

## Educational Article

# Third mandibular molar coronectomy: a way to prevent iatrogenic inferior alveolar nerve injuries—an systematic review

Benoît Lenfant<sup>\*</sup>, Kevin Haese, Said Kimakhe, Philippe Lesclous

OralSurgery Functional Unit, Department of Restorative, Surgical Odontology, Odontology Department of CHU Hôtel-Dieu, 44000 Nantes, France

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**Abstract – Introduction:** In the field of oral and maxillo-facial surgery, the avulsion of third mandibular molar is a very common procedure. However, and although the injury on the alveolar inferior nerve is very rare, the neurological risk must not be underestimated. Indeed, it may lower the patient's quality of life in a significant way. The coronectomy is a technique that allows us to avoid this risk. It consists in remaining in place the third mandibular molar's roots. **Educational objectives:** After a clinical introduction to this surgical technique, the main characteristics of this type of procedure will be presented with the help of an exhaustive literature review. Thus, we will refer to the following subjects: the obvious decrease of neurological risks, the potential pre and post-operating complications, the potential necessity of an endodontic treatment for the residual roots, the becoming of these same roots, and finally the bony and mucosal cicatrization of the operated area. **Conclusion:** Every oral surgeon should have in mind this technique of coronectomy and master it. Indeed, when the case justifies it, the benefits are numerous for the patient.

## Introduction

The extraction of third molar, especially mandibular, is a very standard procedure in oromaxillofacial surgery. In cases where the inferior alveolar nerve (IAN) is in close proximity to the roots of the mandibular third molar (3MM), there is a minimal risk of nerve injury. Previous studies have reported that third mandibular molar extraction causes approximately 0.5–1% of chronic IAN injuries [1,2]. IAN injury must nevertheless be minimized to avoid adverse consequences impeding the patient's quality of life. These consequences may be caused by sensorineural disorders such as hypoesthesia, dysesthesia, anesthesia, etc., as well as the neuropsychological and functional disorders that may also result (chronic pain, long-term changes in the body schema, a functional deficit that may impact social function: drooling, biting, the altering of certain facial expressions etc.) [3,4].

## Pedagogical objectives

### Preoperative assessment

A standard preoperative assessment is performed to identify the current and past medical history of the patient and to have a better grasp of the anesthesia modalities

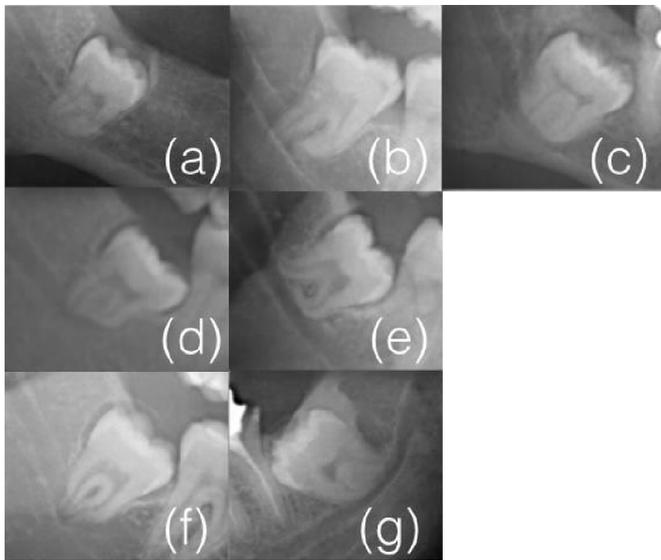
required for the intervention. Some X-rays are required for planning the intervention. First, a panoramic X-ray and initial examination of the mandible will make it easy to detect possible risks. Seven predictors of increased risk of IAN injury have been reported in previous studies [5,6]:

- Disruption of the lamina dura\* (Fig. 1a)
- Dental root translucency\* (Fig. 1b)
- Root canal deviation\* (Fig. 1c)
- Translucency around the roots (Fig. 1d)
- Root curvature (Fig. 1e)
- Narrowing of the roots (Fig. 1f)
- Narrowing of nerve root canal (Fig. 1g)
- \*: Statistically significant according to Rood *et al.* (1990) [5].

Following this, a three-dimensional cone-beam computed tomography (CBCT) should ideally be performed, which will pinpoint nerve proximity. If a bone plate is interposed between the nerve tissue and the tooth root to be extracted, possible risks to the nerves are decreased. A coronectomy can only be considered when direct contact is observed between IAN and the root.

This technique, also known as a partial odontectomy, was first outlined by Ecuyer *et al.* in 1984 [7]. It is widely used in Anglo-Saxon countries but is rarely used in France.

\* Correspondance: [lenfant.b@hotmail.fr](mailto:lenfant.b@hotmail.fr)



**Fig. 1.** (a) The different x-ray images that should alert the surgeon. Loss of lamina dura of canal, (b) radiolucent of mesial apex, (c) deviation of the canal, (d) periapical radiolucent area, (e) curvature of roots, (f) narrowing, (g) narrowing of the canal.



