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Original Research

The Necessity of Root Canal Treatment Following Coronectomy in Mandibular Third Molars: A Randomized Controlled Trial

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Abstract.

Objectives: In the following study, the focal area of discussion is to evaluate and record any infection or complication caused by the remanent root that was intentionally left inside to avoid injury to the inferior alveolar nerve (IAN). This research aimed to determine the effectiveness of the root canal treatment (RCT) with the coronectomy (CM) procedure and evaluate the importance of endodontic treatment during coronectomies. ***Materials and Methods:*** The study included 96 patients. The participants with proximity to IAN diagnosed based on radiographs and standard criteria were selected and divided into two equal groups of 48 each by lottery method into CM and CM with RCT following CM groups. Patients were re-evaluated for 3 weeks for complications and 3 months follow-ups for radiographic evaluations of root-fragment migration. ***Results:*** The overall average age of participants was 23.6 ± 2.7 years. The infection was found in 52 participants overall, with 12 occurring in the control and 40 in the experimental groups. Additionally, root-fragment migration was observed to be higher in the control group (2.2 ± 0.4 mm) compared to the experimental group (0.5 ± 0.2 mm), with an overall

average of 1.3 ± 0.9 mm. The roots had also moved coronally at three months follow-up after the operation in the control group by a mean of 1.4 ± 0.9mm for the males and 1.3 ± 0.9mm for the females. ***Conclusion:*** The outcome of this research concludes that one may not need endodontic treatment following a CM procedure of an impacted mandibular third molar with close relations with IAN. ***Clinical application:*** If CM is chosen, it is better to leave the roots in place and allow them to migrate naturally rather than attempt to treat them with RCT.

Keywords: Tooth Extraction; Nerve Injury; Coronectomy; Root Canal Treatment

1. Introduction

The inferior alveolar nerve (IAN) is responsible for the sensory innervation of the mandibular molars, premolars and the associated soft tissue is a branch of the mandibular nerve which originally branches out from the trigeminal nerve. IAN is prone or likely to be impaired during a surgical procedure, for example, during the removal or extraction of an impacted mandibular third molar leading to several levels of complications. Other procedures like Mandibular posterior implant placements, bone graft harvesting, and orthognathic surgeries can also damage the IAN[1].

The proximity of the root apex with the IAN is the reason for such a complication during extraction of the impacted mandibular third molar. Permanent or temporary paresthesia after extraction of the tooth results due to the nerve being adjacent to the root apex. An event of extreme injury or trauma resulting in deterioration of nerve integrity or degeneration can lead to perpetual and everlasting paranesthesia of the affected nerve. This condition usually occurs in cases where the IAN is placed between the roots, which are fused at the tips[1].

When removing third molars, the incidence of damage to the IAN varies from 0.41% to 8.1% for temporary lack of sensation and 0.014% to 3.6% for prolonged signs and symptoms[2]. Risk factors include advanced age[1] and difficult operation[2], but an important risk factor is the proximity of the third molar to the nerve canal[3].

Coronectomy (CM) is the treatment of choice when IAN is in close relation with the impacted mandibular third molar; the surgical procedure requires the removal of the crown, and one-third of the coronal section of the roots is removed leaving behind the part of the tooth that is near the nerve and can lead to its injury. When the radiologic markers of the proximity of the IAN to the root of the third molars are present, the incidence of damage can be as high as 35%[2].

Radiographic investigation and appropriate interpretation can aid and give clues about the closeness of the IAN to the apex of the root. There are about seven signs that one can appreciate on a periapical or an orthopantomography that reveals the proximity of the nerve to the impacted mandibular third molars. These signs were suggested by Howe G [4] in 1960. Out of seven, four can be visualized on the root of the tooth while three of them can be seen as changes in the inferior alveolar canal. For instance, narrowing or diversion of inferior alveolar canals, darkening of the roots.

