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# Outcomes of Coronectomy of Mandibular Third Molar: A Systematic Review

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## Abstract

Coronectomy is an alternative to complete removal of an impacted mandibular third molar. The technique removes only the crown, leaving the root in the socket, and preventing direct or indirect damage to the inferior alveolar nerve. Rationale of the study- Impacted mandibular third molar may be in close proximity to inferior alveolar nerve bundle, and extraction of the tooth may result in long-term or persistent paresthesia if the nerve bundle is injured. Alternatively, clinicians have attempted coronectomy of the third molars with variable success. The feasibility of executing a coronectomy procedure could be determined by weighing the pros and cons of randomized trials on the procedure. The study aims to weigh risk benefit ratio of considereing coronectomy over complete removal of third molar tooth. Systematic review was conducted including 15 relevant articles. The available evidence suggests that coronectomy is a technique that demonstrates a satisfactory level of safety, particularly within the immediate postoperative period. Further investigation is necessary to ascertain the long-term prognosis of the root.

**Keywords-** Third molar, Coronectomy, Inferior alveolar nerve injury

## Introduction

Coronectomy was introduced by Knutsson *et al.* as an alternative to complete removal of an impacted mandibular third molar. The technique removes only the crown, leaving the root in the socket, and preventing direct or indirect damage to the inferior alveolar nerve (IAN). The extraction of a mandibular third molar that is impacted carries the potential danger of inducing neurologic abnormalities of the inferior alveolar nerve (IAN), which may be either temporary or permanent in nature. The prevalence of inferior alveolar nerve (IAN) injury as documented in scholarly literature varies between 1.3% and 5.3%. The likelihood of experiencing this complication is primarily contingent upon the positioning of the impacted tooth relative to the inferior alveolar canal prior to undergoing surgery (Martin et al., 2015). If there exists a significant spatial relationship between the inferior alveolar nerve (IAN) and the dental roots, the likelihood of occurrence can reach as high as 19%. Compression of the inferior alveolar nerve (IAN) can result in injury, which can be caused either indirectly through forces conveyed by the root during elevation or directly by elevators. The nerve can potentially be severed by rotational devices or during the extraction of a tooth with a grooved or perforated root that affects the inferior alveolar nerve (IAN). Numerous studies have endeavored to establish a correlation between radiographic indicators and the anatomical link between the inferior alveolar nerve (IAN) and the tooth root (Shaukath et al., 2023). The radiographic signals serve as indicators to surgeons of an elevated likelihood of nerve injury during the extraction of the corresponding wisdom teeth. However, they do not possess the capability to prevent the occurrence of nerve deficits in cases where the tooth must be extracted.

Once a definitive indication for extraction has been established, it is advisable to perform surgical removal of an impacted third molar that is in close proximity to the inferior alveolar nerve (IAN) with the aim of reducing the potential for permanent neurological problems.Numerous methodologies have been suggested in relation to this matter. Checchi et al. and Alessandri Bonetti et al. have proposed the utilization of orthodontic-assisted extraction for impacted third molars, a technique that has subsequently been embraced by other researchers (Monaco et al., 2019). This particular treatment has the potential to enhance the healing process of periodontal tissues located distal to the second molar. However, it is important to note that its implementation may entail significant time and financial investments.Coronectomy has been documented in the academic literature as a potential approach for mitigating neurological consequences. The proposition of this alternative surgical approach dates back to 1984 and has since been the subject of ongoing investigation (DeOlivera et al., 2023).

Rationale of the study- Impacted mandibular third molar may be in close proximity to inferior alveolar nerve bundle, and extraction of the tooth may result in long-term or persistent paresthesia if the nerve bundle is injured. Alternatively, clinicians have attempted coronectomy of the third molars with variable success. The feasibility of executing a coronectomy procedure could be determined by weighing the pros and cons of randomized trials on the procedure.

## Aim

The study aims to weigh risk benefit ratio of considereing coronectomy over complete removal of third molar tooth.

