
Safety of coronectomy versus excision of wisdom teeth: A randomized controlled trial

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Objective. The objective of this study was to compare the surgical complications and neurosensory disturbances of coronectomy and total excision of lower wisdom teeth with roots in close proximity to the inferior dental nerve (IDN).

Study design. A randomized controlled trial was conducted to compare the surgical complications and IDN deficit of coronectomy and total removal of wisdom teeth. Patients with specific radiographic signs of close proximity of wisdom teeth roots to the IDN were randomized.

Results. A total of 231 patients underwent surgery for 349 lower wisdom teeth (171 coronectomies, 178 controls); 16 coronectomies failed and were removed in total. Nine patients in the control group presented with IDN deficit, compared with 1 in coronectomy group ($P = .023$). Pain and dry socket incidence was significantly lower in the coronectomy group, and there were no statistical differences in infection rate between the 2 groups. Reoperation of one coronectomy case was performed owing to persistent root exposure.

Conclusion. There are fewer complications in terms of IDN deficit, pain, and dry socket after coronectomy, but the infection rate is similar to that of total excision. (*Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2009;108:821-827)

Anthropologists have hypothesized that an evolutionary reduction in jaw size is the likely cause of frequent wisdom tooth impaction in modern humans.¹ Complications, such as pericoronitis, caries, and periodontal disease, are commonly associated with impacted third molars, and these contribute to the indications that make third molar surgery the most common oral surgical procedure performed. Damage to the inferior dental nerve (IDN) is a well-known complication of surgical removal of deeply impacted wisdom teeth. Over the years, the reported frequency of IDN deficit after wisdom tooth surgery has ranged from 0.4% to 8.4%.²⁻⁶ Injury to the IDN can occur from compression of the nerve, either indirectly by forces transmitted by the root during elevation or directly by elevators. The nerve may also become transected by rotary instruments or during removal of a tooth whose root is grooved or perforated by the IDN.⁷ Several researchers have tried to correlate radiographic markers to the relationship between the IDN and the root of the tooth. Three radiographic signs were identified showing that the

roots of wisdom teeth may be grooved, notched, or perforated by the IDN.⁸ Diversion of the canal, darkening of the root, and interruption of the white line representing the IDN were suggested to be significantly related to IDN injury.⁹ Narrowing of the root was also found to be a significant radiographic sign that predicts the proximity of the nerve and root.¹⁰ These radiographic signs only indicate to surgeons that there is an increased risk of nerve damage associated with the removal of the corresponding wisdom tooth, but they cannot help prevent the nerve deficit if the tooth is bound to be removed.

Coronectomy is an alternative procedure to complete extraction. The method aims to remove only the crown of an impacted mandibular third molar while leaving the root undisturbed, thereby avoiding direct or indirect damage to the IDN. Although coronectomy was first described in 1989,¹¹ only 7 relevant studies of this technique have been published to date, and the technique is yet to gain popularity because of surgeons' concerns about the outcomes and short- and long-term complications.¹² However, outcomes related to treatment of neurosensory disturbance after wisdom tooth surgery remain variable; so coronectomy—if proven to be safe—could be useful in minimizing the occurrence of neurosensory deficit of wisdom teeth that are at high risk of nerve damage.

The aim of this randomized controlled trial was to compare the safety of coronectomy and conventional excision of wisdom teeth in which roots were in close

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proximity to the IDN, in terms of associated surgical complications and neurosensory disturbances.

MATERIALS AND METHODS

Patients

Between June 2006 and June 2008, patients presenting to the Discipline of Oral and Maxillofacial Surgery, Faculty of Dentistry, The University of Hong Kong, for the removal of impacted wisdom teeth were enrolled in this randomized controlled trial if they fulfilled pre-determined inclusion criteria. The main criterion was that the wisdom tooth root touched or overlapped with the superior cortical line of the IDN on radiographs, or showed one or more of the following radiographic signs:

1. Darkening of the root
2. Abrupt narrowing of the root
3. Interruption and loss of the white line representing the inferior dental canal
4. Displacement of the inferior dental canal by the roots
5. Abrupt narrowing of one or both of the white lines representing the inferior dental canal