Thorough investigation and the ability to read these signs properly, offer the surgeon an upper hand to modify the extraction plan and technique in a way that reduces the risk of damage to the nerve. In the following study, the focal area of discussion is to evaluate and record any infection or complication caused by the remanent root that was intentionally left inside to avoid injury to the nerve. The idea or the aim of this research is to figure out the effectiveness of the root canal treatment (RCT) with the CM procedure and to evaluate the importance of endodontic treatment during coronectomies[1].

The rationale for performing RCT after CM was multifold, one being to prevent pulpal necrosis and infection that if the pulp remains vital but exposed due to the CM, it may eventually become necrotic, leading to infection, abscess formation, and pain. Performing RCT can prevent these complications by eliminating pulpal infection. Second management of postoperative symptoms experienced by some patients like persistent pain or discomfort due to inflammation or infection of the retained roots. Root canal therapy can alleviate symptoms by removing the inflamed pulp and sealing the root canals.

To summarize, RCT after CM is justified when there is a risk of infection, persistent symptoms, or root migration complications. It offers a conservative approach to managing retained roots while minimizing the risk of nerve injury associated with extraction. The rationale for this study was rooted in clinical relevance, treatment planning considerations, and the broader contribution to scientific knowledge in the field of oral and maxillofacial surgery.

2. Materials and Methods

The study enrolled 96 patients with written and verbal consent, out of which 60 were females and 36 were males aged between 18-30 years, with a mean age of males 24 ± 2.6 years and females 23.5 ± 2.8 years. Ethical approval was taken from the ethical review board of Altamash Institute of Dental Medicine with IRB No: AIDM/ERC/12/2022/04. This study is registered at https://clinicaltrials.gov/study/NCT05744882 (Identifier: NCT05744882), initially submitted on January 25, 2023.

A total of 96 impacted mandibular teeth from 96 Patients with proximity to IAN diagnosed based on radiographs and evaluation on the criteria of Howe and Poyton[4] were selected for the purpose of this study. The timeline of the study was between January 2021 till June 2022.

The estimated sample size calculated for the study was 12 (6 participants in each group) which was raised to a minimum of 96 (48 participants in each group). The calculations were performed using 12.5% as a proportion of infection in the control group and 87.5% as the proportion of infection in the experimentation group from the study published by Sencimen et al.[1] The software used for the sample size estimation was STATA 13.0 using “Pearson’s Chi-squared test for two-samples proportions test”. The following parameters were considered: alpha = 0.05, Power = 0.8, Delta = 0.75, Proportions of control group = 0.125 (12.5%) and Proportions of Experimental group = 0.875 (87.5%), Considering the high loss to follow up cases into account the sample size was raised to 96 participants with one tooth per individual.

Patients were diagnosed and then referred to the Oral Maxillofacial Department of Altamash Institute of Dental Medicine. Ninety-six patients with 96 impacted mandibular third molars were equally divided into a control group and a study group. Forty-eight patients in the study group had their RCT after coronectomies while the other half, the control group only had their coronectomies done without any further procedure performed.

All the participants were equally divided into a control group and a study group by making them pick concealed envelopes containing a participant code for the participant allocation into groups. The experimental group contained forty-eight participants who had RCT following coronectomies, while on the other hand, only coronectomies were performed in the rest of the participants without RCT. The trials were implemented according to the CONSORT guidelines (Fig. 1). Supplementary file -1; CONSORT check list.

