inferior alveolar nerve injury following orthognathic surgery: a review of assessment issues. J Rehabil 38:547–554. https://doi.org/10.1111/j.1365-2842.2010.02176.x
10. Yamada S, Osanai H, Mori K, Sugino N, Taguchi A (2025) Association between CT image findings and hypoesthesia in the mental region and lower lip after dentigerous cyst removal: a retrospective study and literature review. Oral Radiol 41:414–420. https://doi.org/10.1007/s11282-025-00813-6
11. Soler-Capdevila J, Camps-Font O, Sanmartí-García G, Toledano-Serrabona J, Gay-Escoda C, Figueiredo R, Valmaseda-Castellón E (2026) Age and Risk of Inferior Alveolar Nerve Injury After Removal of Lower Third Molars Close to the Mandibular Nerve. J Oral Maxillofac Surg 84:922–932. https://doi.org/10.1016/j.joms.2026.01.072
12. Li Y, Ling Z, Zhang H, Xie H, Zhang P, Jiang H, Fu Y (2022) Association of the inferior alveolar nerve position and nerve injury: a systematic review and meta-analysis. Book title. MDPI. https://doi.org/10.3390/healthcare10091782
13. Askin Ekinci S, Kiristioglu ZB, Ates O, Gocmen G (2025) Traditional vs. orthodontic extraction of impacted teeth related to the inferior alveolar nerve: a randomized control trial. BMC Oral Health

25:1036. https://doi.org/10.1186/s12903-025-06402-7

14. Wang Y, He D, Yang C, Wang B, Qian W (2012) An easy way to apply orthodontic extraction for impacted lower third molar compressing to the inferior alveolar nerve. J Cranio-Maxillofacial Surg 40:234–237. https://doi.org/10.1016/j.jcms.2011.05.001
15. Renton T, Hankins M, Sproate C, McGurk M (2005) A randomised controlled clinical trial to compare the incidence of injury to the inferior alveolar nerve as a result of coronectomy and removal of mandibular third molars. Br J Oral Maxillofac Surg 43:7–12. https://doi.org/10.1016/j.bjoms.2004.09.002
16. Li J, Zhang W Coronectomy for high-risk mandibular third molars: neuroprotection efficacy, long-term outcomes, and clinical controversies. Oral Surgery, Oral Medicine, Oral Pathology and, Radiology O (2025) https://doi.org/10.1016/j.oooo.2025.12.001
17. Luo G-M, Yao Z-S, Huang W-X, Zou L-Y, Yang Y (2024) Two-stage extraction by partial grinding of impacted mandibular third molar in close proximity to the inferior alveolar nerve. World J Clin Cases 12:1728. https://doi.org/10.12998/wjcc.v12.i10.1728
18. Wang Y, Xu Y, Chi Z, Mao R (2022) Compressing inferior alveolar nerve impacted mandibular third molar: a comparison of three techniques. Oral Surg 15:158–162. https://doi.org/10.1111/ors.12663
19. Andreadou A, Sipka E, Zavogianni V, Papageorgiou D, Ieronymou L, Kafas P, Lillis T, Dabarakis N (2026) Managing Impacted Mandibular Third Molars: A Scoping Review of Surgical Extraction versus Orthodontic Traction and Nerve Injury Risk. ACTA Med 69:19–25. https://doi.org/10.14712/18059694.2026.12
20. Landi L, Manicone PF, Piccinelli S, Raia A, Raia R (2010) A novel surgical approach to impacted mandibular third molars to reduce the risk of paresthesia: a case series. J Oral Maxillofac Surg 68:969–974. https://doi.org/10.1016/j.joms.2009.09.097
21. Long H, Zhou Y, Liao L, Pyakurel U, Wang Y, Lai W (2012) Coronectomy vs. total removal for third molar extraction: a systematic review. J Dent Res 91:659–665. https://doi.org/10.1177/0022034512449346
22. Pogrel MA, Lee J, Muff D (2004) Coronectomy: a technique to protect the inferior alveolar nerve. J Oral Maxillofac Surg 62:1447–1452. https://doi.org/10.1016/j.joms.2004.08.003
23. Leung Y, Cheung K (2018) Root migration pattern after third molar coronectomy: a long-term analysis. Int J Oral Maxillofac Surg 47:802–808. https://doi.org/10.1016/j.ijom.2018.01.015
24. Di Spirito F, Caggiano M, Acerra A, Rizki I, Leonetti G, Allegretti G, Amato M (2025) Re-intervention rate, timing, and indications following coronectomy of the mandibular third molar: a systematic review of systematic reviews. J Clin Med 14:3877. https://doi.org/10.3390/jcm14113877
25. Nowak SM, Justice J, Aslam A, Suida MI (2024) The success rates and outcomes of mandibular third molar coronectomy: 167 cases. Oral Maxillofacial Surg 28:1227–1239. https://doi.org/10.1016/j.jcms.2024.06.003
26. Bernabeu-Mira JC, Peñarrocha-Oltra D, Peñarrocha-Diago M (2023) Coronectomy of impacted mandibular third molars: A clinical and radiological retrospective case series study with 2–9 years

of follow-up. Medicina oral patología oral y cirugía bucal 29:e180. https://doi.org/10.4317/medoral.26159

