

Long-term morbidities of coronectomy on lower third molar



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Objective. To monitor the long-term morbidity of retained roots up to 5 years following lower third molars coronectomy with close proximity to the inferior alveolar nerve (IAN).

Study Design. A prospective study on long-term morbidities after lower third molar coronectomy.

Results. This study included 612 lower third molar coronectomies in 458 patients. The prevalence of IAN injury was 0.16% (1/612) and was temporary. Long-term postoperative infection occurred in 1 case at 6 months following surgery and another at 12 months. No infection was found after 12 months. The incidence rates of pain at 6 months, 12 months, 24 months after surgery were 0.50% (3/596), 0.38% (2/529), 0.49% (2/411), respectively. Root exposure was noted in 2.3% of cases (14/612). Reoperation to remove the exposed root did not cause any IAN deficit.

Conclusions. Lower third molar coronectomy is safe in the long term. (Oral Surg Oral Med Oral Pathol Oral Radiol 2016;121:5-11)

Lower third molar impaction is a common finding in the population, and pericoronitis and dental caries are commonly associated with impacted third molars. Lower third molar surgery is therefore the most common surgical procedure performed in the oral cavity. A rare but significant risk from lower third molar surgery is injury to the inferior alveolar nerve (IAN), leading to paresthesia or even anesthesia of the lower lip and chin region on the affected side. The incidence of IAN deficit ranges from 0.3% to 8.4%, and a significant proportion could be permanent.¹ Injury to the IAN has been found by an evidence-based review to be associated with increased age, deep impaction, and proximity of the root to the inferior dental canal associated with specific radiographic signs and intraoperative IAN exposure.² Since the risks are mostly inherent to third molar impaction, this may not be totally avoidable even in the hands of experienced surgeons.²

Coronectomy of the lower third molar is a new surgical option to manage symptomatic lower third molar impaction. It is a surgical procedure that intentionally removes only the crown of an impacted mandibular third molar, leaving the root undisturbed, thus avoiding possible direct or indirect damage to the IAN.³ Our

center has published the finding of a phase 3 randomized controlled trial (RCT) comparing coronectomy and total removal of the mandibular third molar in close proximity to IAN and confirmed that coronectomy was superior to traditional third molar surgery, with a much smaller risk of postoperative IAN deficit.⁴ However, reports of well-designed, prospective, phase 4 long-term studies of coronectomy are lacking in the literature. The long-term safety of coronectomy and the behavior of the retained roots following of lower impacted wisdom teeth following surgery are unknown. We published the pilot data of 135 coronectomies and showed that the technique is safe within the first 3 years.⁵ This study serves to present the complete longitudinal data of a large sample of coronectomized teeth up to 5 postoperative years.

The aim of this study was to monitor the long-term morbidities of retained roots following coronectomy of impacted lower third molars up to 5 postoperative years.

MATERIALS AND METHODS

This was a prospective study on the long-term safety of coronectomy and the behavior of the retained roots of the impacted lower third molars following surgery. The study followed the guideline of the Helsinki Declaration. Ethic approval was granted by the local institutional review board (HKU/HA HKW IRB UW 10-001). This study provides further evidence from a phase 3 RCT on the long-term safety of coronectomy with

The study was presented as oral presentation in the 11th Asian Congress in Oral and Maxillofacial Surgery, 2014, in Xi'an, China. This study was based on a thesis submitted to the University of Hong Kong, in partial fulfillment of the requirements for the PhD degree. A preliminary report was published in the *Journal of Oral and Maxillofacial Surgery* (Leung YY, Cheung LK. Coronectomy of lower third molar is safe within the first 3 years. *J Oral Maxillofac Surg.* 2012;70:1515-1522).

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Statement of Clinical Relevance

This study is, by far, the largest prospective long-term study on coronectomy of lower third molar with high inferior alveolar nerve risk and showed that the technique carried very low morbidity in 5 years.

regard to neurosensory deficits compared with total removal of an impacted lower third molar.⁴ Pilot data of a smaller sample up to 3 postoperative years were published and included in this final database.⁵

Eligible patients

Patients who were referred to the Discipline of Oral and Maxillofacial Surgery, Faculty of Dentistry, the University of Hong Kong, for treatment of impacted lower third molars were included if they showed one or more of the following radiographic signs and agreed to undergo coronectomy of lower third molar:

1. Darkening of third molar root(s)
2. Abrupt narrowing of third molar root(s)
3. Interruption and loss of the white line(s) of inferior alveolar canal (IAC)
4. Displacement of the IAC by the root(s)
5. Abrupt narrowing of one or both of the canal white line representing the IAC(s)

Patients who had successful coronectomies of their impacted lower third molars during the previous RCT conducted at our center were also included in the study.⁶ Written informed consents were obtained from all included patients.

