



# Coronectomy: a retrospective outcome study

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## Abstract

**Purpose** Inferior alveolar nerve (IAN) injury is reported as a complication following surgical removal of lower third molars. In cases where the IAN is intimately related to the roots of the tooth, coronectomy may be performed as an alternative. The objectives of this study were to record operative indications for coronectomy and assess the short- and long-term post-operative outcomes following coronectomy.

**Methods** This retrospective study included patients (19–95 years old) that had coronectomies carried out in the Edinburgh Dental Institute and Chalmers Dental Centre within the last 10 years. The patients were invited by letter to attend a review appointment. High-risk radiographic signs and short- ( $\leq 3$  months) and long-term complications ( $> 3$  months) were recorded.

**Results** A total of 124 patients were invited to participate and a total 28 patients returned for review. From the rest of the patients, data was extracted from their dental records. IAN injury was reported in 5 cases (4.3%) as a short-term complication and in 2 cases (3.5%) as a long-term complication. One patient presented with eruption of roots at the review appointment 7 years following surgery. In this study, ‘very’ long-term complications were recorded as the 28 patients that returned for a review, were seen on an average of 4.8 years post-operation.

**Conclusions** Coronectomy is a relatively safe technique for preservation of the IAN. However, prospective large scale research is needed to more accurately report on the prevalence of short- and long-term complications.

**Keywords** Coronectomy · Surgical extraction · Third lower molars · Inferior alveolar nerve (IAN) injury

## Introduction

Surgical removal of lower third molars is the most common surgical procedure carried out in everyday practice in Oral Surgery. However, surgical extraction of these teeth can involve a number of complications with the most important being the injury to the inferior alveolar nerve (IAN) [1–3]. Following removal of high-risk mandibular third molars, IAN injury may result in temporary (20%) or permanent (2%) altered or loss of sensation to the lower lip, chin, teeth, and gingivae on the operated side [1–4].

The need to reduce IAN injury has led surgeons to look for an alternative surgical technique for treatment of third molars. Coronectomy was first proposed back in 1984 and this technique has gained increased popularity in recent years [5]. Coronectomy, or intentional partial odontectomy, involves the removal of the crown of a tooth and at the same time the deliberate retention of the root(s). If completed successfully, this technique helps to avoid injury to the IAN [1, 3].

The relationship of the IAN to the impacted tooth, and subsequently the possible need for a coronectomy, can be identified through pre-operative radiographic assessment [6]. Three radiological signs are most predictive of an intimate relationship between the impacted tooth and the IAN, namely darkening of the roots in relation to the canal, interruption of the white (radiopaque) lines of the canal, and diversion of the canal [6–8]. Rood and Shehab also mentioned other signs including deflected roots, narrowing of roots, dark and bifid roots, and narrowing of the canal [6].

Although coronectomy was first described almost 3 decades ago, it has only recently gained popularity owing to concerns about outcomes and potential complications. Complications can be classified as short-term—pain,

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bleeding, swelling, infection, dry socket, delayed or non-healing sockets, need for extraction, and nerve injury; and long term—migration of roots, eruption of roots, infection/chronic inflammation, nerve injury, need for reoperation/extraction, and others (i.e. sensitivity) [1, 3, 9]. Regarding dry socket, the incidence following coronectomy has been widely reported in previous studies and is described as the occurrence of severe pain, loss of blood clot from the socket, and wound breakdown post-operation [1, 3, 10]. The need for extraction, although an outcome of coronectomy, is included in the list of complications as it is mentioned in other papers [1, 3, 4, 10]. While short-term outcomes have been described in a number of studies, a lack of evidence base is noted with regard to long-term complications post-coronectomy [11].

The aim of this study was to record operative indications for coronectomy and to assess the short- and long-term outcomes following coronectomy.

## Materials and methods

This study was a 10-year retrospective observational study. Ethical approval was granted by the NHS South East Scotland Research Ethics Committee (REC reference: 16/SS/0210) and the NHS Research & Development board.

Coronectomy patients (19–95 years old) that were treated in the Edinburgh Dental Institute (EDI) and Chalmers Dental Centre (CDC) in the last 10 years who were able to give consent were included in the study. Deceased patients (identified through TRAK Health Care System), patients unable to provide consent, and patients with a history of failed coronectomy were excluded from the study.

Patients who fulfilled the inclusion criteria were sent an initial invitation letter explaining the purpose of the study. Patients who were happy to participate were sent a second letter including the participant information sheet (PIS) which explained the study protocol in more detail. Subsequently, patients attended a 20-min review appointment at EDI between April 2017 and July 2017.