Patients were excluded if their wisdom tooth roots did not touch the IDN cortical lines, or if wisdom teeth were associated with apical pathology or cystic or neoplastic lesions. Patients were also excluded if they had any of the following:

1. Systemic conditions predisposing to local infection, such as diabetes mellitus or AIDS, or concurrent cancer chemotherapy
2. Local factors predisposing to infection, such as fibrous dysplasia or a history of radiotherapy on mandible
3. Craniofacial syndromes with preexisting IDN deficit
4. Any plans for orthognathic surgery

The protocol of the trial was approved by the Institutional Review Board of The University of Hong Kong/Hospital Authority Hong Kong West Cluster. All eligible participants were invited to give written informed consent.

Sample size calculation

The sample size calculation was based on assuming the incidence of IDN deficit in the control group (conventional extraction) and the study group (coronectomy) would be 5% and 0%, respectively. If these assumptions were correct, 152 patients per group would be sufficient to detect a statistical difference, with a 2-sided type 1 error of 5% and a power of 80%.

Randomization

A house officer not participating in the study generated a randomization table using a computer program. Patients were randomly assigned to 1 of the 2 groups according to the randomization table. The unit of randomization was each patient, who might present with 1 or 2 impacted lower wisdom teeth that met the inclusion criteria of the study. The allocation sequence was kept by an assigned nurse and concealed from both the operator and patient until the patient was assigned to a group by the nurse.

Interventions

The eligible patients were assigned randomly to either the coronectomy group or the control group. The surgical procedures were performed under local anesthesia, intravenous sedation with local anesthesia, or general anesthesia by surgical residents.

After the injection of sufficient local anesthetic (lignocaine 2%, with 1:80,000 adrenaline), a 3-sided mucoperiosteal flap was created and raised. A lingual flap was not raised, but instead the lingual aspect was protected with a periosteal elevator. Buccal and distal bone were then guttered with a round bur until the buccal cemento-enamel junction was accessible. The surgical techniques were then as follows:

1. **Coronectomy Group:** Decrowning of the wisdom tooth was performed along the cemento-enamel junction with a fissure bur and, when needed, the crown was sectioned into pieces to minimize stress to the root portion. The cut surface was trimmed to 3 to 4 mm below the bony margin. The pulp was left untouched and the root was checked for any mobility. After the wound was thoroughly debrided and irrigated with saline, it was closed with resorbable polyglactin sutures. Coronectomy was deemed to have failed if there was loosening of the root during or after the decrowning procedure, in which case the root was removed as well.
2. **Control Group:** The tooth was sectioned if indicated and completely removed. After the wound was thoroughly debrided and irrigated with saline, it was closed primarily with resorbable polyglactin sutures.

After surgery, paracetamol and codeine were prescribed for 3 days as analgesics. No antibiotics were prescribed.

Measurement of outcomes

The primary outcome of the study was the presence of IDN deficit 1 week postoperatively. The secondary outcomes were the presence of lingual nerve (LN) deficit, recovery from IDN and LN deficit, pain, infec-

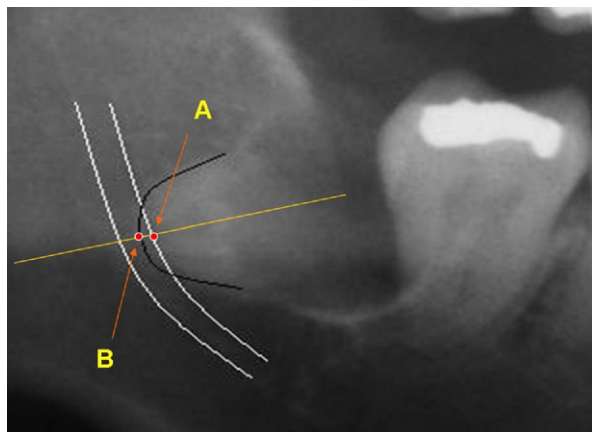


Fig. 1. Measurement of root migration after coronectomy. Distance between Point A (interception of the upper white line of the inferior dental canal and the long axis of root) and Point B (apex of the root along the long axis).

tion, dry socket, root exposure, root migration, and the need for reoperation. Patients' demographic characteristics, tooth status, and neurosensory test results were recorded in the preoperative assessment. Postoperatively, patients were assessed at 1 week and at 1, 3, 6, 12, and 24 months.

