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REVIEW

A review of coronectomy

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Abstract

Coronectomy or intentional partial odontectomy is a procedure whereby the root(s) of a lower third molar tooth that is deemed close to the inferior alveolar canal on radiographic imaging is left in-situ. Coronectomy is a relatively new procedure and to date there have only been a handful of publications that investigate its' effectiveness as a treatment modality. As a result it is still not commonly practiced worldwide. However, coronectomy is gaining popularity as a risk reducing procedure. This article looks at nine most recent studies on coronectomy and reviews each paper with respect to treatment outcomes.

Introduction

Third molar surgery related inferior alveolar nerve injury (IANI) is reported to occur in up to 3.6% of cases permanently and 8% of cases temporarily[1,2]. Factors associated with IANI are age, difficulty of surgery and proximity to the inferior alveolar nerve (IAN) canal. If the tooth is closely associated with the IAN canal radiographically, 20% of patients having these teeth removed are at risk of developing temporary IAN nerve injury and 1–4% are at risk of permanent injury[1–5].

Contrary to lingual nerve injuries, damage to the IAN may be a calculated risk to be accepted and weighed against the indication for third molar removal. Based on this concept, the justification for prophylactic removal in general has been questioned. Refraining from surgery is the most effective method of nerve injury prevention and the National Institute of Clinical Excellence guidelines in the UK ensure surgery is undertaken only when necessary[6]. However, in the USA 95% of oral surgeons regularly undertake routine prophylactic removal of mandibular third molars resulting in what some describe as a silent epidemic of iatrogenic trigeminal nerve injuries[7].

If the third molar (or indeed any mandibular tooth) requiring extraction is in close proximity to the IAN, then traditionally panoral radiography has been the mainstay for evaluation.

Radiographic signs indicative of possible IAN risk include:

- Diversion of the canal[1,2]
- Darkening of the root[2]
- Deflection of the root[2]
- Narrowing of the canal[1–4]
- Interruption of the canal lamina dura[1–4]
- Juxta apical area[5]

Assessment of the likelihood of injury depends to a great extent on the quality of preoperative radiographic examination. Three radiological signs were found to be significantly related to nerve injury: (a) diversion of the inferior alveolar canal (b) darkening of the third molar root at the site of over-projection and (c) an interruption of the white line of the mandibular canal[2,3]. In the presence of one or more radiological signs of warning, the prospect of nerve injury must be discussed with the patient and surgery may be postponed until the advent of absolute indication. One preventive measure might be coronectomy with intentional root retention[5].

If plain film radiographic risk factors are identified, removal of the third molar will result in elevated risk of

IANI (2% permanent and 20% temporary). The patient must be informed about this elevated risk[1,2,4,5].

The use of cone beam computer tomography

Assessment of high risk third molars using Cone beam computer tomography (CBCT) scanning is becoming more popular as scanners become cheaper and easier to use. The additional radiation the patient receives must be justified clinically. At the present time, there are a number of studies emerging with respect to the usefulness of this new imaging modality. However, evidence is often conflicting, depending on which paper one reads. Some studies show that CBCT is advantageous over plain panoramic views[8,9], while others show no significant difference in specificity or sensitivity between the two imaging modalities[10,11]. A prospective study by Tantanapornkul *et al*.[8] reported the specificity and sensitivity of CBCT versus panorals in identifying the proximity of the IAN to the tooth roots in 161 mandibular third molars. Results for sensitivity and specificity for CBCT were 93% and 77%, respectively and for panoramic, 70% and 63%. These results were significantly different. Friedland[9] highlighted the benefits of CBCT imaging for the assessment of high risk third molars. Conversely, Ghaeminia *et al*.[10] reported that CBCT was not significantly more sensitive compared with panoramic radiography and Jhamb *et al*.[11] compared spiral CT with panoramic assessment and found no significant differences in 31 teeth. All these studies do however claim that CBCT scanning of high risk teeth will further establish the relationship between the IAN and the roots and may be of some value.

In many cases, the CBCT reaffirms the relationship that would support planned coronectomy if appropriate (but would not change the planned treatment)[12]. There are of course some incidences, where despite high risk identification based on plain films, some IANs are found to be distant from the roots using CBCT, which would allow for removal of the tooth rather than planned coronectomy[12]. It is evident that further research in the form of randomised controlled trials is needed to further ascertain the risk benefits of CBCT and as to whether it is indicated for treatment planning in these high risk cases.