27. Gleeson CF, Patel V, Kwok J, Sproat C (2012) Coronectomy practice. Paper 1. Technique and trouble-shooting. Br J Oral Maxillofac Surg 50:739–744. https://doi.org/10.1016/j.bjoms.2012.01.001
28. Leung YY, Cheung LK (2009) Safety of coronectomy versus excision of wisdom teeth: a randomized controlled trial. Oral Surgery, Oral Medicine, Oral Pathology. Oral Radiol Endodontology 108:821–827. https://doi.org/10.1016/j.tripleo.2009.07.004
29. Jin Q-R, Xie Z-J (2022) Evaluating the risk factors of inferior alveolar nerve injury following removal of the mandibular third molars. Zhonghua kou Qiang yi xue za zhi= Zhonghua Kouqiang Yixue Zazhi=. Chin J Stomatology 57:258–265. https://doi.org/10.3760/cma.j.cn112144-20210713-00326
30. Xie S, Zhang Y, Shi P, Zhu Y, Tan X, Yang J (2025) Effectiveness of collagen nerve conduit combined with PRP for incomplete peripheral nerve injury: a retrospective case-control study. Sci Rep 15:31931. https://doi.org/10.1038/s41598-025-09305-3
31. Stoker AD, Binder WJ, Frasco PE, Morozowich ST, Bettini LM, Murray AW, Fah MK, Gorlin AW (2024) Estimating surgical blood loss: A review of current strategies in various clinical settings. SAGE Open Med 12:20503121241308302. https://doi.org/10.1177/20503121241308302
32. Jensen MP, Chen C, Brugger AM (2003) Interpretation of visual analog scale ratings and change scores: a reanalysis of two clinical trials of postoperative pain. J pain 4:407–414. https://doi.org/10.1016/s1526-5900(03)00716-8
33. Osunde O, Adebola R, Saheeb B (2012) A comparative study of the effect of suture-less and multiple suture techniques on inflammatory complications following third molar surgery. Int J Oral Maxillofac Surg 41:1275–1279. https://doi.org/10.1016/j.ijom.2012.04.009
34. James O, Oyeneyin AO, Adeyemi MO, Erinoso OA, Adekunle AA, Adeyemo WL (2023) Neurosensory deficits of inferior alveolar nerve following impacted mandibular third molar extraction: comparison of one-stage complete extraction with two-stage partial coronectomy surgical technique. J Oral Maxillofac Surg 22:178–186. https://doi.org/10.1007/s12663-021-01601-5
35. Khalid Al-Ali M, Saqan R, Alkhazraji S, Gaballah K (2025) Standardized coronectomy versus total extraction for impacted mandibular third molars: a single-blinded prospective analysis of patient-reported outcomes. Front Oral Health 6:1647852. https://doi.org/10.3389/froh.2025.164785
36. Kubo H, Kubota R, Ioku Y, Ueda M, Nishiguchi Y, Ikebe S, Arai H, Yamaguchi T, Takenobu T, Shirao K (2024) Evaluation of outcome following coronectomy for mandibular third molars. J Osaka Dent Univ 58:7–12. https://doi.org/10.7860/jcdr/2016/20991.8273
37. de Oliveira Peixoto A, Bachesk AB, Leal MOCD, Jodas CRP, Machado RA, Teixeira RG (2024) Benefits of coronectomy in lower third molar surgery: a systematic review and meta-analysis. J Oral Maxillofac Surg 82:73–92. https://doi.org/10.1016/j.joms.2023.09.024
38. Rico-Barroso L, Barroso-Medel M-E, Gutiérrez-Pérez J-L, Serrera-Figallo M-A, Torres-Lagares D (2025) Coronectomy as an alternative technique to complete extraction of mandibular third molars

with risk of nerve injury. Medicina oral patología oral y cirugía bucal 31:e19. https://doi.org/10.14712/18059694.2026.12