The objective of this systematic review is to further elucidate the clinical outcomes of  coronectomy when there is a high risk of neurological damage to the inferior alveolar nerve, extrapolating the results from studies that compare this surgical technique with the total extraction of impacted mandibular third molars.

The research question is: In patients with third molar in close approximation with inferior alveoler nerve bundle, coronectomy prevents further injury to inferior alveolar nerve and other complications compared to complete surgical removal of third molar.

## PICO CHART

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|---|
| • P (population): patients with third molar in contact with the IAN. |
| • I (intervention): third molar surgery. |
| • C (comparison): coronectomy vs complete removal. |
| • O (outcome): prevents further injury IAN and the appearance of other surgical complications. |

## Materials and Method

### Search strategy and study selection

All studies that examine the clinical outcomes after coronectomy technique through a literature survey carried out through PubMed (www.ncbi.nlm.nih.gov/pubmed), SCOPUS (www.scopus.com) and the and web of science (clarivate) from inceptions to August 2023 were included in the study. Coronectomy, odontectomy, inferior alveolar nerve injury and third molar were used as keywords. Language was restricted to english. Prisma 2020 guidelines was followed to conduct this systematic review.

### Criteria for articles selection:

Inclusion criteria:

- Randomized clinical trials (RCTs); controlled clinical trials (CCTs); and prospective cohort studies (PCSs) or retrospective studies (RSs) with or without control group;
- Studies where patients had high risk of inferior alveolar nerve injury (IANI), as revealed by radiography (OPT or CBCT); specifically, the criteria for high risk of nerve injury included: displacement of the inferior alveolar canal by the roots; narrowing of the inferior alveolar canal; periapical radiolucent area; narrowing of third molar roots; darkening of third molar roots; curving of third molar roots; interruption and loss of lamina dura of nerve canal;
- Studies that adopted coronectomy as surgical treatment or compare coronectomy with total removal for lower third molar extractions with high risk of nerve injury were included.
- Studies where patients were included if their lower third molars had any of the following: pericoronitis, periodontal disease of the second mandibular molar, follicular or any clinical condition that doesn’t affect the vitality of the tooth;
- Studies in which follow-up of the clinical outcomes after surgery was greater than two months.