Deficits in the IDN and LN were determined by the presence of subjective sensory changes and by objective neurosensory measurements in the light touch test, pain threshold test, and 2-point discrimination test. Neurosensory deficit was diagnosed if both subjective and objective measurements were different from those on the nonaffected side or preoperative baseline. Pain was recorded on a visual analog scale (VAS) ranging from 0 to 10, with 0 signifying no pain and 10 signifying the most severe pain that the patient could imagine. Infection was defined as the presence of pus, fever, and pain. Dry socket was defined as the presence of severe pain, loss of the blood clot in the socket, and wound breakdown. The time and reason for reoperation after coronectomy to remove the root were also recorded. Standardized orthopantomograms (Gendex Orthoralix 9200, Kavo, Italy) were taken for patients in the coronectomy group postoperatively at 1 week and at 3, 6, 12, and 24 months. Root migration measurement was performed by a separate examiner and was measured as the radiographic distance from the point of interception of the upper white line of the inferior dental canal and long axis of root, to the apex of the root along the long axis (Fig. 1). The 1.2 magnification factor of the orthopantomogram was adjusted in the final measurement. Twenty orthopantomograms were selected randomly and the root migration after coronectomy was measured by the same examiner. This pro-

cess was repeated 2 weeks later. Reliability and error analysis tests from the 2 sets of measurements were performed. Reliability analysis with paired *t* tests showed no significant difference ($P > .05$) between the 2 measurements, and the random error was within acceptable limits.

Statistical analysis

Data were analyzed with the Statistical Package for Social Sciences (SPSS version 15.0, SPSS Inc, Chicago, IL). Statistical analyses were performed to compare the control and coronectomy groups, after the exclusion of patients with failed coronectomy. The chi-square test was used to examine whether there were differences between the 2 groups in terms of the incidence of IDN and LN deficit, and the presence of pain, infection, and dry socket. The independent *t* test was used to examine the mean of the VAS pain score. The 5% probability level was taken as the cut-off for statistical significance.

RESULTS

A total of 271 patients were recruited in the study; 231 patients with 349 eligible wisdom teeth underwent surgery. The remaining 40 patients refused surgery after recruitment or underwent the surgery in the private sector. In all, 171 wisdom teeth underwent coronectomy and 178 wisdom teeth were extracted conventionally. The basic demographic characteristics of the patients and the characteristics of the affected teeth are shown in Table I. There were no statistical differences between the 2 groups in terms of age and sex of the patients; eruption status, pattern and depth of impaction, and root shape of the wisdom teeth; the type of anesthesia used; or the presence and type of radiographic signs.

Sixteen (9.4%) roots were loosened during or after coronectomy, so the roots were removed as well; these cases were considered as failed coronectomies. No significant risk factors were found to be associated with failure of coronectomy in terms of age, sex, root shape, and pattern and depth of impaction ($P > .05$). The mean follow-up duration of the coronectomy group, failed coronectomy group, and control group was 10.6 months (SD, 7.7 months), 11.4 months (SD, 7.9 months), and 7.7 months (SD, 6.6 months), respectively.