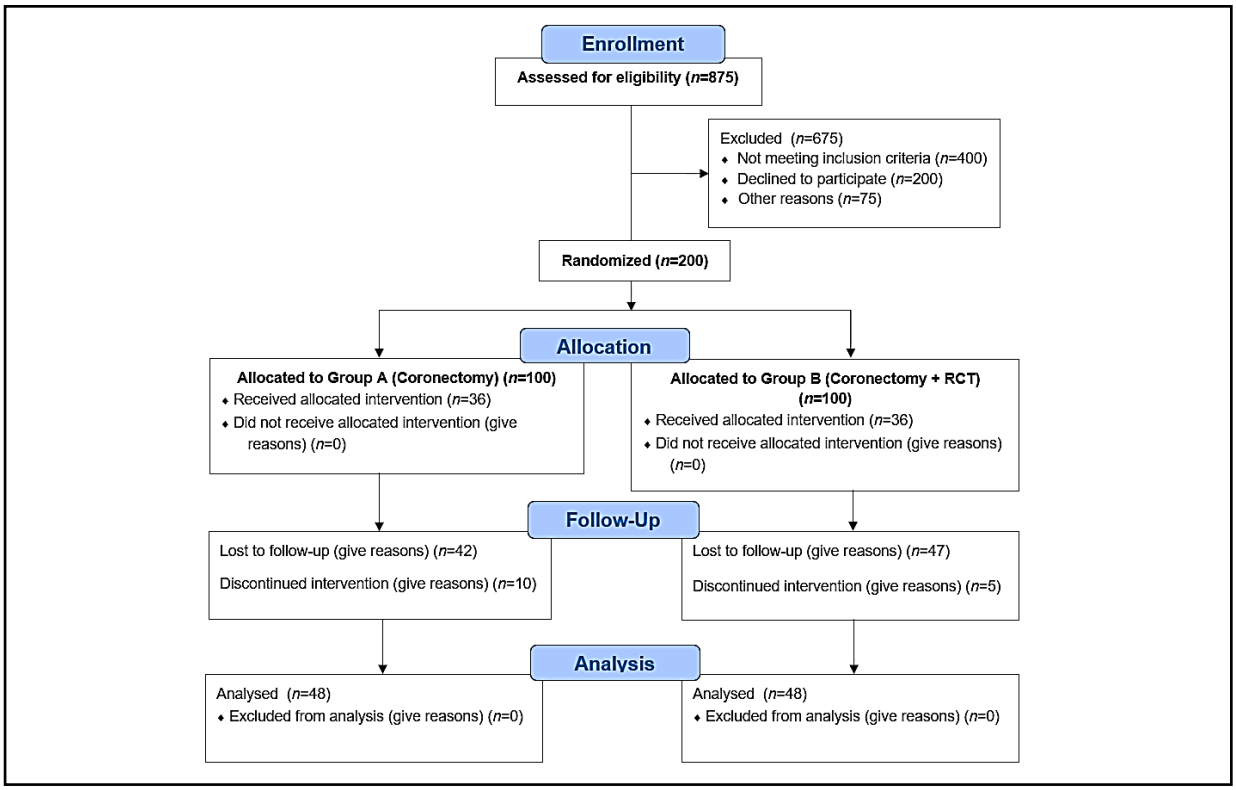

Figure 1. CONSORT flow Diagram of the study

Patients who were willing and cooperative, along with no known uncontrolled medical conditions and no history of radiotherapy in the head and neck region, were included as a part of this research, while patients who showed resistance or were uncooperative, gave a history of uncontrolled medical condition, showed signs of local pathology or infection, had carious lesion or a cavity, history of radiotherapy in head and neck area or were pregnant were excluded from being included in the study.

All surgical procedures were performed under local anesthesia by the same surgeon. None of the patients were prescribed prophylactic antibiotics but were given a chlorhexidine mouth was

given before the procedure. Prophylactic antibiotics were not advised as there was no active indication according to NICE guidelines related to the patient or the procedure.

Patients were prescribed postoperative antibiotics with analgesics and thorough written instructions for proper wound care. A buccal approach for CM was performed for all of them by the surgeon. Furthermore, all the endodontic treatment was performed by the same endodontist.

In the study group, the endodontist performed a pulpectomy and used a hypochlorite solution for irrigation of the canals. Finally, gutta-percha (GP) was used as a canal-filling material. Radiographs were done by the end of the procedure to ensure the quality of the treatment. All procedures performed by the endodontic followed the aseptic conditions and protocol.

The surgeon decided on a buccal approach with a three-cornered envelope incision resulting in a full thickness mucoperiosteal flap. The incision and eventually the flap were raised following the principles of incision and flap to promote clean surgery leading to an uneventful and complication-free healing. The crown along the dental follicle was eliminated in addition to removing one-third of the root coronally (Fig. 2).