39. Li J, Leung Y (2025) Ten-year-plus follow-up study on coronectomy of the mandibular third molar. Int J Oral Maxillofac Surg. https://doi.org/10.1016/j.ijom.2025.11.004
40. Abu-Mostafa N, AlRejaie LM, Almutairi FA, Alajaji RA, Alkodair MM, Alzahem NA (2021) Evaluation of the outcomes of coronectomy procedure versus surgical extraction of lower third molars which have a high risk for inferior alveolar nerve injury: a systematic review. Int J Dent 2021:9161606. https://doi.org/10.1155/2021/9161606
41. Kurita K, Yuasa H, Taniguchi S, Achiwa M, Goto M, Kubota E, Nakayama A, Abe A (2024) Residual enamel removal to improve outcomes of mandibular third molar coronectomy: A single-center retrospective cohort study. J Cranio-Maxillofacial Surg 52:1042–1049. https://doi.org/10.1016/j.jcms.2024.06.003
42. Pinto KVA, Velasques BD, Moura LB, Damian MF, Xavier CB (2022) Factors associated with root migration after lower third molar coronectomy-preliminary results. Brazilian Dent Sci 25. https://doi.org/10.4322/bds.2022.e3055
43. Tamer Y, Çubuk S, Somay E, Pektaş ZÖ (2024) Analysis of clinical and radiographic outcomes at least 5 years after coronectomy for deeply impacted mandibular third molars. J Stomatology Oral Maxillofacial Surg. https://doi.org/10.1016/j.jormas.2024.102188. :102188
44. Braimah RO, Ali-Alsuliman D, Taiwo AO, Ibikunle AA, Alsalah Y (2022) Coronectomy of deeply impacted mandibular third molars: socio-demographics and sequelae after one year evaluation in a Saudi Arabian Sub-population. J Oral Maxillofacial Surg Med Pathol 34:267–274. https://doi.org/10.1016/j.ajoms.2021.10.014
45. Mathew N, Sharma A, Rajora A, Raza H, Siddiqui S, Sybil D (2026) Predicting and modulating root migration after mandibular third molar coronectomy: Umbrella review and proposed conceptual risk stratification model. Oral and Maxillofacial Surgery 30:77. https://doi.org/0.1007/s10006-026-01560-6
46. Niyomthai P, Vorakulpipat C, Manosuthi P, Waikakul A (2021) Distance and Direction of Retained Root Migration After Lower. https://doi.org/10.21203/RS.3.RS-524109/V1. Third Molar Coronectomy