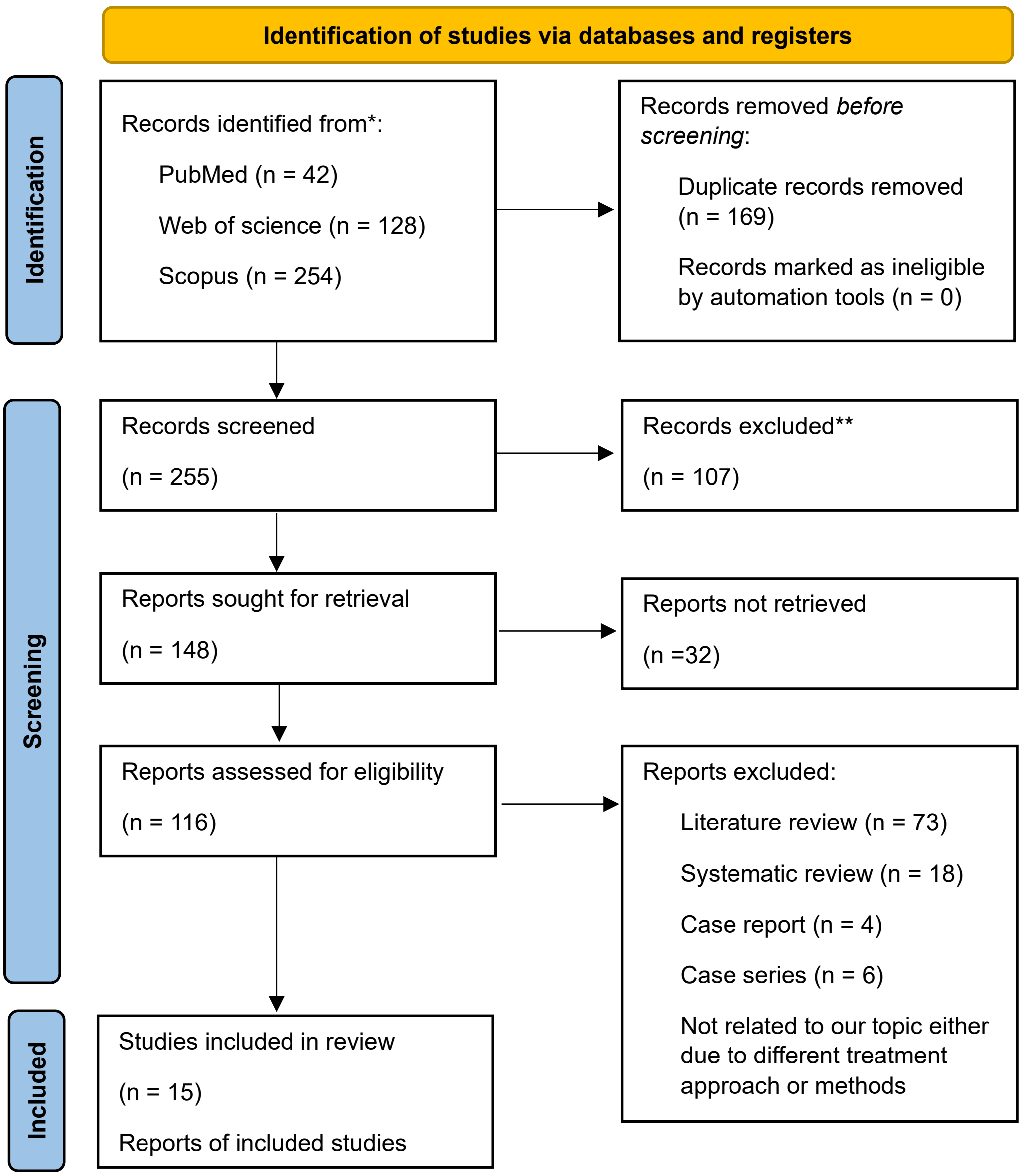
Exclusion criteria:

- Case report, case series, study enrolling less than 10 subjects, comments, expert opinion, letters to the Editor, reviews, studies that analysed the same sample of a pre-existing study;
- Studies where patients were excluded if they had any of the following: clinical signs of systemic infection; medically compromised conditions because of diabetes, chemotherapy, previous radiotherapy, immunologic disease, bone disease (osteoporosis, osteosclerosis or osteopetrosis); existing neural disorders; craniofacial syndromes with pre-existing IAN deficit; any plans for orthognathic surgery; pregnancy; patients younger than 16 years old (premature roots);
- Pstudies where patients were excluded if their lower third molars had any of the following: non-vital third molars; caries; endodontic disease; wisdom teeth associated with apical pathology or apical cystic or neoplastic lesions.

Data Extraction and Analysis

After duplicates were removed, abstracts were screened and full copies of papers that met the inclusion and exclusion criteria were obtained and reviewed according to PRISMA guidelines (Table. 1).19 The level of evidence for each of the included studies were ranked according to the National Health and Medical Research Council (NHMRC) hierarchy of evidence (Higgins et al.,2011). The quality and risk of bias of included studies were assessed using published assessment tools.(Wells et al.,2000) Data regarding neurological disturbance, post-operative pain, patient experience, postoperative infection and alveolar osteitis for both coronectomy and complete extraction were analyzed. Further data on root migration, root exposure, reoperation rate and follow-up protocol after coronectomy was evaluated.

Prisma 2020 (Table 1)




Assessment of study quality and risk of bias

Evaluation of methodological quality of published studies gives an indication of the strength of evidence provided. However, no single approach in assessing methodological soundness may be appropriate to all systematic reviews. Therefore contextual, pragmatic, and methodological considerations are followed when assessing study quality. Herein, ROB 2 assesment tool was used.