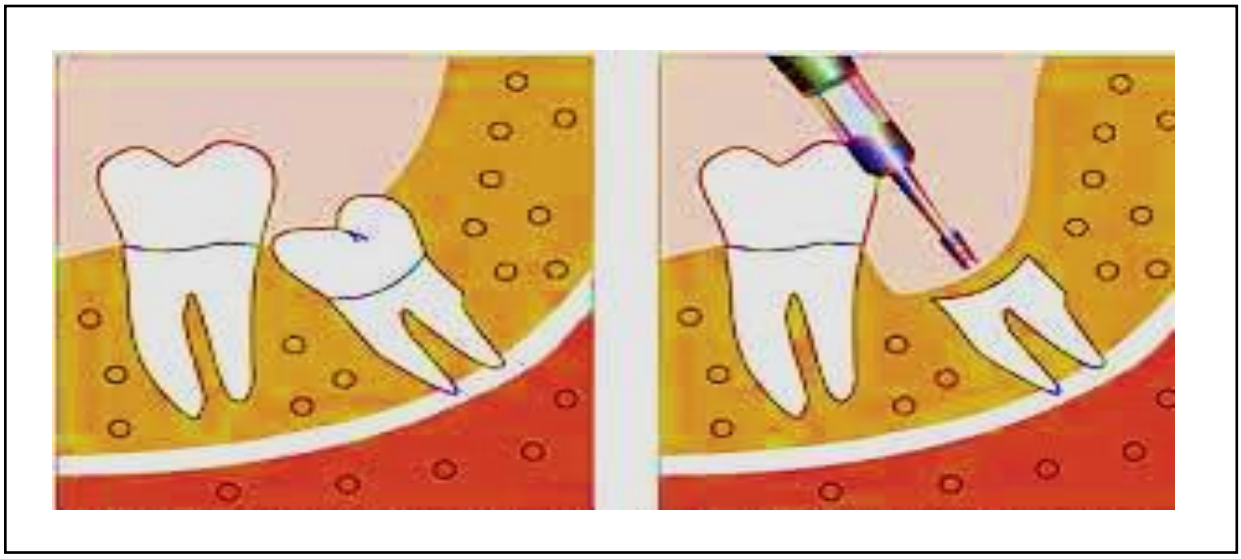

Figure 2. Illustration of surgical procedure performed in this study.

The clinician decided to establish a tilted or angled slope, the level of the slope descending lingually via a buccal surface. This inclination resulted in a discrepancy of about 3-4mm in the levels of the corresponding root surfaces, the consequence of which was the formation of a sharp edge on the buccal root surface. While the lingual root was 3-4mm below the lingual alveolar crest level. To compensate for the height, the difference between the buccal and lingual root surfaces, a reduction in the height of the buccal surface was performed to match with the lowered lingual root portion. Winding up the surgery with copious irrigation with saline followed by primary wound closure.

The mentioned step was carried out for both the study and the control group but in the study group, after removal of the pulp and biomechanical preparation, the canals were filled with GP.

Multiple periapical radiographs were taken during endodontic procedure to ensure the correct filling of the canals and optimum filling until the apices (Fig. 3).