Exclusion criteria included the following:

1. Lower third molar with roots not touching the IAN cortical lines on orthopantomogram
2. Lower third molars presented with apical pathology
3. Pre-existing neurosensory deficit of IAN
4. Systemic condition predisposing local infection: diabetes, acquired immunodeficiency syndrome, concurrent chemotherapy
5. Local factors predisposing infection: metabolic bone diseases (e.g., fibrous dysplasia), history of radiotherapy on mandible
6. Cystic or neoplastic lesion associated with the lower third molars
7. Mobile roots which removed during coronectomy procedures

Preoperative and postoperative assessments

Preoperatively, patients' demographic characteristics (age and gender), tooth status (eruption status, pattern and depth of impaction, root shape, and radiographic signs), and baseline neurosensory test results were recorded.

The patients were reviewed postoperatively at 1 week, 6 months, 12 months, 24 months, 36 months, and 60 months. The following findings were recorded at each follow-up assessment:

1. The presence of lingual nerve (LN) or IAN deficit, recorded with a standardized neurosensory test,

including subjective and objective assessments. Neurosensory deficit was considered to be present when there were both subjective sensory changes and changes in objective measurements, which included light touch test, two-point discrimination, and pain threshold test, compared with preoperative neurosensory baseline values.

2. Pain scores were recorded with a visual analogue scale (VAS) from 0 (no pain) to 10 (most severe pain).
3. Presence of infection pus, fever, and pain.
4. Presence of dry socket, with loss of blood clot or wound breakdown and severe pain in the early postoperative period.
5. Root exposure in the oral cavity.
6. Time and reason for reoperation and the incidence of IAN deficit after reoperation.
7. Development of any pathology.

Standardized orthopantomography (Gendex Orthoralix 9200, Kavo, Italy) was performed at the review appointments to check the root status and presence of any pathology.

Surgical technique

The surgical procedures were performed under local anesthesia, intravenous sedation with local anesthesia, or general anesthesia by the surgical residents.

After standard disinfection and draping, a three-sided mucoperiosteal flap was incised and raised. A lingual flap was not raised, but a periosteal elevator was used to protect lingual tissue. Buccal and distal bone was then removed until the cemento-enamel junction was accessible. The crown was removed along the cemento-enamel junction with a fissure bur. The cut root surface was trimmed down to at least 3 to 4 mm below the bony margin. If there was any mobility of the root, the coronectomy procedure was considered unsuccessful, and the case was removed from the study. The wound was then closed primarily with resorbable polyglactin sutures after thorough cleaning and irrigation. Routine analgesics with paracetamol and codeine phosphate were prescribed. No antibiotics were given.

Outcome measures

The primary outcomes of the study were morbidities, including neurosensory deficit, pain, infection rate, and root exposure rate. The secondary outcomes included dry socket rate, incidence of reoperation, and the rate of pathology development.

Criteria of termination of study

As this was the first phase 4 clinical trial on coronectomy of lower third molars, the criteria for study

termination were set before the start of the study if the coronectomy was considered hazardous or might cause significant morbidities to the patients in the long term. The criteria were set to be 10% incidence of pain, infection, or development of any pathology at any period of review at 6 months postoperatively and onward. Annual data from 2009 to 2013 were to be analyzed.

RESULTS

This study included 612 lower third molar coronectomies performed in 458 patients (286 females and 172 males). The surgical procedures were performed between June 2006 and May 2013. The mean age of the patients was 28.0 years (standard deviation [SD] 7.9 years). The number of patients (in terms of coronectomy cases) attended the 1-week, 6-month, 12-month, 24-month, 36-month, and 60-month follow-ups were 612, 596, 529, 411, 324, and 126, respectively. The characteristics of coronectomized teeth, related radiographic signs, and the mode of anesthesia of the operations are presented in [Table I](#).

Morbidities after coronectomy

The morbidities of coronectomy are presented in the following sections and are summarized in [Table II](#).

Neurosensory deficit. One patient (0.16%) presented with postoperative IAN deficit as moderate hypoesthesia of the lower lip but was seen to have recovered at the 12-month follow-up. There was no lingual nerve deficit following coronectomy in all cases.

Infection. The infection rate at week 1 after coronectomy was 2.9% (18/612). All patients with infection who presented in this follow-up time were treated with antibiotics and local measures, including debridement with or without incision and drainage, and the infections resolved uneventfully. None of these cases presented with subsequent chronic infection or required removal of the retained root.