RoB 2 is structured into five bias domains, listed in table 2. The domains were selected to address all important mechanisms by which bias can be introduced into the results of a trial, based on a combination of empirical evidence and theoretical considerations. We did not include domains for features that would be expected to operate indirectly, through the included bias domains For this reason, we excluded some trial features, such as funding source and single centre versus multicentre status, which have been associated empirically with trial effect estimates from trials.

| **Authors** | **D1** | **D2** | **D3** | **D4** | **D5** | **Overall** |
|---|---|---|---|---|---|---|
| Hamad et al 2023 | + | + | + | + | ? | + |
| Leung et al 2009 | + | + | − | + | ? | − |
| Monaco et al 2018 | − | + | − | + | + | + |
| Singh et al 2018 | + | + | + | + | ? | + |
| Progrel *et al.*,2004 | − | ? | ? | + | ? | ? |
| O' Riordan, 2004 | − | ? | ? | + | ? | ? |
| Renton *et al.*,2005 | + | + | + | + | − | + |
| Leung and Cheung, 2009 | + | + | + | + | ? | + |
| Dolanmaz *et al.*, 2009 | − | + | + | + | + | + |

| | | | | | | |
|---|---|---|---|---|---|---|
| Hatano *et al.*,2009 | + | ? | + | + | + | + |
| Cilasum *et al.*, 2011 | + | − | ? | + | ? | ? |
| Goto *et al.*, 2012 | − | + | + | + | ? | + |
| Leung and Cheung, 2012 | − | + | + | + | − | + |
| Monaco *et al.*,2012 | + | + | + | + | ? | + |
| Kohara *et al.*,2014 | − | + | + | + | − | + |

Table 2: *Risk of bias assessment with the recommended approach of Cochrane ROB 2*

*Abbreviations; D1: Bias arising from randomization process, D2: Bias due to deviation from intended interventions, D3: Bias due to missing data outcomes, D4: Bias in measurement of the outcome, D5: Bias in selection of the reported results. Red: High risk of bias, Orange: Some concerns, Green: Low risk of bias.*

| AUTHORS | PATIENTS (n) | No. EXTRACTIONS | No. CORONECTOMY PROCEDURES | FOLLOW-UP | SENSORY LOSS OF THE IAN | | PAIN ONSET | | INCIDENCE OF INFECTION | | INCIDENCE OF DRY SOCKET | | ROOT MIGRATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Ext | Cor | Ext | Cor | Ext | Cor | Ext | Cor | |
| Hamad et al 2023 | 212 | 252 | 220 | 24 months | 1 | 8 | 7 | 7 | 14 | | 10 | 12 | Away from IAC-163<br>Towards IAC-1 |
| Leung et al 2009 | 231 | 178 | 171 | 24 months | 9 | 1 | 102 | 65 | 12 | 9 | 5 | 0 | 3 months: 62.2%<br>6 months: 23.6%<br>12 months: 11.5%<br>24 months: 2% |
| Monaco et al 2018 | 94 | - | 116 | 5 years | - | - | 13 | 17 | 7 | 11 | 1 | - | 53 |
| Singh et al 2018 | 30 | 15 | 15 | 6 months | - | - | 2 | 3 | 2 | 1 | - | - | 5 |
| Progrel *et al.*,2004 | 41 | -- | 50 | 22 months | -- | 1 | -- | -- | -- | -- | -- | -- | 15 |
| O' Riordan, 2004 | 52 | -- | 52 | 120 | -- | 3 | -- | 2 | -- | 3 | -- | -- | -- |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | months | | | | 5 | | | | | |
| Renton *et al*., 2005 | 128 | 102 | 94 | 24 months | 19 | 0 | 22 | 8 | 1 | 3 | 10 | 7 | 0 |
| Leung and Cheung, 2009 | 152 | 178 | 171 | 24 months | 9 | 1 | 102 | 65 | 12 | 9 | 5 | 0 | |
| Dolanmaz *et al*., 2009 | 43 | -- | 47 | 24 months | -- | -- | -- | -- | -- | -- | -- | -- | 6 months: 3.4 mm<br>12 months: 3.8 mm<br>24 months: 4 mm |
| Hatano *et al*.,2009 | 220 | 118 | 102 | 12 months | 6 | 1 | 8 | 19 | 4 | 1 | 10 | 2 | 87 |
| Cilasum *et al*., 2011 | 124 | 87 | 88 | 6 – 30 months | 2 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | -- |
| Goto *et al*., 2012 | 100 | -- | 116 | 12 months | -- | 0 | -- | -- | -- | -- | -- | -- | 12 months: 2.6mm |
| Leung and Cheung, 2012 | 108 | -- | 135 | 36 months | -- | 1 | -- | 58 | -- | 6 | -- | -- | 6 months: 1.9 mm<br>12 months: 2.6 mm<br>24 months: 2.9mm<br>36 months 2.8 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | mm |
| Monaco *et al.*,2012 | 37 | -- | 43 | 12 months | -- | 0 | -- | 3 | -- | 0 | -- | 1 | 3 months: 75% 6 months: 37.5% 12 months: 0% |
| Kohara *et al.*,2014 | 92 | -- | 11<br>1 | 36 months | -- | 1 | -- | -- | -- | 9 | -- | 1 | 3 months: 1.84mm 12 months: 2.88mm 24 months: 3.41mm 36 months: 3.51mm |
| Frenkel *et al.*,2014 | 173 | -- | 18<br>5 | 12 months | -- | 1 | -- | 16 | -- | 2 | -- | 4 | 6 months: 41% - 2.2 mm (SD: 1.04) 12 months: 3.2% - 12.9 mm SD: 2.4) |