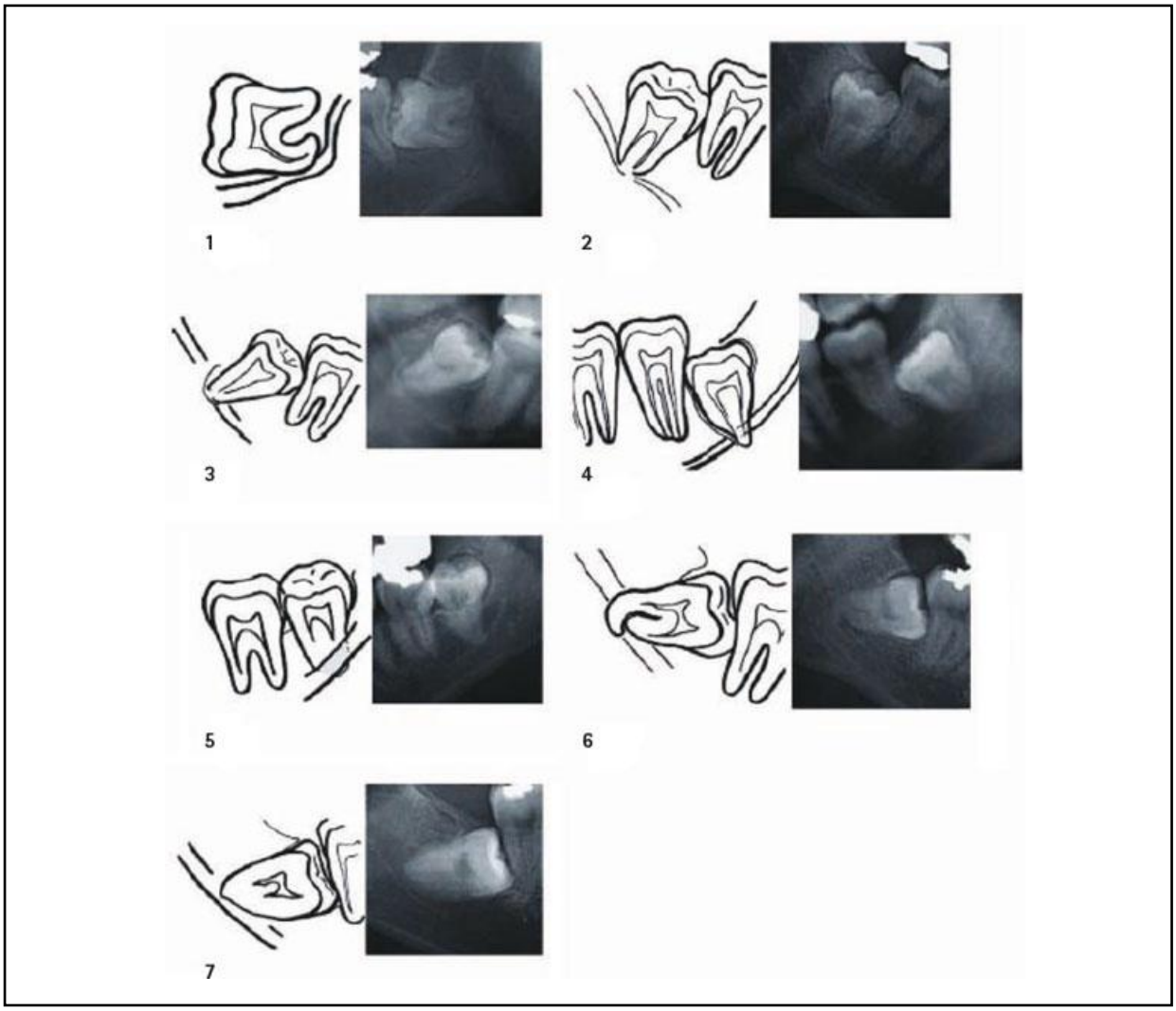

Figure 3. Radiographic signs of increased risk of inferior alveolar nerve injury: 1, deviation of the canal; 2, narrowing of the canal; 3, periapical radiolucent area; 4, narrowing of root; 5, darkening of roots; 6, curving of root; and 7, loss of lamina dura of canal.[6]

Moreover, the surgeon made a point of using a sharp bur for every operation to exercise the crown without mobilizing the roots. In the control group the pulp was left in place. Periodic follow-up initially after the first, third and sixth months were done with the help of panoramic radiographs. Finally, one year after the operation, the last panoramic radiographs were taken for assessment of the CM site.

At each follow-up visit, the patient was assessed for any signs of infection both clinically and radiographically. Local symptoms such as pain, swelling, redness or pus discharge were noted

while the patient was also evaluated for fever, lymphadenopathy or trismus as a part of systemic symptoms of infection.