Figures

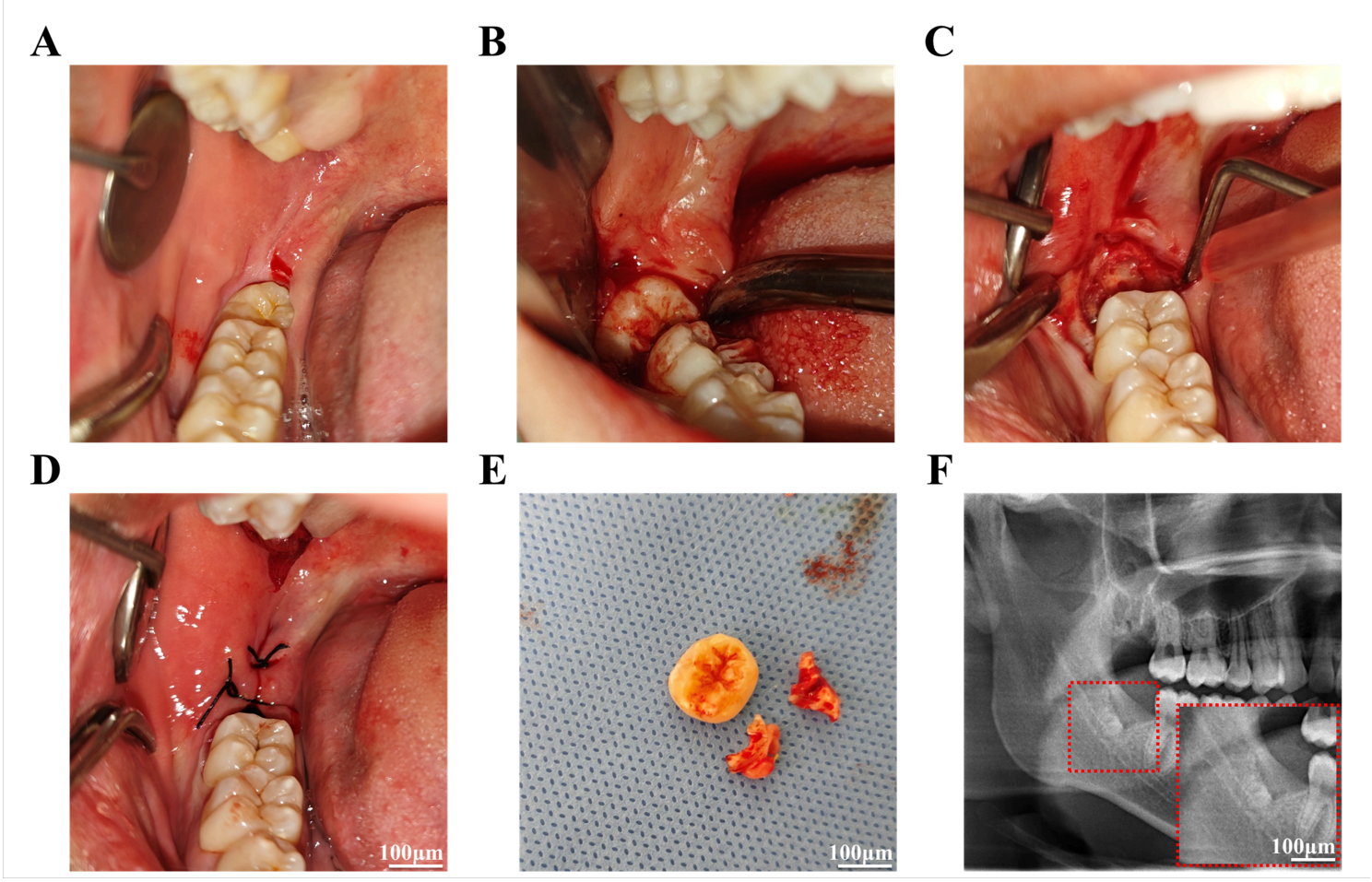


Figure 1

Surgical procedure flowchart for modified coronectomy. (A) Intraoral view following preoperative inferior alveolar nerve block and local infiltration anesthesia. (B) Exposure of the tooth neck after gingival flap elevation. (C) Remaining root structure after modified coronectomy. (D) Postoperative photograph of modified coronectomy. (E) Removal of the crown and the upper two-thirds of the root during modified coronectomy. (F) Radiographic image of the remaining root postoperatively.