Based on the authors' experience, using CBCT may not have a routine role in preoperative assessment for removal of third molars in a unit that regularly undertakes coronectomy procedures as it rarely alters ones treatment plan[12].

Rarely the tooth is distant from the IAN canal based on high risk plane film assessment and would result in a rare change to a planned procedure. However, if the patient is medically compromised or the tooth non-vital and has to be removed then CBCT may play a role in assisting the surgeon to plan the tooth section in order to minimise damage to the IAN[5].

It is common practice for broken fragments of the root of vital teeth to be left in place and most heal uneventfully. Another technique for extraction of a third molar is the deliberate retention of the root adjacent to the nerve, also known as coronectomy[13].

Coronectomy

Coronectomy is an alternative procedure to complete extraction when a tooth is deemed 'high risk' but vital and in a patient whom is not medically compromised. Coronectomy avoids inferior alveolar nerve injury by ensuring retention of the vital roots when they are close to the canal (as estimated on radiographs). 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 IAN. Although coronectomy was first described in 1989[13], only nine relevant studies of this technique have been published to date. These published articles on coronectomy consist of two randomised controlled trials[5,14], two prospective cohort studies[15–17], one case control study[18], two retrospective studies[19,20] and one case series[21] (Table 1). The ninth paper[16] is an update of Pogrel's retrospective study that follows up a further 409 coronectomy procedures. All studies were of level 3 evidence or above. All papers suggested that the technique had merit and many practitioners should regularly use the coronectomy approach in order to minimise IAN injuries.

Despite these positive reports on coronectomy, this technique is yet to gain popularity because of surgeons' concerns about the outcomes and short and long-term complications. 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 minimising the occurrence of neurosensory deficit of wisdom teeth that are at high risk of nerve damage.

Coronectomy technique involves using the buccal approach and removal of buccal bone using a fissure bur down to the amelo-dentinal junction (crown root junction). The crown is part sectioned from the root using a fissure bur (into the pulp chamber with lateralisation of the cut ensuring the mesial, distal and lingual margins of the tooth are not breeched) and the crown elevated similar to the buccal approach technique. However, the technique may vary and some

Table 1 Studies on coronectomy

Paper	Study design	*n* subjects	Exclusion criteria	Outcome measures	Conclusions	National Institute for Clinical Excellence	Evidence level
Knutsson 1989[19]	Retrospective study, post-op status at one year	33	Not stated	Satisfactory healing Root movement	27/33 roots migrated. 3/33 had IANI. 24/33 roots healed satisfactorily.	–	3
Freedman 1992[21]	Case series over 6 years	32	Not stated	Need for second operation	1/32 cases needed re-operation	–	3
Renton *et al*. 2004[5]	RCT: incidence of IANI. coronectomy versus removal	128 pts XLA 102 Coron 94	Immunocompromised Systemic infections Previous IANI Neuromuscular disorders Non-vital teeth	IANI Dry socket Soft tissue infection Re-operation	Coron more likely to fail in women. 25/12 follow-up sufficient. No increase in side-effects/morbidity with coronectomy	Yes	1
O'Riordan 2004[20]	Retrospective study: rate of infection post coronectomy.	52, over 10 years	None stated	Questionnaire asking about pain, swelling and infection	1/52: immediate removal 1/52: root removes after 7 years 1/52: pain, swelling 18/12 later	Yes	3
Pogrel *et al*. 2004[15]	Prospective cohort study: coronectomy, a technique to protect the IAN	50	Active infection Mobility	IANI Primary healing Root movement	3/50 roots needed removal 15/50 roots migrated. Mean F/U of 22/12 insufficient	–	2
Hatano *et al*. 2009[18]	Case control study: Coronectomy versus XLA in teeth deemed high risk on CBCT	220 pts XLA 118 Coron 102	Existing IANIs Infection, pregnancy, medically compromised, non-vital and immature teeth	IANI, dry socket, pain, infection	Increased post op pain in coronectomy. Dry socket inc in XLA group. Longer follow-up needed.	–	2
Leung & Cheung, 2009[14]	RCT: safety of coronectomy versus XLA	231 pts XLA 178 Coron 171	No contact with IDN on DPT, pathology, Immunocompromised pre-existing IANI, orthognathic Sx planned.	Neurosensory deficit, Pain, infection, dry Socket, root migration, re-op.	IANI in 1 pt in coron group. IANI in 9 pts in control group. Pain and dry socket less in coronectomy group.	–	1
Dolanmaz *et al.*, 2009[17]	Prospective cohort study: a preferable technique for protecting the IAN	47	Systemic disorders, acute infection, mobile teeth, horizontal teeth	Root migration Need for re-op	Root movement at its most up to 6/12. Review >6/12 not needed. No control group as unethical. Coronectomy is an acceptable technique.	–	2
Pogrel 2009[16]	Prospective cohort	450	Active infection Mobility	IANI Primary healing Root movement	150/450 roots erupted within 1 year 4/450 infection rate. 1/450 permanent IANI	–	3