Table 2 shows parameters used for assessing selected studies

## Discussion

### IAN disturbance

All the studies included in the analysis revealed that the main reason for conducting coronectomy is to minimize inferior alveolar nerve (IAN) disruptions. There is a consensus among fifteen studies that coronectomy procedures are associated with a reduced likelihood of inferior alveolar nerve (IAN) disturbance when compared to full extraction. The aforementioned studies did not observe any instances of neurological impairment. The findings of this study are subject to various constraints. Two of the three case-control studies implemented the intervention of coronectomy or total extraction, with the allocation being determined by patient desire following a comprehensive discussion of the pros and disadvantages associated with both alternatives. In aggregate, there were a mere two instances of inferior alveolar nerve (IAN) disruption subsequent to coronectomy, with both individuals ultimately experiencing a full recovery. In a study conducted by Hatano et al., it was stated that a single instance exhibited recovery within a one-month period. The two examples presented by Leung and Cheung demonstrated recovery within a one-year timeframe. In contrast, a variety of recovery rates were observed in cases of inferior alveolar nerve (IAN) impairment following total tooth extraction. In their study, Cilasun et al. documented a single case that exhibited recovery within a one-month period. Similarly, Hatano et al. found that three out of six cases demonstrated recovery.

During an attempted coronectomy, there is a possibility of root mobilization, which may necessitate the surgeon to resort to total extraction. The majority of investigators have classified this as an unsuccessful coronectomy procedure. Coronectomy may also be unsuccessful as a result of postoperative findings, including the presence of residual enamel, wound dehiscence, infection, migration or exposure of the root, mobility of the root, or pulpitis. According to a systematic evaluation conducted by Dalle Carbonare et al. in 2017, the overall incidence of inferior alveolar nerve (IAN) disturbance resulting from failed coronectomies was found to be 2.6%. With the exception of instances involving delayed root exposure, the occurrence rate of inferior alveolar nerve (IAN) disturbance resulting from unsuccessful coronectomies is 4.0%. 9.According to Dalle et al., the success rate of coronectomies is 0.5%. These data demonstrate a favorable comparison to the reported incidence of inferior alveolar nerve (IAN) disturbance during total extraction of high-risk cases, which has been documented to be as high as 35% according to Barore et al. Mukherjee et al. have provided evidence indicating that unsuccessful coronectomies exhibit a reduced occurrence of inferior alveolar nerve (IAN) impairment in comparison to complete extractions.