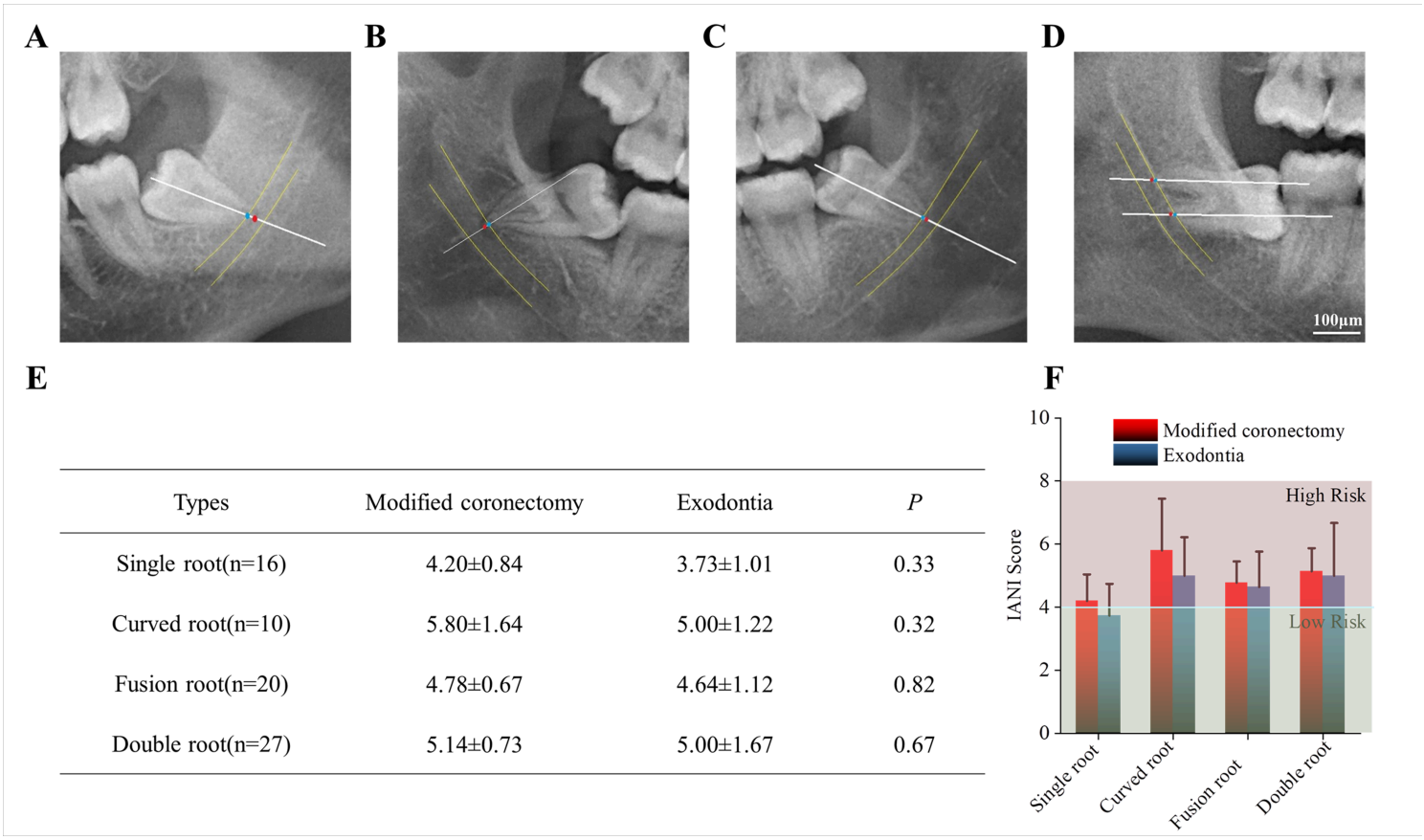


Figure 2

Root measurement methods for different types of mandibular third molars and assessment of nerve injury risk. (A-D) Root measurement methods for single root teeth A), curved root teeth B), fused root teeth C), and double root teeth D). (E) Risk of nerve injury for different root types. (F) High/low risk of nerve injury for different root types. Yellow line: mandibular nerve canal; white line: root long axis. Blue dots: intersection points of the root long axis and the upper margin of the mandibular nerve canal; red dots: root apex locations. Data are presented as means ± SD. Statistical significance was assessed by the Mann-Whitney U test.

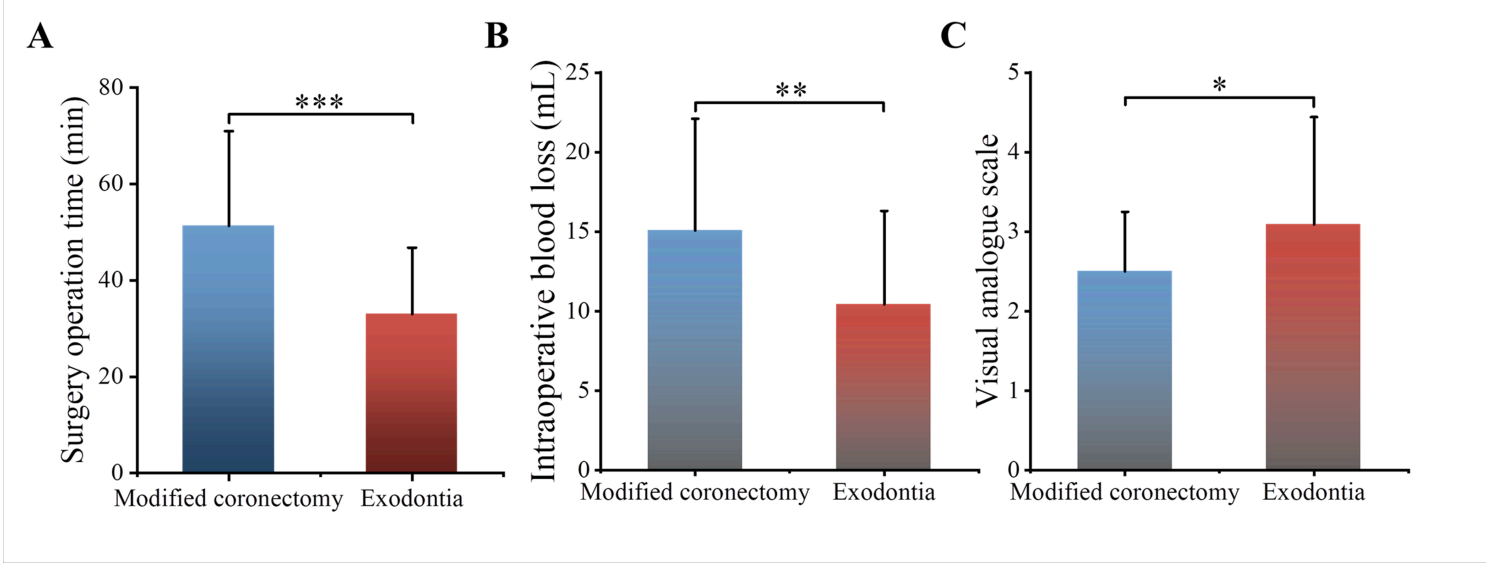


Figure 3

Intraoperative assessment of modified coronectomy. (A) Surgical duration. (B) Intraoperative blood loss. (C) Patient visual analog scale (VAS) scores. Data are presented as means ± SD. Statistical significance was assessed by the t- test. *p< 0.05, **p < 0.01, and ***p < 0.001.