CBCT, Cone Beam CT; IAN, inferior alveolar nerve; IANI, inferior alveolar nerve injury; IDN, inferior dental nerve; RCT, randomnised controlled trial; XLA, extraction under local anaesthetic.

authors recommend complete transection of the crown from the root using a bur[16,17]. In our experience, we feel this places the lingual nerve at higher risk. On elevation of the crown from the roots, mobilisation of the roots may occur particularly if the patient is young, female and the roots are conical[5]. If the roots are mobilised, they must be removed. Thus, the patient must be consented for coronectomy and/or removal if the roots are mobilised intraoperatively. On exposure of the pulp and immobilised roots, the surgeon must ensure that there is no enamel retained and the use of a rose head bur may be necessary to remove any enamel spurs. The vital pulp should not be instrumented or medicated. Closure of the buccal flap over the roots is achieved with one or two 4/0 vicryl sutures. No antibiotics are recommended. Pre- and postoperative chlorhexidine and good oral hygiene are sufficient. The patient must be warned of possible 'dry socket' and to seek treatment if there is persistent pain or swelling also of the possibility of a necessary second procedure for removal of the roots should they become infected or should they erupt later (30%[16] and 5%[5]).

Conclusions

Only two of the six articles were prospective randomised controlled trials, and thus level 1 evidence[5,14]. The number of patients involved in these studies ranged from 41[15] to 231[14]. In total, 981 coronectomies were undertaken in these studies.

Review periods

Review periods vary among the nine papers. The shortest mean review period was 9.3 months[17], followed by 10.6 months[14], 12 months[19], 13 months[18], 22 months[15], 25 months[5], 6.5 years[21] and finally 10 years[20]. Pogrel[15] specifically states that 22 months was not a long enough review for this procedure.

Surgical technique

Different surgical techniques have been used in these studies. For example sectioning through the crown was partial by Renton[5], Leung & Cheung[14] and O'Riordan[20]. Complete section of the crown from the roots was undertaken by Pogrel[16] and Dolanmaz[17], Hatano *et al.*[18] Knutsson[19] and Freedman[21] and made no reference to specific coronectomy technique. This may explain why there were relatively few root mobilisations in the fully sectioned groups, but may also indicate why so many more roots erupt in the first year postcoronectomy rather than being initially mobilised with partial tooth section[16]. The authors also feel that complete sectioning of the crown from the root may place the lingual nerve at risk and Dolanmaz *et al.*[17] suggested that complete sectioning may not be necessary.

Surgeons

Pogrel[16], Dolanmaz[17], Knutsson[19] and Freedman[21] did not state in their papers the grade of surgeon carrying out the coronectomy procedures. Renton[5], O'Riordan[20] and Hatano[18] stated that qualified oral surgeons carried out all surgery and Leung & Cheung[14] stated that surgical residents carried out-patient treatment.

Inclusion criteria

All papers had lower third molar teeth that appeared high risk on dental panoramic tomography (DPT) or CBCT[18] as their inclusion criteria.

Exclusion criteria

Pogrel[16], Freedman[21], Knutsson[19] and O'Riordan[20] did not mention the medically compromised patient in the exclusion criteria. However, there does not seem to be an increased rate of coronectomy failure in their studies[15,16]. Only 1/50 cases in the Pogrel[15] study failed to heal and required subsequent removal, and in the O'Riordan[20] study 1/53 patients failed to heal immediately.