During the review appointment, an interview and clinical oral examination took place. A post-operative radiograph was also taken when clinically necessary. The occurrence of any post-operative complications along with relevant radiographic signs was recorded. Complications were divided into short-term ( $\leq 3$  months) and long-term ( $> 3$  months) complications (Table 1).

Additionally, the dental records of all patients that fulfilled the inclusion criteria were collected and analysed with regard to post-operative coronectomy outcomes. The operative indications, any high-risk radiographic signs, and whether or not a cone-beam computed tomography (CBCT) was obtained were also recorded.

All patient-related data was anonymised and patients were only identifiable to researchers involved.

## Statistical analysis

Data was transferred onto a spreadsheet (Excel 2015; Microsoft), and SPSS 22 was used for statistical analysis. Basic descriptive statistics were used to analyse the rate of short- and long-term complications post-coronectomy. Differences were tested for statistical significance by using a chi-square test. Statistical significance was set to  $p < 0.05$ .

## Surgical technique

The surgical protocol for coronectomy followed in both centres was based on the technique described by Renton [3, 4]. Following administration of effective local anaesthesia, a 3-sided mucoperiosteal full thickness buccal flap was raised. Buccal bone removal with a round or fissure bur was performed to create a narrow buccal gutter down to the cemento-enamel junction (CEJ). Decoronation of the tooth was performed by initially cutting through the CEJ with the fissure bur. The cut was lateralised along the CEJ to a depth no deeper than the cutting edge of the fissure bur to avoid perforation of the lingual plate. Decoronation was then completed with an elevator such as a straight Warwick James or a Coupland's elevator I. Following removal of the crown, the root was tested for mobility with immediate removal of the root indicated if mobile. In cases where the root was confirmed to be stable, a rose-head bur was then used to ease the root surface 3–4 mm below the alveolus ensuring removal of all remaining enamel. The pulp was left untouched at all times. Closure was performed with resorbable sutures by a simple approximation of the wound edges or primary closure, depending on the preference of the clinician. Chlorhexidine mouthwash was advised for post-operative care and no prophylactic antibiotics were prescribed.

The procedures were carried out by clinicians of different levels of experience as both units are training centres. The surgeons in question were consultants, speciality registrars, or post-graduate students.

## Results

In total, 124 patients from EDI and CDC databases fulfilled the inclusion criteria and were invited to participate in the study. Forty-one patients replied to the invitation letter, and a total of 35 patients were interested in participating in this study. Twenty-eight patients (10 males, 18 females) returned for review at the EDI clinic. From the patients that did not attend or reply, data was collected from their dental records. Therefore, data was obtained from 124 patients (33 males, 91

**Table 1** Short- and long-term complications post-coronectomy

| Short-term complications (≤3 months) | Long-term complications (> 3 months) |
|--------------------------------------|--------------------------------------|
| Bleeding                             | IAN injury                           |
| Pain                                 | Eruption of roots                    |
| Infection                            | Infection/chronic inflammation       |
| Dry socket (alveolar osteitis)       | Root migration                       |
| IAN injury                           | Need for reoperation/extraction      |
| Delayed healing/non-healing sockets  | Others (i.e. sensitivity)            |
| Need for extraction                  |                                      |

females), which resulted in data from 133 teeth, as 9 patients underwent coronectomy bilaterally.

The average age of the 124 patients on the day of surgery was 34.3 years. In addition, 53% of coronectomies were performed on the left side and 47% on the right. Most patients had 1 post-operative review (52 patients/39.1%), while 33 (24.8%) and 33 (24.8%) patients had reported 2 and ≥ 3 reviews respectively.

Radiographic signs showing a high risk of nerve involvement were as follows: darkening of roots 83.3% (111/133), deviation of the canal 19.5% (26/133), loss of lamina dura 26.2% (35/133), narrowing of the canal 4.5% (6/133), juxta-apical area 2.2% (3/133), deflection roots 0% (0/133), and narrowing of roots 0% (0/133). On average, 1.33 total signs were observed per tooth. Three cases demonstrated no signs of high-risk involvement, but they underwent coronectomy due to complexity of the procedure, i.e. difficulty elevating the roots intra-operatively. CBCT was obtained for 21.8% (29/133) of the cases.

Fifteen of the patients failed to return for review following the procedure and consequently were excluded from further analysis of post-operative complications. One hundred and eighteen teeth were analysed for complications related to coronectomy, from which 116 attended for a short-term (≤ 3 months) review and 57 for a long-term (> 3 months) review. The incidence of pain, bleeding, infection, dry socket, IAN injury, delayed/non-healing socket, root migration, and need for reoperation/extraction was reported as short-term complications (Table 2). The average time to short-term review was 3.4 weeks.