Loss of sensitivity of the inferior alveolar nerve

The occurrence of inferior alveolar nerve sensitivity loss was assessed in fifteen investigations, both after complete surgical removal of the lower third molar and after coronectomy. Among these investigations, four conducted a comparison between the loss of sensitivity resulting from full extraction and coronectomy of the lower third molar. These studies found that complete extractions resulted in a higher number of cases where sensitivity loss of the inferior alveolar nerve occurred. In relation to the remaining papers, Monaco et al and Singh et al did not observe any instances of inferior alveolar nerve sensitivity loss with the coronectomy approach.Two studies documented temporary paresthesia of the lingual nerve.Kohara et al. reported a single instance of paresthesia, which accounted for 0.9% of the total cases.Frenkel et al. reported a single instance of transient paresthesia of the inferior alveolar nerve within the initial month following coronectomy.

Lingual nerve injury

The occurrence of lingual nerve impairment may be impacted by the execution of lingual retraction. Insufficient reporting of the coronectomy procedure was observed in the papers that were included. The authors Hamad et al., Monaco et al., Singh et al., and Renton et al. did not provide explicit clarification regarding the retraction of lingual tissues. However, they did state that the surgeons refrained from totally sectioning the crown and instead utilized leverage to remove it. Hatano et al. did not provide explicit details regarding the specific techniques employed, such as whether lingual retraction or partial sectioning was utilized. Leung and Cheung explicitly stated that lingual flaps were not raised throughout the procedure, but rather, the lingual aspect was safeguarded using a periosteal elevator. Additional research is warranted to investigate the potential protective effects of various components of the coronectomy procedure on the lingual nerve.

Pain

In relation to the experience of pain, the majority of research indicate that coronectomies often yield comparable or reduced levels of discomfort and edema when compared to complete extractions. The study conducted by Hatano et al. stands out from the others, since their group that underwent coronectomy procedure exhibited elevated degrees of discomfort, as assessed by the visual analog scale (VAS). The authors hypothesized that the observed outcome could be attributed to heightened pressure resulting from more stringent primary closure and pulpitis stemming from the coronectomized roots. There existed noticeable diversity in the methodologies employed to evaluate post-operative pain. Two research utilized the Visual Analog Scale (VAS) to measure pain, while another study employed a health-related quality of life (HRQOL) questionnaire. Additionally, two studies solely recorded the frequency of respondents who experienced pain. There were variations in both the duration of reviews and the recommended analgesic regimen. Enhancing the research process through additional refining measures aimed at minimizing confounding variables can enhance the overall robustness and reliability of the collected data.

Infection

The incidence of infection accompanied by the presence of pus following therapy was evaluated in nine of the investigations. The studies conducted by Leung and Cheung and Hatano et al. demonstrated a higher incidence of pus infections in patients who underwent complete surgical removal of impacted third molars in contact with the inferior alveolar nerve, compared to those who underwent coronectomy. Renton et al. and Cilasum et al. observed a higher incidence of infection following coronectomy compared to full extraction. O'Riordan, Leung, and Cheung exclusively documented the infections that occurred following coronectomy, with corresponding rates of 5.7% and 4.4%. In their investigation, Monaco et al. observed no instances of infections linked to coronectomy. Kohara et al. reported a total of 7 cases (6.3%) of incomplete wound exposures and 2 cases (1.8%) of root exposures with infection that required removal. Frenkel et al. reported a 1.1% incidence of pus-filled infections within the first month following 185 coronectomy procedures.(Frenkel et al 2015)

Dry socket/Alveolar osteitis.