The other studies excluded patients whom were immunocompromised, pregnant, had systemic infections, previous IANI and neuromuscular disorders.

All studies excluded non-vital third molars and Leung & Cheung[14] also specifically excluded no contact with Inferior Dental Nerve (IDN) on DPT, pathology and planned orthognathic surgery. Two studies[15,16] suggested that horizontal third molars should also be excluded and lack of exclusion of patients with medical compromise may explain the increased root infection rate.

Lingual retraction

Two papers stated that lingual retraction was recommended in all cases to protect the lingual nerve[16,20]. Pogrel[15,16] raised a lingual flap and protected the lingual nerve with a retractor to avoid injury. The remaining papers did not use lingual retraction. There is no mention of technique in the Freedman[21] and Knutsson[19] papers. Dolanmaz *et al.*[17] did not state whether a lingual flap was raised even though a full bur cut was made through the tooth.

Outcome measures (Table 2)

Primary healing, infection pain and swelling were reported outcome measures in six studies[5,14–16,18,21].

Table 2 Outcome measures

	Knutsson[19]	Freedman[21]	Renton[5]	O'Riordan[20]	Pogrel (2009)[16]	Hatano[18]	Leung & Cheung[14]	Dolanmaz[18]
Pain	–	–	Less with coronectomy	–	–	Less with coronectomy	Less with coronectomy	–
Infection	9/33	–	No significant Difference	1/52	4/450	No significant Difference	No significant Difference	–
Dry socket	–	–	No significant Difference	–	–	Less with coronectomy	Less with coronectomy	–
Temporary IANI	9/33	–	16% XLA 0% Coron	3/52	2/450	5% XLA 1% Coron	9% XLA 0.65% Coron	–
Permanent IANI	–	–	1.4% XLA 0% Coron	1/52	0/450	2.5% XLA 0% Coron	1.7% XLA 0% Coron	–
Failed Coronectomy	–	–	38%	0/52	48/450	–	9.3%	–
Root Migration	27/33	–	13%	–	150/450	–	0–6 mm in 2 years	4 mm at 2 years
Re-operation	–	1/35	0%	3/52	9/450	–	0.65%	0
Review period	1 year	–	25 months	2–10 years	6 months (2004)	13 months	2 years	9.3 months

IANI, inferior alveolar nerve injury.

Re-operation rate was specifically monitored in three studies[5,15,17]. IAN neuropathy was also specified as an outcome in most studies[5,14–16,18]. Root movement or migration was specified in four studies[5,15–17].

Three out of the nine papers compared outcome measures between extraction and coronectomy[5,14,18]. All three papers stated that postoperative pain was significantly less after coronectomy. Hatano[18] and Leung & Cheung[14] used a visual analogue scale to record pain, whereas Renton[5] noted a number of patients with pain postoperatively.

Antibiotic protocols

Antibiotics were used in two of the nine studies. Pogrel *et al.*[15,16] administered preoperative prophylactic antibiotics to all patients, and Dolanmaz *et al.*[17] administered postoperative antibiotics to all patients. Pogrel[16] argued that an acute infection rate of less than 1% when carrying out coronectomy is lower than the normal infection rate after third molar removal. Possible reasons mentioned for this are that all patients take prophylactic antibiotics before coronectomy and that the surgeons are possibly taking 'extra care' with these procedures[15].

No antibiotics were prescribed by Renton[5], and Leung & Cheung[14] recommended only pre- and postoperative chlorhexidine mouth wash. The other papers did not mention antibiotics.

Primary closure

Leung and Cheung[14], Pogrel[16] and Hatano[18] stated that they closed the mucoperiosteal flaps primarily postoperatively. Renton[5] and Dolanmaz *et al.*[17] replaced flaps to normal anatomical position. The remaining papers made no mention of method of flap closure.

Complications (Table 2)

Roots inadvertently removed at the time of attempted coronectomy

Three papers stated a range of 3–9% of patients failing to achieve coronectomy and the roots needing to be removed at the time of primary surgery[16,19,20]. One paper noted a 38% failure rate at primary surgery, because the roots were only sectioned about half way before an attempt was made to remove the crown[5]. This appeared to mobilise the roots in many cases and did result in an 8% incidence of temporary IAN involvement with no permanent injuries. In Pogrel's second report[16], 18/450 were failed coronectomies,

whereby the roots were mobilised during the procedure when the crown was elevated. These roots were removed at the same time, and paraesthesia developed in two patients, which was resolved[16].