An early post-operative radiograph was taken in 3 patients (2.6%), in which root migration was present in 2, with a mean migration distance of 3.3 mm. In addition, antibiotics were prescribed post-operatively in 12 patients (10.3%) by the oral surgeon at the review appointment or by the general dental practitioner (GDP) at a previous emergency appointment.

Long-term complications (> 3 months) following coronectomy were reported in 57 follow-ups, with the average time to long-term review being 17.4 months. Events of root migration, eruption of roots, infection/chronic inflammation, need for reoperation/extraction, IAN injury, and others (i.e.

sensitivity) were the main complications examined in follow-up review (Table 3).

Subsequently, in 9 patients (15.8%), a post-operative radiograph was taken on a long-term review. Root migration was observed in 5 of these cases with an average migration of 3.2 mm. Only 1 patient (1.7%) reported sensitivity in the area of previous operation 9 months after the procedure.

At this point, it is worth mentioning that 21 (22 teeth) out of the 28 patients that were recalled by the authors returned to the clinic on a follow-up with an average of 4.8 years post-operation; therefore, ‘very’ long-term complications could be examined. In particular, 1 patient presented with eruption of roots, and another with hypoesthesia of the lower right lip at a 7- and 2-year review respectively.

In general, older patients were more likely to present with complications, both early and late, associated with coronectomy. This difference was statistically significant ( $p = 0.007$ ). However, gender appears not to correlate with the incidence of complications related to coronectomy ( $p > 0.05$ ). Similarly, the existence of high-risk radiographic signs has not been related to the incidence of any complication post-coronectomy ( $p > 0.05$ ). Finally, the time to review following operation appears to be important for the presence of short-term complications. Specifically, 2-week post-operative reviews are more likely to present complications, rather than later reviews ( $p < 0.001$ ).

**Table 2** Incidence of early (≤ 3 months) complications associated with coronectomy

| Short-term complications        | Percentage (number of events, $n = 116$ ) |
|---------------------------------|---|
| Pain                            | 19.8% (23)                                |
| Bleeding                        | 1.7% (2)                                  |
| Infection                       | 13.7% (16)                                |
| Dry socket                      | 14.6% (17)                                |
| IAN injury                      | 4.3% (5)                                  |
| Delayed/non-healing socket      | 0.8% (1)                                  |
| Root migration                  | 1.7% (2)                                  |
| Need for reoperation/extraction | 0.8% (1)                                  |

**Table 3** Summary of long-term (> 3 months) complications associated with coronectomy

| Long-term complications         | Percentage (number of events, <i>n</i> = 57) |
|---------------------------------|--|
| Root migration                  | 12.2% (7)                                    |
| Eruption of roots               | 1.7% (1)                                     |
| Infection/chronic inflammation  | 5.3% (3)                                     |
| Need for reoperation/extraction | 1.7% (1)                                     |
| IAN injury                      | 3.5% (2)                                     |
| Others (i.e. sensitivity)       | 1.7% (1)                                     |

## Discussion

This study was a 10-year retrospective study, giving the opportunity for the first time to investigate the incidence of ‘very’ long-term complications. The purpose of this study was to examine the presence of operative indications and the rate of short- and long-term post-operative complications following coronectomy. Age, gender, and time to review were also evaluated and compared with the incidence of complications post-coronectomy. The main findings of the present study were as follows: (a) increasing age of patients may result in more complications post-operation; (b) in earlier reviews ( $\leq 2$  weeks); complications were more likely to be reported; and (c) pain (19.8%), dry socket (14.6%), and infection (13.7%) were the main short-term complications.

Although ageing was associated with more post-operative complications ( $p = 0.007$ ), gender and radiographic signs appear not to be related to the incidence of complications ( $p \geq 0.05$ ). Hatano et al. [10] did not observe a statistically significant difference between age and complications. However, their study divided patients into two age groups—< 30 year-olds and > 30 year-olds—rather than comparing the total of complications to the mean age. No statistically significant differences were reported when comparing gender and complications in previous studies, which is in line with the results of this study [1, 10].

CBCT was used in 29 cases for further assessment of IAN-root relationship. Although studies have demonstrated that following CBCT a decision change on the treatment plan may occur [3, 12], the SEDENTEXCT guidelines suggest that a scan is redundant in the cases where a decision is made for coronectomy based on a conventional radiograph [13].

With regard to the prevalence of post-coronectomy complications in this study, pain was the greatest short-term complication, reported in 19.8% of patients. It should be noted that in a retrospective study, limited information can be obtained as no additional tools, e.g. visual analog scale (VAS), can be used to assess the level of pain. However, these results are confirmed by the Hatano et al. study (18.6%) that used a VAS [10]. Similarly, Long et al. [14] in their systematic review concluded that approximately 23% of patients experienced

pain following coronectomy, in comparison to 26% of patients following extraction. Leung and Cheung reported a remarkably higher rate of pain (41.9%) although it was still lower than the incidence of pain following extraction (57.3%). However, Leung and Cheung reviewed patients relatively early (1 week post-coronectomy) [1].