Neurosensory deficit

Postoperative IDN deficit occurred after coronectomy for only 1 tooth (0.65%, 1/155), whereas 9 cases occurred (5.10%, 9/178) after extraction. This difference was statistically different ($P = .023$). There was also 1 case (6.25%; 1/16) of IDN deficit in the failed

Table 1. Preoperative patient demographic characteristics and tooth characteristics

	Coronectomy	Control	<i>P</i> value
Mean age, y (SD)	27.2 (7.3)	26.2 (6.3)	.164
Sex, % (n)			.904
Female	59.1 (101)	58.4 (104)	
Male	40.9 (70)	41.6 (74)	
Eruption status, % (n)			.358
Erupted	0 (0)	1.1 (2)	
Partially erupted	54.4 (93)	55.6 (99)	
Unerrupted	45.6 (78)	43.3 (77)	
Pattern of impaction, % (n)			.445
Vertical	17.5 (30)	12.9 (23)	
Horizontal	42.1 (72)	50 (89)	
Mesial	35.1 (60)	32.6 (58)	
Distal	5.3 (9)	4.5 (8)	
Depth of impaction (Winter's line), % (n)			.312
0-4 mm	22.2 (38)	23.6 (42)	
5-9 mm	52.6 (90)	48.9 (87)	
10-14 mm	19.9 (34)	25.3 (45)	
≥15 mm	5.3 (9)	2.2 (4)	
Root shape, % (n)			.918
Conical	39.7 (68)	38.2 (68)	
Diverge	16.4 (28)	15.7 (28)	
Parallel	43.9 (75)	46.1 (82)	
Type of anesthesia, % (n)			.633
General anesthesia	50.3 (86)	48.3 (86)	
Intravenous sedation/ local anesthesia	3.5 (6)	5.6 (10)	
Local anesthesia	46.2 (79)	46.1 (82)	
Radiographic signs, % (n)			
Darkening of root	30.4 (52)	27.5 (49)	.577
Abrupt narrowing of root	1.2 (2)	2.8 (5)	.271
Interruption and loss of white line of inferior dental canal	96.5 (165)	93.8 (167)	.242
Displacement of the inferior dental canal by the root	22.8 (39)	17.4 (31)	.219
Abrupt narrowing of one or both of the canal white lines	4.7 (8)	5.1 (9)	.860
Number of radiographic signs, % (n)			.282
1 sign	56.7 (97)	63.5 (113)	
2 signs	31.6 (54)	28.1 (50)	
3 signs	11.1 (19)	6.7 (12)	
4 signs	0.6 (1)	1.7 (3)	
5 signs	0 (0)	0 (0)	

coronectomy group. No cases of LN deficit were noted in any of the groups.

Pain

Among the coronectomy group, 41.9% (65/155) of teeth were reported to be painful 1 week postoperatively. The corresponding proportion in the control group was 57.3% (102/178), which was statistically

different ($P = .005$). However, there were no statistical differences between the 2 groups 1 to 24 months after surgery.

The mean pain VAS score at the end of the first postoperative week was 3.1 (SD, 1.9) for the coronectomy group and 3.7 (SD, 1.8) for the control group; these scores were statistically different ($P = .026$). There were again no statistical differences between the 2 groups in terms of pain score 1 to 24 months after surgery.

Infection rate

The incidence of infection at 1 week after surgery was 5.8% (9/155) in the coronectomy group, and 6.7% (12/178) in the control group. No incidence of infection was noted from the third postoperative month onward in either group. There were no statistical differences in infection rate between the 2 groups throughout the follow-up period. Infections in both groups were managed with local measures and antibiotics.

Dry socket

No case of dry socket was noted in the coronectomy group, whereas 2.8% (5/178) of cases in the control group developed dry socket in the first postoperative week. This difference was statistically significant ($P = .036$).

Recovery of IDN deficit

The single patient in the coronectomy group who had postoperative IDN deficit recovered after 12 months. Six of the 9 subjects in the control group who had postoperative IDN deficit recovered in 1 month, whereas the remaining 3 (33.3%) had persistent hypoesthesia of the lower lip and showed no improvement after the 12th-month review. The single patient in the failed coronectomy group who had postoperative IDN deficit recovered in 6 months.

Root migration after coronectomy

The proportion of patients who presented postoperatively with root migration after coronectomy at 1 week and 3, 6, 12, and 24 months was 16.2%, 62.2%, 23.6%, 11.5%, and 2.0%, respectively. The rate of root migration was fastest in the first 3 postoperative months, with a mean movement of 1.90 mm (SD, 1.23 mm), and then the rate decreased gradually, reaching 2.97 mm (SD, 1.47 mm) in the 12th postoperative month. At 24 months, the mean total movement of the root was found to be 3.06 mm (SD, 1.67 mm) (Fig. 2). The total distance of root migration in the 24th postoperative month ranged from 0 mm to 6 mm (Fig. 3, a-f).