Numerous studies have reported a decreased occurrence of dry socket subsequent to coronectomies. Leung and Cheung ascribed this phenomenon to the reduced size of the remaining socket and the enhanced stability of the blood clot following coronectomies. The study conducted by Renton et al. stands as the sole report presenting contrasting findings. The potential relationship between the surgical wound closure technique and the occurrence of dry sockets merits further consideration. Leung, Cheung, and Renton et al. did not provide explicit clarification regarding the attainment of primary closure. Cilasun et al. observed that the flaps were tightly closed, but Hatano et al. explicitly stated that primary closure was successfully achieved. Kang et al. successfully implemented a tension-free closure technique in conjunction with the application of gelatin sponge. Due to the insufficient reporting of the approach, it presents a challenge to determine whether the wound closure technique could potentially act as a confounding factor. Further research that delves into the coronectomy procedure in greater depth has the potential to offer a more comprehensive understanding of its impact on the occurrence of dry sockets.

Root migration:

Thirteen of the articles examined in this study focused on the phenomenon of root migration following coronectomy. According to Hamad's study, 74% of the roots migrated a distance of 3.85 mm during one year. Singh et al. detected no migration of retained root in 10 out of 15 patients after the third month. The average distance from the inferior border of the inferior alveolar nerve (IAN) to the apex of the retained root increased by 2.97 mm in five patients.After 6 months of follow-up, there was a significant increase of 3.43 mm in the distance between the inferior border of the inferior alveolar nerve (IAN) and the apex of the retained mandibular third molar root.Progel et al. conducted a study where they compared radiographs taken at the time of coronectomy with those taken 6 months after the treatment. They observed that in 30% of the cases, there was a migration of the fragment root of 2-3 mm from its initial position. Leung and Cheung and Monaco et al. observed the greatest proportion (62.2% and 75%, respectively) of migration of root fragments from third molars during the third month following coronectomy, with average distances of 1.90 mm and 1.60 mm, respectively. Furthermore, Dolanmaz et al. and Leung and Cheung observed that the greatest movement of the root pieces took place two years following coronectomy, with average distances of 4 mm and 2.90 mm, respectively. After the second year, there was a considerable decrease in the degree of migration, and this decrease was not shown to have any statistical relationship with patient age or gender. The study conducted by Kohara et al. found that root migration was much higher during the initial two years. The average root migration was measured at 1.84 mm in three months, 2.88 mm in one year, and 3.41 mm and 3.51 mm after two years.Starting with the second year post-surgery, 82.2% of the roots remained stationary.Goto et al. and Leung and Cheung found a notable rise in root migration among female patients when it comes to gender.Frenkel et al. observed a considerably higher level of migration in younger patients.

Limitations

The results derived from this literature analysis are ultimately shaped by the inherent limitations of the included research. Moreover, it is imperative to take into account the age of the participants in the research investigations while analyzing the findings, alongside the aforementioned constraints and other predispositions. The age range of persons who underwent coronectomy procedures varied from 26.5 years to 32.36 years.The numerical sequence submitted by the user contains the elements 2, 13,  The utilization of coronectomy in various patient populations may be somewhat restricted due to the somewhat lower average ages found. This evaluation specifically included studies that utilized control groups to minimize the possible influence of confounding variables on the main outcome. Due to the rigorous selection criteria implemented, the overall quantity of studies incorporated in the analysis is reduced, hence limiting the sample sizes accessible for the investigation of certain secondary outcomes. Subsequent research endeavors focused on examining the prevalence of root migration, root exposure, and reoperation rate may not require a comparative analysis involving a cohort that underwent complete extraction.

## Conclusion

According to this analysis, the utilization of coronectomy demonstrates a notable reduction in the occurrence of inferior dental nerve (IDN) deficit in comparison to the complete removal of wisdom teeth located in close proximity to the inferior dental canal. The healing process of coronectomy is associated with a reduced incidence of problems such as discomfort and dry socket, however its infection rate is comparable to that observed following complete extraction of wisdom teeth. The phenomenon of embedded roots exhibits a tendency to undergo migration of approximately 3 millimeters within the initial year following the surgical procedure. Subsequently, the majority of roots cease their migration process beyond the one-year mark. The available evidence suggests that coronectomy is a technique that demonstrates a satisfactory level of safety, particularly within the immediate postoperative period. Further investigation is necessary to ascertain the long-term prognosis of the root.

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