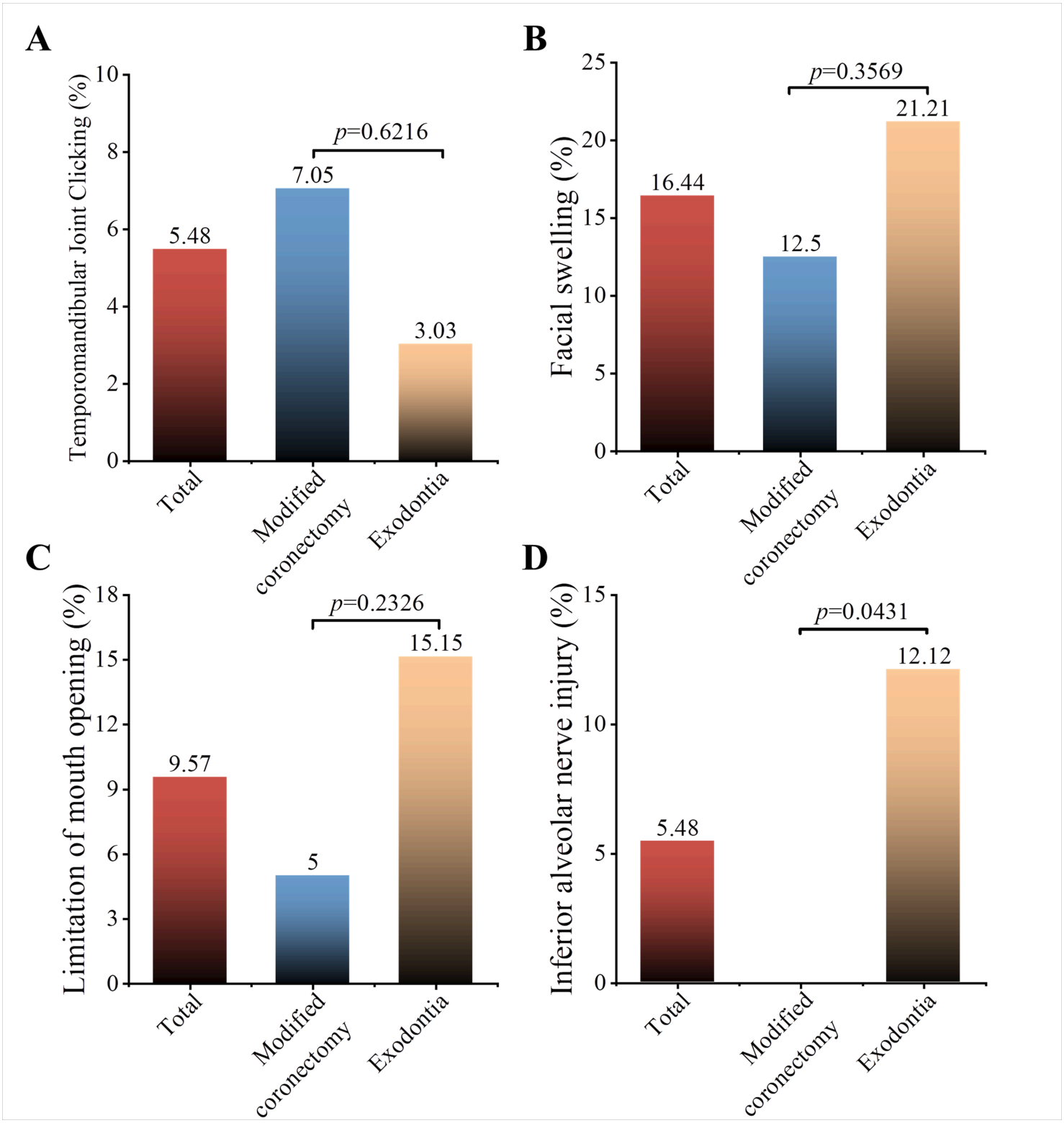


Figure 4

Postoperative complications of modified coronectomy. (A) Temporomandibular joint clicking. (B) Swelling of the maxillofacial region. (C) Limited mouth opening. (D) Injury for the inferior alveolar nerve. Data are presented as percentages. Statistical significance was assessed by the fisher's exact test.