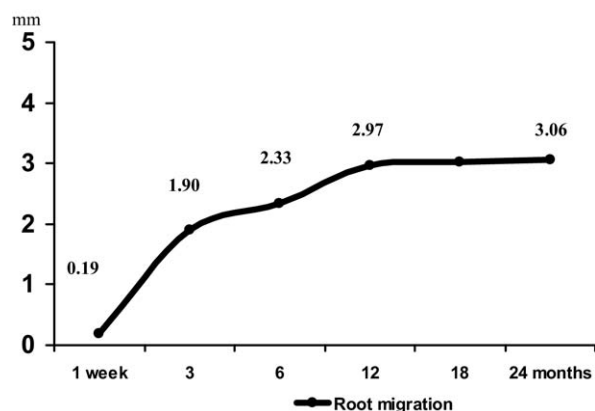


Fig. 2. Mean root migration after coronectomy.

Root exposure and reoperation

The root became exposed in 2 patients in the coronectomy group. In one of the patients, the exposed root was noted during the first month's review, and it became covered by soft tissue by the third month's review. The other patient presented with persistent root exposure from the first month onward and complained of sensitivity to cold water. This patient's adjacent second molar showed apical pathology owing to a preexisting endodontic failure, which also likely affected bone healing around the root of the wisdom tooth. Reoperation to remove the root and extract the adjacent molar was thus performed in month 9. The root of the wisdom tooth was sent for histological assessment and showed viable pulpal tissue. There was no IDN deficit after the reoperation.

DISCUSSION

This randomized controlled trial indicates that successful coronectomy of wisdom teeth is significantly safer than conventional total removal when the wisdom tooth shows radiographic signs of close proximity of the IDN to the root. Coronectomy was proposed as a clinical procedure more than 20 years ago, but has not been commonly performed, largely owing to the lack of well-designed evidence-based trials to support its use.¹² A significantly lower rate of IDN deficit for coronectomy than for total extraction (0% versus 19%) was found in the first randomized controlled trial in 2005 on this subject.¹³ Our findings concur with those results, but we did not encounter such a drastic difference between the 2 groups (0.65% versus 5.10%). However, we found that failed coronectomy carried a similar risk of IDN deficit as total removal of the wisdom tooth, and this finding was also noted by Renton et al.¹³

Renton et al.¹³ reported a 38% failure rate of coronectomy, in which subsequent root removal was

needed. They also found that being female and having conical roots were risk factors associated with coronectomy failure. We observed a low rate of coronectomy failure and found no correlation between any factors and failure of this technique.

IDN deficit occurred in a small proportion of patients who underwent coronectomy in 2 previous studies.^{11,14} This finding was not noted in other studies reporting this technique.^{13,15-18} We encountered only one case of temporary postoperative IDN deficit in a patient in the coronectomy group. We believe that apical pressure on the IDN caused neurapraxia in this case owing to the intimate relationship between the root and the nerve. The patient recovered after 1 year, possibly because of only transient neurapraxia or coronal migration of the root away from the nerve.

Adverse effects of coronectomy have been a concern to clinicians.^{15,19} Although a smaller proportion of patients experiencing postoperative pain after coronectomy than after total removal of wisdom teeth was found in a randomized controlled trial,¹³ that finding was not statistically significant. There were significantly fewer subjects who complained of pain in the coronectomy group than in the control group in our study; the mean pain VAS score was also significantly lower. Although persistent infection around the retained root after coronectomy that justified subsequent removal has been reported,¹⁴ it seems that infection rate between coronectomy and total removal of wisdom teeth is similar.¹³ Our study also found no statistical difference in infection rate between the 2 groups, and wound infections were cured with local debridement and oral antibiotics. There was also a smaller proportion of subjects with postoperative dry socket in the coronectomy group. We presumed this was because of a smaller socket and blood clot after coronectomy. This finding might also correlate with the lower incidence of pain in this group.