Renton *et al*.[5] identified that women below the age of 30 years with conically shaped roots of the third molars were more likely to sustain mobilisation of the roots during coronectomy.

Early post-op infection

Leung & Cheung[14] stated that 9/155 roots became infected and that this was managed with local measures without the need for re-operation. Renton[5] also managed the postoperative infection locally with an incidence of 10–12% infection. O'Riordan[20] stated that 3/52 coronectomies became infected and roots needed to be removed in a second procedure. Freedman[21] had one case out of 33 coronectomies that became infected and required subsequent root removal. Pogrel[15] reported 1/50 case of postoperative infection that required re-operation. In Pogrel's[16] article, 4/450 cases of acute infection were noted, three of which required re-operation. Knutsson *et al*.[19] reported 9/33 cases where roots has not satisfactorily healed at 1 year, but no mention of immediate post-op infection was made. Dolonmaz *et al*.[17] reported no cases of postoperative infection in the 43 coronectomies done.

Root migration

Subsequent root migration is mentioned in all papers with varying values of 5–81%[5,15,16,20] that show later migration of the roots towards the superior border of the mandible. Dolanmaz *et al*.[17] reported that none of the 43 patients required a second procedure to remove retained roots and Pogrel[15] reported 1/41 patients requiring immediate root removal. Eruption root movement was reported to be at a maximum at 6 months[17]. In some papers, there is no mention of whether any of these roots required removal. In all cases there was radiographic evidence of migration of the retained root away from the canal that may infer that if the roots do require removal at a later stage, then the risk of damage to the IAN will remain reduced. In our clinics, we do not retreat 'dry sockets' or persistent infection associated with retained coronectomied roots, but prefer to remove the roots early on.

Two papers mention a 2% and 6% later root removal rate[15,20]. One paper mentioned that 27% of coronectomies had unsatisfactory healing[19]. Pogrel[16] stated that 30% of roots erupted in first year and required removal with no associated morbidity as all roots had migrated away from the nerve. In every case, this was carried out uneventfully with the patient under local anaesthesia[16].

Permanent neuropathy

One paper with 38% failed primary coronectomy, noted an 8% temporary IAN involvement with failed coronectomy[5]. Temporary IANI was sustained among 2/450 patients during inadvertent mobilisation of the tooth roots[16].

Permanent IAN neuropathy was reported, as a result of inadvertent drilling, in 1% of patients in one study[21]. Persistent neuropathy was experienced by 1/50 patients[16] and 1/171 of the coronectomy patients sustained neuropathy compared with 9/171 in the removal group[14]. None of the other studies reported neuropathy with coronectomy. The permanent neuropathy associated with the retained coronectomied roots may be associated with the development of persistent periapical infection postoperatively. The authors recommend that if dry socket occurs more than two times the coronectomised roots should be removed as infective neuritis may occur leading to permanent neuropathy in some cases.

Statistically significant reduction of IANI in relation to coronectomy was reported by Renton *et al*.[5] and Leung & Cheung[14].

Lingual nerve neuropathy

A 2% transient rate was noted in one study, presumably because of lingual retraction[15]. This is probably a result of the technique whereby the crown is completely sectioned from the root rather than partial section[5]. The other papers do not mention it.

These studies confirm that coronectomy can reduce the incidence of IAN deficit when compared with total excision of wisdom teeth that are in 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 the 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.

Consent issues for coronectomy

The patient must be warned of a possible second surgical intervention if complications arise. If a tooth is

non-vital, or associated with pathology, complete tooth removal has to take place and the roots should be sectioned appropriately to minimise trauma to the adjacent IAN. The patient should be warned of a 2% risk of permanent and 20% risk of temporary IANI.

Due to the possibility of displacement of roots during elevation of the crown during intended coronectomy, the patient should be warned of *intended* coronectomy along with the potential risk of root mobilisation that is associated with a higher risk of nerve injury may apply because of necessary root removal.

Need for a second procedure

Once the coronecomy procedure has been completed, there is still a risk of failure of the surgical site to heal. If this occurs, a second surgical procedure is required to remove the retained root. This again, carries with it the risk of 2% permanent and 20% temporary IAN injury and should be discussed with the patient during the consent process.