One patient (0.19%, 1/529) presented with infection postoperatively at 12 months and required removal of the retained root. One patient (0.24%, 1/411) presented with infection at 24 months postoperatively and required removal of the retained root. There were no incidences of infection postoperatively at 6 months, 36 months, and 60 months.

Pain. There were 31.2% (191/612) of the patients in the study who reported pain at postoperative week 1. For those who complained of pain, the pain intensity VAS score was 3.2 (SD 1.7) out of 10.

Patients who complained of pain postoperatively at 6 months, 12 months, and 24 months were 0.50% (3/596), 0.38% (2/529), and 0.49% (2/411), respectively. For these patients, the pain intensity VAS scores at 6

months, 12 months, 24 months were 2.7 (SD 0.58), 2.5 (SD 0.71), and 2.0 (SD 0) out of 10, respectively.

No patients complained of pain postoperatively at 36 months and 60 months.

Dry socket. One patient (0.16%) presented with dry socket in the first week postoperatively. The condition was treated with local measures, including irrigation and pain control. The patient healed uneventfully.

Root exposure ([Figure 1](#)). The overall root exposure rate was 2.3% (14/612) among all the cases in this study. All roots except one were removed after exposure in the oral cavity. Root edge exposure was noted in one case postoperatively at 60 months and was treated with trimming of the exposed root edge.

None of the roots was seen to be exposed at postoperative week 1. The incidences of root exposure postoperatively at 0–6 months, 7–12 months, 13–24 months, 25–36 months, and 37–60 months were 0.67% (4/596), 0.38% (2/529), 0.73% (2/411), 0.31% (1/324), and 2.4% (3/126), respectively.

Development of pathology. None of the patients in the study developed any pathology at all follow-up time points.

Reoperations and removal of the retained roots

Of the study patients, 20 (3.3%) required reoperation. Incomplete crown removal was noted in one case (0.16%) at the first postoperative week and reoperation to remove the residual crown portion was performed at the second postoperative week ([Figure 2](#)). A case of root exposure was noted postoperatively at 60 months, and the exposed root edge was trimmed without removing the root. In the other 18 cases (2.9%), the retained lower third molar roots were removed. As reported in the previous sections, in 2 cases (0.49%), the lower third molars were removed due to chronic infection noted around the retained roots, and 13 patients (2.1%) presented with root exposure and their teeth were removed surgically. There were two cases (0.49%) of reoperations to remove the roots because the patients complained of mild, vague pain at the posterior mandible despite no correlation with root exposure or infection. One patient (0.16%) decided to undergo orthognathic surgery after receiving coronectomy of the lower third molar. The root was removed during the sagittal split osteotomy. There were no neurosensory deficits after any of these reoperations. A summary of the reasons for reoperation and the related symptoms is presented in [Table III](#).

DISCUSSION

This study is, by far, the largest prospective study on coronectomy of impacted lower third molars reported in

Table 1. Characteristics and radiographic signs of coronectomized teeth and mode of anesthesia of the operations

Tooth		
Left lower third molar (38)	53.1%	(325/612)
Right lower third molar (48)	46.9%	(287/612)
Eruption Status		
Erupted	1.3%	(8/612)
Partially erupted	60.3%	(369/612)
Unerrupted	38.4%	(235/612)
Pattern of Impaction		
Vertical	10.6%	(65/612)
Horizontal	38.6%	(236/612)
Mesioangular	44.1%	(270/612)
Distoangular	6.7%	(41/612)
Winter's Depth of Impaction		
0–4 mm	21.6%	(132/612)
5–9 mm	52.6%	(322/612)
10–14 mm	22.4%	(137/612)
>15 mm	3.4%	(21/612)
Root Form		
Conical	30.4%	(186/612)
Divergent	20.9%	(128/612)
Parallel	48.7%	(298/612)
Radiographic Signs		
Darkening of root	35%	(214/612)
Abrupt narrowing of root	4.1%	(25/612)
Interruption or loss of canal white line	92.5%	(566/612)
Displacement of canal white line by root	24.5%	(150/612)
Abrupt narrowing of canal white line	8.8%	(54/612)
No. of Radiographic Signs		
1 sign	50%	(306/612)
2 signs	36.4%	(223/612)
3 signs	12.3%	(75/612)
4 signs	1.3%	(8/612)
Mode of Anesthesia		
General anesthesia	34.3%	(210/612)
Intravenous sedation and local anesthesia	4.9%	(30/612)
Local anesthesia	60.8%	(372/612)

the literature and is also the first phase 4 clinical trial after a large phase 3 RCT reporting on the short-term safety of the treatment. The key finding of this study is that coronectomy of lower third molars carries minimal morbidity in the long term.