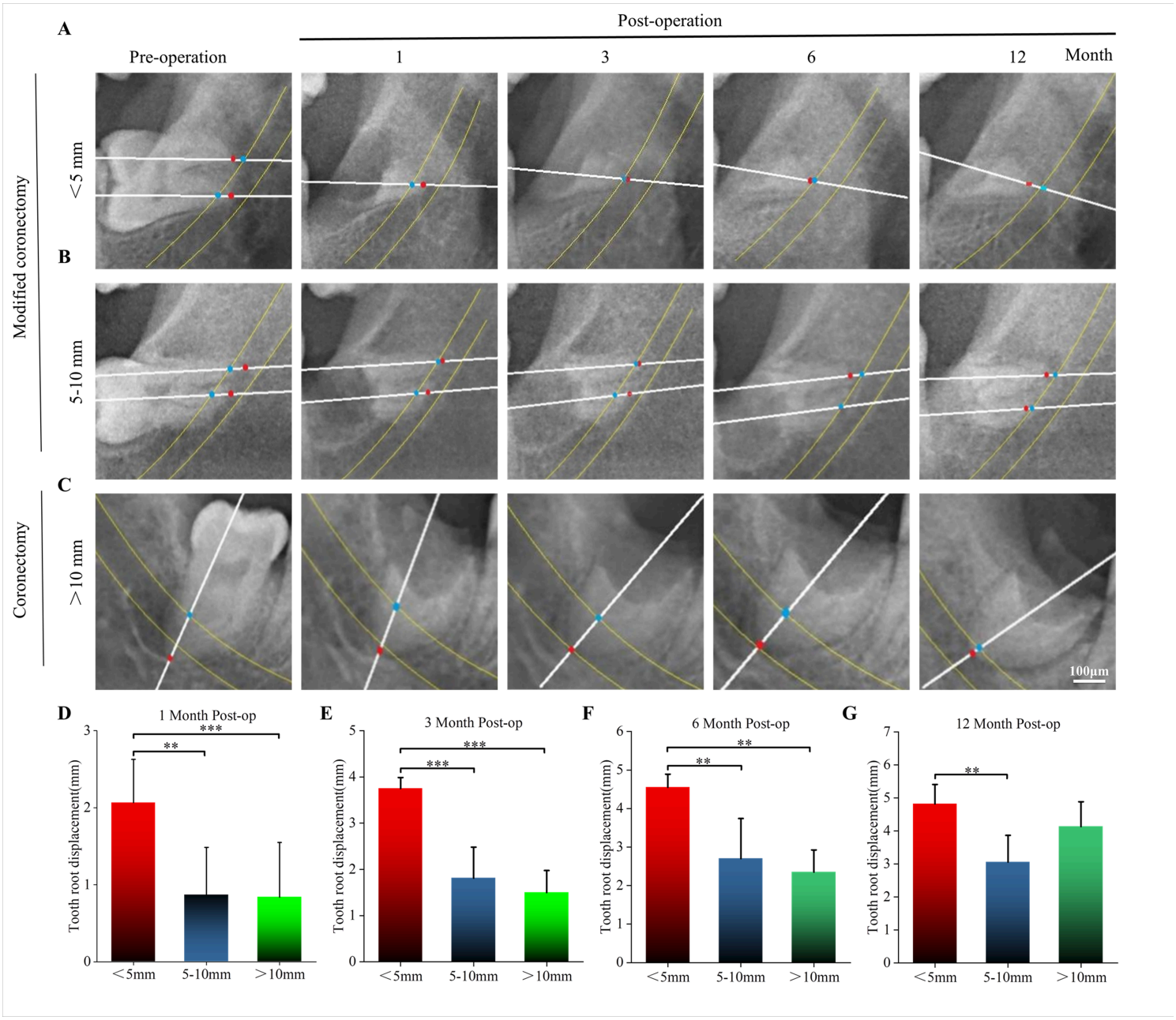


Figure 5

12-month follow-up of residual root length displacement. (A-C) Radiographic images showing residual root displacement of less than 5 mm A), 5-10 mm B), greater than 10 mm C). (D-G) Quantitative comparison of residual root length displacement at 1 month D), 3 months E), 6 months F), and 12 months G) postoperatively. Yellow line: mandibular nerve canal; white line: root long axis. Blue dots: intersection points of the root long axis and the upper margin of the mandibular nerve canal; red dots: root apex locations. Data are presented as means ± SD. Statistical significance was assessed by the one-way ANOVA with post-hoc LSD. $^{**}p < 0.01$, and $^{***}p < 0.001$.