In addition, complications such as dry socket and infection were observed in a relatively higher rate in this study when compared with previous ones. Specifically, 14.6% of patients had dry socket, while other studies reported percentages of 0–2% [1, 15]. However, Renton et al. [3] presented high percentage (12.1%), which is comparable with the present study. Regarding infection, this study observed a 3-times higher incidence of infection in patients than previous studies [1, 3, 10, 15, 16]. The high percentage found in the present study may relate to the fact that some of the patients were treated by their GDP for infection and subsequently reported this incidence of infection to the oral surgeon on the day of the follow-up. Notably, two patients experienced recurrent episodes of infection resulting in a second operation for removal of the retained roots, at 4 weeks and 1 year post-coronectomy.

Root migration (mean distance of 3.3 mm) was reported in 2 cases as a short- and in 7 cases as a long-term observation in this study. However, post-operative radiographs were only taken in 12 patients and not at a specified time after the procedure. This would suggest that the incidence of root migration cannot be properly evaluated in this study. Interestingly, one case of erupted roots (1.7%) was recorded at 7 years following surgery, which is in agreement with previous studies indicating 0.6–1.8% root eruption in long-term reviews [17–19]. However, the exact timing of the eruption could not be specified. It is worth mentioning that this was a case where coronectomy was chosen as an unplanned procedure (no presence of high-risk radiographic signs) due to the difficulty in elevation of the roots. The patient decided not to proceed with removal of the erupted roots as they did not cause any problems, although they have been warned about possible complications such as infection.

The incidence of IAN injury, the most significant complication related to third molar extraction, appears to be reduced after coronectomy, as reported in many studies [1, 10, 20, 21]. Indeed, 5 (4.3%) cases of IAN injury were observed in the present study, which is high in comparison to the incidence reported in literature (0.98%) [1, 10]. However, relative to the incidence of nerve damage with high-risk wisdom teeth, this rate is favourable [4]. Interestingly, all teeth had a difficult angle of impaction (3 distoangular, 2 horizontal) and 3 out of 5 were unerupted. In addition, 3 out of 5 presented with two high-risk radiographic signs. In two of the cases, it remained unclear if IAN injury resulted in temporary or permanent damage as the patients did not return for further reviews after the diagnosis. One case reported altered sensation 2 weeks post-operatively, which resolved when they attended

a follow-up at 4 years. Finally, hypoesthesia of the lower lip was observed in two patients at a 7-month and a 2-year follow-up.

The higher incidence of IAN injury reported in this study may be due to different levels of skill of the operators in both centres. Both EDI and CDC are training centres and have trainees of varying levels treating patients.

This study confirmed that patients who attended a review appointment 2 weeks post-operation presented a higher incidence of short-term complications, compared with later reviews. Similarly, Leung and Cheung reviewed patients at 1 week following coronectomy, indicating a high percentage of complications such as pain [1]. In contrast, studies with later reviews (1 month etc.) reported a relatively lower rate of complications [15, 16]. A lack of guidelines in regard to a specific timeline and frequency for review following coronectomy leads to a variety of follow-ups among the studies. This variation may cause confusion and misleading in the interpretation of results regarding complications associated with coronectomy, as it is difficult to compare the studies with different timelines. One could argue that although a later review may present a more comprehensive view of complications, an earlier review may have better prognosis in the management of IAN injury.

### Limitations

The difficulty associated with retrospective recalling of patients, i.e. wrong contact details, a long time from operation, and the variation on timing and frequency of reviews were the main limitations of this retrospective study. Only one third of patients replied to the invitation, while a higher number of participants would have provided us with more significant data specifically regarding long-term complications. Therefore, it is suggested that further large-scale prospective studies with specific timelines for review following coronectomy are needed in order to accurately determine incidence of complications and ensure the safety of the procedure.

### Conclusion

Coronectomy is an alternative to removal of high-risk third molars. The results of this study were in line with findings of previous studies which examined the incidence of complications following this procedure. These results suggest that coronectomy is a relatively safe procedure to perform for preservation of the IAN in high-risk third molars. However, it also confirms the occurrence of adverse outcomes related to the procedure and, therefore, the fact that further research is needed to verify the prevalence of both short- and long-term complications.

### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** This study has obtained ethical approval from the NHS Research Ethics Committee of South East Scotland and the NHS Research and Development board.

**Informed consent** Informed consent was obtained from all individual participants included in this study.

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