3. Results

The study included 96 participants with an overall average age of 23.6 ± 2.7 years. The control group had an average age of 23.4 ± 2.9 years, while the experimental group had an average age of 23.9 ± 2.6 years. Among the participants, there were 36 males and 60 females, with the control group consisting of 16 males and 32 females, and the experimental group comprising 20 males and 28 females. Coronectomies were successfully performed on all 96 patients, while in the study group, having 48 patients, it was followed by RCT, of which 40 roots of the third molar had to be extracted because signs and symptoms of infection were seen after the procedure. However, in the control group that did not go through any treatment other than CM, only 12 cases returned for the removal of the remnant of the tooth due to infection in contrast to 40 cases in the experimental group.

This means that only 25% (12 out of 48) of the cases were infected in the control group while, on the other hand, 83.3% (40 out of 48) incidence of complications in the experimental group in which RCT was performed following the CM procedure.

Pearson's chi-square was used to analyze the statistical difference between the study variables (CM group and RCT + CMs group) and the incidence of infections, which turned out to be X^2 (df=1, 24) = 8.224, p= 0.004. Considering the incidence of infections, the *p-value* of < 0.05 demonstrates that a statistical difference exists between the two study groups.

The odds ratio was calculated to find out the risk of complications which showed that there was 15-times more risk of infections in the experimental group (RCT with CM) than in the group that did not receive RCT following CM.

Additionally, the roots had also moved coronally at three months follow-up after the operation in the control group by a mean of 1.4 ± 0.9mm for the males and 1.3 ± 0.9mm for the females. This resolved the proximity to the nerve tissue. Tables 1 and 2 describe the study outcomes in detail.

Table 1. Group-wise distribution of participants

Modalities	**Total (*n*=96)**	**Group (RCT + CMs) (*n*=48)**	**Group 2 (CMs) (*n*=48)**
Age (years)	23.6 ± 2.7	23.4 ± 2.9	23.9 ± 2.6
Sex, *n* (%) Males Females	 36 (37.5) 60 (62.5)	 16 (33.3) 32 (66.7)	 20 (42) 28 (58)
Infections, *n* (%) *	52 (52.1)	40 (83.3)	12 (25)
Root-fragment migration (mm) **	1.3 ± 0.9	0.5 ± 0.2	2.2 ± 0.4

RCT Root canal treatment; CM Coronectomy
*The percentage of infections was determined three weeks after the procedures
**Root displacement was evaluated three months after the procedures

Table 2. Gender-wise distribution of participants

Modalities	**Males (*n*=48)**	**Females (*n*=48)**
Age (years)	24 ± 2.6	23.5 ± 2.8
Infections, *n* (%) *	18 (34.6)	34 (65.4)
Root-fragment migration (mm) **	1.4 ± 0.9	1.2 ± 0.9

*The percentage of infections was determined three weeks after the procedures
**Root displacement was evaluated three months after the procedures

4. Discussion

IAN is a common complication and accounts for about 90% of all IAN damage following extraction of the mandibular molars[4]. Kubota et al. described important factors for the IAN injury during extraction procedures including position of the inferior alveolar canal (IAC) with respect to mandibular third molar, perforation of IAC by multi rooted third molar and age of over thirty years[7]. To avoid the risk of IAN injury from routine extractions, CM is a commonly adapted procedure[8].

CM alone has been linked with no or minimal complications[3]. The overall success of the CM procedure has been well-validated in the previous literature. Leung and Cheung published a longitudinal study reporting 5-year follow-up of 126 CM cases with no occurrence of infections[10]. While Pedersen et al. published similar results, (only three complications) in 231 CM cases with five- and seven-year follow-ups[11]. The results of this study are also well consistent with the above-mentioned studies, i.e., the incidence of complications is only 25% in the control group, compared to 83.3% of the group that received RCT following the CM procedure.

Moreover, the addition of RCT fails to augment the positive outcomes of CM and even predisposes patients to more incidence of complications[1,12]. The statement has also been validated by the conclusions of a systematic review by Nishimoto et al.[13] The results of these studies also force us to mention similar outcomes in our research, as there were 15 times more chances of having complications in the group receiving RCT than the one who did not receive it.