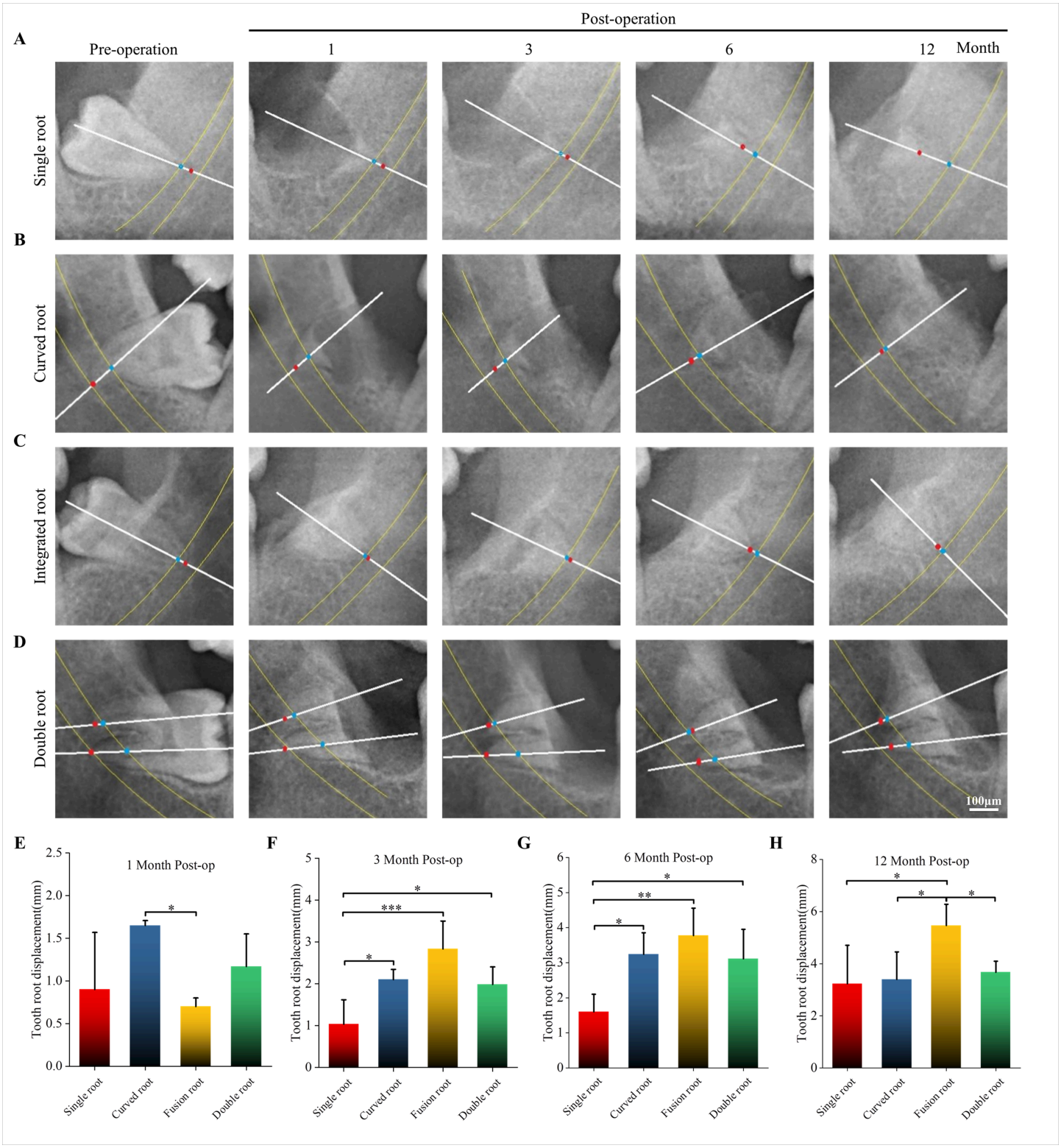


Figure 6

12-month follow-up of root displacement with different root morphologies. (A-D) Radiographic image showing root displacement in the single-rooted teeth A), the curved-rooted teeth B), the fused-rooted teeth C), and double-rooted teeth D). (E-H) Quantitative comparison of root displacement for different root morphologies at 1 month E), 3 months F), 6 months G), and 12 months H) postoperatively. Yellow line: mandibular nerve canal; white line: root long axis. Blue dots: intersection points of the root long axis

and the upper margin of the mandibular nerve canal; red dots: root apex locations. Data are presented as means ± SD. Statistical significance was assessed by the one-way ANOVA with post-hoc LSD. *$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- 26823Supplementalinformation.docx