A clinical trial is set to determine the safety and efficacy of an intervention by measuring certain clinical outcomes. A phase 4 clinical trial is conducted to find out the side effects and safety of a treatment or drug in the long term.⁶ At our phase 3 RCT to compare coronectomy and total removal of lower third molars, the findings proved that coronectomy could significantly reduce the risk of postoperative IAN deficit in cases with roots lying in close proximity to the nerve.⁴ It was also proven that short-term (within 2 years) morbidity rates following coronectomy were comparable with those for total removal of lower third molars. However, coronectomy being a relatively new treatment, its long-term safety has not been proven in any well-conducted prospective studies. It was not a

surprise to see resistance in oral surgeons to coronectomy even after several smaller-scale clinical studies had reported on the technique to prevent IAN injury.^{7,8} After two RCTs (including the work from our group) proved that coronectomy could significantly prevent IAN injury in high-risk cases with minimal morbidities, at least in the short term, attention focused on the long-term safety of coronectomy.^{3,4} Subsequent smaller-scale clinical studies all reported only the short-term outcomes and morbidities of the technique, and the clinical question of long-term safety remained unanswered.^{9–11} This study therefore aimed to provide new information to add to existing knowledge on coronectomy of the lower third molars. As this was the first phase 4 clinical trial, we were cautious with regard to the possible side effects of coronectomy that might appear during the study. Therefore the criteria for study termination were set to be 10% of the study participants presenting with morbidities following treatment. It was proven that coronectomy was safe, and the procedure has passed all the annual audits. We have published the 3-year results from the pilot data of this study, showing promising outcome, and thus have confirmed the safety of this technique in longer term.⁵

In all the cases in this study, the impactions were considered to be in close proximity to the IAN. The prevalence rate of IAN deficit was only 0.16% when coronectomy was performed in these high-risk cases. The only case of IAN deficit after coronectomy was believed to have occurred because the crown sectioning at the cemento-enamel junction of the third molar was lying in close proximity to the IAN, leading to the postoperative complication. The IAN deficit, however, was temporary, and the patient recovered after 12 months, which indicates that the nerve injury was likely to be neurapraxia. Other studies have reported that IAN deficit might also happen after coronectomy,^{10,12} but the overall prevalence rate is very low and shows that coronectomy is significantly less risky than total excision.

One major safety concern after coronectomy is infection, since the pulpal system of a lower third molar is exposed after decoronation. In the previous RCT at our center, no statistical differences were observed between coronectomy and total excision of lower third molar within 2 years.⁴ In this study, infection occurred in 2.9% of the cases in the first week. Like all oral surgical procedures, infection may occur as an early postoperative complication, especially when postoperative antibiotics are not prescribed or there is pericoronitis. An important finding in our study was that all the cases with acute infection developed in the first postoperative week could be managed with local measures and antibiotics, and in all of these cases, there was no infection of the retained root or

Table II. Morbidities after coronectomy at various follow-up times up to 5 years

	1 week (n = 612)	6 months (n = 596)	12 months (n = 529)	24 months (n = 411)	36 months (n = 324)	60 months (n = 126)
Infection rate	2.9%	0	0.19%	0.24%	0	0
Pain incidence	31%	0.50%	0.38%	0.49%	0	0
Mean pain intensity (VAS 0-10)	3.2 (SD ± 1.7)	2.7 (SD ± 0.58)	2.5 (SD ± 0.71)	2 (SD ± 0)	0	0
Dry socket	0.16%					
Root exposure	0	0.67%	0.38%	0.73%	0.31%	2.4%
Development of pathology	0	0	0	0	0	0

VAS, Visual analogue scale; SD, standard deviation.



Fig. 1. Radiograph of an exposed root as a consequence of continuous migration.

development of chronic infection. It was suggested that revascularization occurred in the decoronated open pulp and that this provided sufficient local immune defense when the acute infection was treated adequately with local measures and antibiotics.¹³ This theory was based on a previous animal study that had shown that retained root after teeth decoronation could undergo angiogenesis from the surrounding tissues in retaining its vitality.¹⁴ In the literature, there is a knowledge gap with regard to the actual infection rate in the long term after coronectomy of impacted lower third molars. Most studies did not report a sizable number of cases with sufficient follow-up time of over 3 years. This study showed that the long-term infection rate was extremely low (two cases within the first 2 years), and no infection was observed in the 126 cases that were reviewed for 5 years.