Pitros et al[14]. 2019 analyzed long-term problems of 22 teeth with an average follow-up time of 4.8 years and discovered one incidence of an erupted root (1.7%), which is consistent with earlier research showing 0.6 to 1.8% root eruption[15].

One of the highest root fragment migrations following CM in mandibular third molars, over the period of three months, has been reported by Leung et al[16]. at 62.2% (average distance of 1.90mm) and Monaco et al.[17] at 75% (with an average distance of 1.6mm). Furthermore, the evidence of root migration was also found by Pogrel et al. when they examined the patients of third molar coronectomies after six months and found 2 to 3 mm of coronal movement of root fragments

in 30% of participants[18]. The results of this study are also consistent with these findings as we also found the migration of root fragments in the coronal direction between the ranges of 2 to 3 mm.

The migration of root-fragments in the coronal path has been reported to be higher among younger study participants by this study (average age 23.6 ± 2.7 years) at three months follow-up. The similar coronal migration of root-fragments was noted by Frenkel et al.[15] The mean age was 24.5 years in the individuals in which root segment migration was noted compared to 39.6 years of group with no migration. Additionally, very similar outcomes were noted at twelve-month follow-up.

CM performed as a solo procedure minus RCT is an efficient and cost-effective treatment for the patient that will result in better and higher patient satisfaction and compliance. It will greatly limit the number of visits to the dental practice resulting in reducing the financial burden as well as the stress and anxiety related to each visit on the patient. Overall, besides being a procedure with a very good outcome, due to the paucity of long-term outcome studies[19,20], CM still necessitates clinical and radiological monitoring of the residual root, as well as subsequent root extraction.

5. Conclusion

This study demonstrates that endodontic treatment following a CM procedure for an impacted mandibular third molar, which has been diagnosed with contiguity to the IAN, is not needed for better results. Our research highlights the importance of a properly performed CM that leads to infection- and complaint-free patients. Our findings call attention to the fact that a CM on its own is a complete treatment for an impacted mandibular third molar with a risk of damaging the nerve and the procedure should not be coupled with RCT. This minimizes surgical complexity and expenses, reduces the need for additional medications, improves patient compliance and comfort, lowers postoperative pain and promotes faster healing.

CM preserves bone and nerve integrity, leading to less pain, swelling, and discomfort compared to complete extraction or root canal therapy. This improves patient satisfaction and reduces the need for excessive analgesic use. Additional studies should be undertaken with a longer follow-up with a larger sample size to further emphasize the concept of not requiring RCT after a CM.

Abbreviations

IAN	Inferior alveolar nerve
CM	Coronectomy
RCT	Root canal treatment
GP	Gutta-percha
IAC	Inferior alveolar canal

Declarations:

Supplementary Materials: Not applicable.

Author Contributions: Conceptualization, B.S, R.A, Z.A, S.M, R.N, A.M and M.A.A.-S.; methodology, B.S, R.A, Z.A, S.M, R.N, and A.M.; software, B.S, R.A, Z.A, S.M, R.N, A.M.; formal analysis, B.S, R.A, Z.A, S.M, R.N, A.M and M.A.A.-S.; investigation, B.S, R.A, Z.A, S.M, R.N, and A.M; resources, B.S, R.A, Z.A, S.M, R.N, and A.M.; data curation, B.S, R.A, Z.A, S.M, R.N, and A.M.; writing—original draft preparation, B.S, R.A, Z.A, S.M, R.N, A.M and M.A.A.-S.; writing—review and editing, B.S, R.A, Z.A, S.M, R.N, A.M and M.A.A.-S.; visualization, B.S, R.A, Z.A, S.M, R.N, A.M and M.A.A.-S.; supervision, B.S, R.A, Z.A, S.M, R.N, A.M and M.A.A.-S.; project administration, B.S, R.A, ZA, S.M, R.N, and A.M. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Written and verbally informed consent has been obtained from all participants involved in this study.

Consent for publication: Written consent has been obtained from all participants involved in this study.

Data Availability Statement: The data is available upon request from the corresponding author.

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