Upward root migration after coronectomy was a common finding.^{11,13,14,18} Our study revealed that more than half of the roots migrated at a high rate for 3 months postoperatively and then gradually stopped at 12 to 24 months. No roots migrated above the crestal bone level. We therefore believe that as the bone regenerates and remodels, root migration is slowed down and gradually halted. We predict that the chance of reactivation of the migration process will be slim.

The rate of postoperative failure after coronectomy seems to be low. Reoperation rate owing to postoperative root migration or infection ranged from 0% to 12.1%.^{11,13,14,18} We adopted a similar technique of coronectomy to that described by Renton et al.,¹³ and observed only 1 case of reoperation, likely because of apical infection of the endodontically failed adjacent

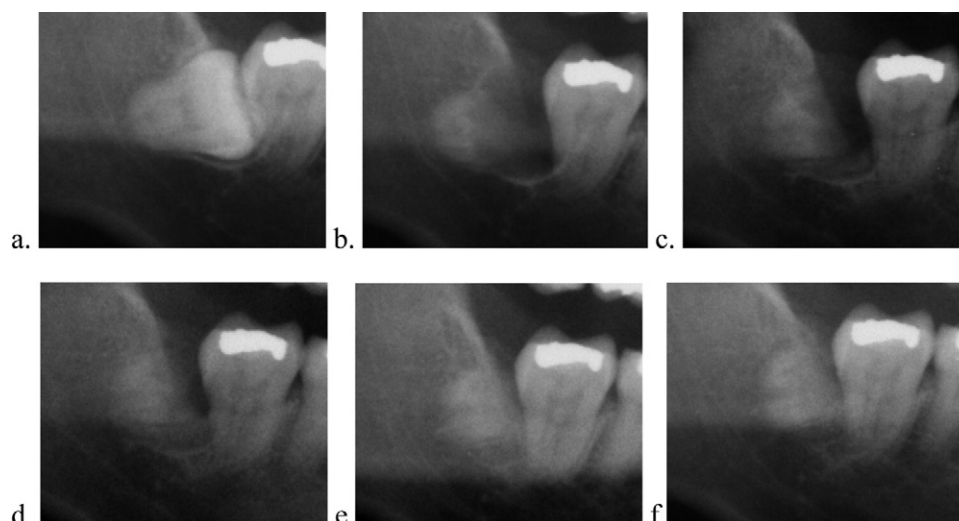


Fig. 3. Serial radiographs after coronectomy. **a**, Preoperative; **b**, postoperative 1 week; **c**, postoperative 3 months; **d**, postoperative 6 months; **e**, postoperative 1 year; **f**, postoperative 2 years.

second molar as suggested by serial radiography and clinical symptoms. This diagnosis was confirmed by the histological assessment of the retained wisdom tooth root after reoperation, which showed viable pulpal tissue. This finding also concurs with that of several animal studies demonstrating that dental pulp retains its vitality after coronectomy.²⁰⁻²²

The follow-up duration of this study for coronectomy patients was not as long as in other studies. However, this would not affect the assessment of the primary outcome of the study, which was to compare postoperative IDN deficit of coronectomy and total removal of wisdom teeth. Coronectomy was proven in this study to be safe at least for the first 2 years. Longer follow-up of the patients undergoing coronectomy is planned to assess the late complications of this technique.

CONCLUSION

This study confirms that coronectomy can significantly reduce the incidence of IDN deficit when compared with total excision of wisdom teeth with close proximity to the inferior dental canal. There are also fewer complications in terms of pain and dry socket in the healing process of coronectomy, whereas its infection rate is similar to that after total excision of wisdom teeth. The embedded roots tend to migrate 3 mm in the first year postoperatively, and most roots stop migrating after 1 year. Coronectomy appears to be a safe procedure at least in the short term. Longer follow-up is required to determine the fate of the root in the long term.

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