Root exposure might happen if root migration persisted. Studies on coronectomy have reported controversial findings on root exposure. Those studies that reported no incidence of root exposure had smaller samples or shorter follow-up periods.¹⁵ One study reported a root exposure rate of 2%, with the patients



Fig. 2. A case with incomplete crown removal and required reoperation.

requiring reoperations.¹⁶ In our study, root exposure was the main cause of reoperation, but the overall incidence was similarly very low (2.3%). Most of the patients with exposed root complained of sensitivity to cold at the third molar region or presented with some mild discomfort over the exposed root area. It was important to note, however, that none of the reoperation cases for root retrieval from root exposure developed any postoperative IAN deficit. This finding supports the logical thinking that if the root migrated away from the nerve canal and even exposed into the oral cavity causing symptoms, reoperation to retrieve the root would pose a much smaller risk to the IAN compared with removing the third molars in total in the first place.

Despite the evidence from this study that coronectomy is a safe procedure in the long term and carries minimal morbidity, we are advising against over-prescription of coronectomy even for those with a low risk for IAN injury. In settings with three-dimensional imaging facilities, it may be possible to reduce the prescription of coronectomy if roots showing risky radiographic signs on orthopantomography are proved to be separated from the IAC. It may also justify the extra radiation from the three-dimensional imaging (although small) because the extremely long-term fate

Table III. Summary of reoperation cases and related symptoms

Case	Reason for reoperation	Symptoms	Reoperation procedure	Time of reoperation	Postoperative complication
#1	Incomplete crown removal	Asymptomatic	Removal of residual crown	2 weeks	Nil
#2	Exposed root edge	Asymptomatic	Trimming of exposed root edge	60 months	Nil
#3	Infection around retained root	Pain, swelling, and pus discharge at third molar region	Removal of retained root	1 month	Nil
#4	Infection around retained root	Pain, swelling, and pus discharge at third molar region	Removal of retained root	24 months	Nil
#5	Root exposure	Asymptomatic	Removal of retained root	6 months	Nil
#6	Root exposure	Asymptomatic	Removal of retained root	6 months	Nil
#7	Root exposure	Sensitivity to cold at third molar region	Removal of retained root	6 months	Nil
#8	Root exposure	Sensitivity to cold at third molar region	Removal of retained root	6 months	Nil
#9	Root exposure	Sensitivity to cold at third molar region	Removal of retained root	9 months	Nil
#10	Root exposure	Mild pain at third molar region	Removal of retained root	12 months	Nil
#11	Root exposure	Sensitivity to cold at third molar region	Removal of retained root	18 months	Nil
#12	Root exposure	Sensitivity to cold at third molar region	Removal of retained root	24 months	Nil
#13	Root exposure	Asymptomatic	Removal of retained root	24 months	Nil
#14	Root exposure due to endodontic failure at adjacent second molar	Mild discomfort at third molar region	Removal of retained root	36 months	Nil
#15	Root exposure	Vague discomfort	Removal of retained root	60 months	Nil
#16	Root exposure	Mild discomfort at third molar region	Removal of retained root	60 months	Nil
#17	Root exposure	Mild discomfort at third molar region	Removal of retained root	60 months	Nil
#18	Patient felt vague pain at mandibular region	Mild vague pain	Removal of retained root	12 months	Nil
#19	Patient felt vague pain at mandibular region	Mild vague pain	Removal of retained root	24 months	Nil
#20	Underwent orthognathic surgery	Asymptomatic	Removal of retained root during sagittal split osteotomy	36 months	Nil

of the retained root (e.g., over 20 years) is still unknown. However, the choice of performing coronectomy or traditional total removal of the lower third molar is still a decision that is made by the surgeon and the patient. This study offers valuable information on the 5-year outcome for this treatment modality for the impacted lower third molar.

Future studies on coronectomy of the lower third molar will focus on the long-term fate of the retained root by including an even longer term of follow-up. Another focus of coronectomy research may be the methods to reduce root migration.

CONCLUSIONS

This prospective study on coronectomy for impacted lower third molars demonstrated that the technique has minimal morbidity in terms of infection, pain, dry socket, or development of pathologies. In this study, the risk of IAN injury from coronectomy is 0.16%, and the

injury was temporary. In the study patients, 2.3% of the roots became exposed in the oral cavity and required removal. Reoperation to remove the exposed root did not cause any IAN deficit. Coronectomy is therefore considered a treatment option with long-term safety for managing impacted lower third molars with high risk of IAN injury.

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