Thus, all the studies overall concede that the coronectomy technique can minimise IAN injuries in relation to the removal of vital third molars proximal to the IAN canal in non-compromised patients who can be followed up. There is a need for reports on long term evaluation of coronectomy complications.

References

1. Howe GL, Poyton HG. Prevention of damage to the inferior dental nerve during the extraction of mandibular third molars. Br Dent J 1960;109:355–63.
2. Rood JP, Nooraldeen-Shehab BA. The radiological prediction of inferior alveolar nerve injury during third molar surgery. Br J Oral Maxillofac Surg 1990;28:20–5.
3. Rud J. Third molar surgery perforation of the inferior dental nerve through the root and lingual bone. Tandlaegebladet 1983;87:585–8.
4. Rud J. Third molar surgery: relationship of root to mandibular canal and injuries to inferior dental nerve. Dan Dent J 1983;87:619–31.
5. Renton T, Hankins M, Sproate C, McGurk M. A randomised controlled clinical trial to compare the incidence of injury to the inferior alveolar nerve as a result of coronectomy and removal of mandibular third molars. Br J Oral Maxillofac Surg 2005;43:7–12.
6. National Institute of Clinical Excellence. NICE 2000/003a Issued: 27 March 2000.
7. Fieldman JW. The prophylactic extraction of third molars: a public health hazard. Am J Public Health 2007;97:1554–9.
8. Tantanapornkul W, Okouchi K, Fujiwara Y, Yamashiro M, Maruoka Y, Ohbayashi N *et al*. A comparative study of cone-beam computed tomography and conventional panoramic radiography in assessing the topographic relationship between the mandibular canal and impacted third molars. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;103:253–9.
9. Friedland B, Donoff B, Dodson TB. The use of 3-dimensional reconstructions to evaluate the anatomic relationship of the mandibular canal and impacted mandibular third molars. J Oral Maxillofac Surg 2008;66:1678–85.
10. Ghaeminia H, Meijer G, Soehardi A, Borstlap W, Mulder J, Bergé S. Position of the impacted third molar in relation to the mandibular canal. Diagnostic accuracy of cone beam computed tomography compared with panoramic radiography. Int J Oral Max Surg 2009;38:964–71.
11. Jhamb A, Dolas RS, Pandilwar PK, Mohanty S. Comparative efficacy of spiral computed tomography and orthopantomography in preoperative detection of relation of inferior alveolar neurovascular bundle to the impacted mandibular third molar. J Oral Maxillofac Surg 2009;67:58–66.
12. Frafjord R. Does Cone Beam CT Alter Treatment Planning for High Risk Third Molars? MclinDent Thesis, 2010.
13. O'Riordan BC. Uneasy lies the head that wears the crown. Br J Oral Maxillofac Surg 1997; 35:209.
14. Leung YY, Cheung LK. Safety of coronectomy versus excision of wisdom teeth: a randomized controlled trial. Oral Surg Oral Med Oral Pathol Oral Radiol Endodontol 2009;108:821–7.
15. Pogrel M, Lee J, Muff D. Coronectomy: a technique to protect the inferior alveolar nerve. J Oral Maxillofac Surg 2004;62:1447–52.
16. Pogrel MA. An update on coronectomy. J Oral Maxillofac Surg 2009;67:1782–3.
17. Dolanmaz D, Yildirim G, Isik K, Kucuk K, Ozturk A. A preferable technique for protecting the inferior alveolar nerve: coronectomy. J Oral Maxillofac Surg 2009;67:1234–8.
18. Hatano Y, Kurita K, Kuroiwa Y, Yuasa H, Ariji E. Clinical evaluations of coronectomy (intentional partial odontectomy) for mandibular third molars using dental computed tomography: a case-control study. J Oral Maxillofac Surg 2009;67:1806–14.
19. O'Riordan B. Coronectomy (intentional partial odontectomy of lower third molars). Oral Surg Oral MedOral Pathol Oral Radiol Endodontol 2004;98:274–80.
20. Knutsson K, Lysell L, Rohlin M. Postoperative status after partial removal of the mandibular third molar. Swed Dent J 1989;13:15–22.
21. Freedman GL. Intentional partial dontectomy: review of cases. J Oral Maxillofac Surg 1997;55:524–6.