**Fig. 2.** (a) Incision, (b) Full-thickness flap elevation, (c) alveolectomy to the cemento-enamel junction, (d) crown separation and enamel reducing to 2–4 mm below the level of alveolar crest.

The patient will receive prescriptions, including analgesics, adapted to the clinical situation (palliative 1 or 2), a local antiseptic (chlorhexidine 0.2%) to be taken 24 h after the intervention, and antibiotic prophylaxis (in accordance with current recommendations for dental avulsions of mandibular wisdom teeth: 2 g of amoxicillin 1 h before surgery or 600 mg of clindamycin in case of a penicillin allergy [8]).

Precise and reliable information is provided to the patient and informed consent is obtained.

At the end of this preoperative assessment:

- The indications for a coronectomy should be decided in a rational manner by the surgeon;
- Informed consent should be obtained from the patient;



**Fig. 3.** Failed separation causing the necessity of a new intervention.

- Drug prescriptions appropriate to this intervention should be prescribed.

### Operative technique

After intraoral disinfection (with 10% povidone iodine or 0.2% chlorhexidine), an intrasulcular incision is made from the first to second molar. This is followed by a distovestibular relieving incision of a few millimeters at a 45° along the external oblique line (Fig. 2a).

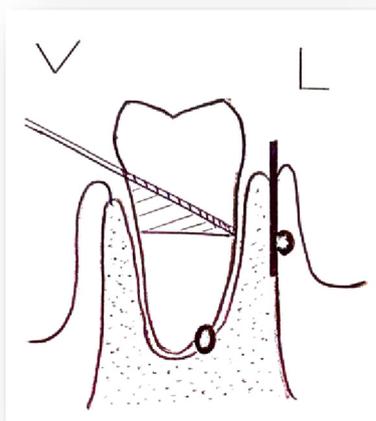
Next, a full-thickness gingival flap is elevated (Fig. 2b). The flap is supported on a retractor so that a clear view of the operating site is ensured. Some authors advocate using a lingual protection plate, which will create a deep coronoradicular separation without the risk of lingual nerve injury [9].

Alveolectomy is performed using either round or fissure bur attached to a contra-angle handpiece with constant saline irrigation until the enamel–cement junction is exposed (Fig. 2c).

Coronoradicular separation is performed using a fissure or Lindhemann bur attached to a contra-angle handpiece with saline solution irrigation. Then, the crown is separated from the radicular complex (Fig. 2d). The separation axis should be perpendicular to the long axis of the tooth. The risk here is the creation of an incomplete segment, resulting in a residual amelodentinal substance which would require a repeat surgery. (Fig. 3). The immobilization of the root complex is required; otherwise, infection risk is increased. [9].

Amelodentinal substance 2–4 mm deep to the alveolar rim is delicately removed with a round bur, which is reported to enhance new bone growth (Fig. 4) [9].

The dental pulp tissue does not require any special treatment [10]. Bone smoothing, rinsing, and suturing are performed. A postinterventional retroalveolar or panoramic dental X-ray should be performed to confirm that there is no residual amelodentinal lamina and to serve as a reference



**Fig. 4.** Drawing of crown separation and enamel reducing.

for any residual roots. Regular clinical and radiological follow-up is required every 6 months for a period of 1–2 years and annually thereafter. This will make it easier to intercept any complications, to assess the migration of the residual roots and, if necessary, to predict possible avulsions (Fig. 5).

The operative technique must allow:

- a clear view of the optimal operating site;
- a clear section of the crown without any mobility of the radicular complex.

#### Literature review

The aim of this literature review is to answer the following issues regarding the coronectomy:

- decreasing the risks of nerve injury;
- risk of infection;
- the clinical outcomes of roots retained in the bone;
- the need for the endodontic treatment of residual roots;
- periodontal healing of the operative area.

Consequently, a keyword search was conducted using such scientific databases as “PubMed,” “Google Scholar,” and “ScienceDirect.” The French and English results for the keywords “coronectomy” and “partial odontectomy” were analyzed and 298 references were found.

Nineteen articles remained after eliminating case studies with <30 subjects, clinical cases, literature reviews, letters to the editor, and articles that were insufficiently detailed (Fig. 6):

- 3 meta-analyses [11,12]
- 4 randomized controlled trials [13,14]
- 5 nonrandomized controlled trials [6,16]
- 6 prospective cohort follow-up studies [9,17–24]
- 7 retrospective studies [25–27]
- 8 randomized controlled trial without statistical analysis [15].

Each article was assessed according to the study design, sample size, including how many 3MM, the presence of a control group, the radiological diagnosis which allowed for the inclusion of subjects, the average follow-duration up (in months), and the level of proof according to the French National Authority for Health (HAS) scale [28].

#### Decreasing nerve injury risk

The randomized controlled studies by Renton *et al.* (2005) and by Leung *et al.* (2009) found statistically significant outcomes, showing that coronectomy showed a lower incidence of nerve damage than conventional extraction. In radiologically at-risk patients, nerve damage was reported in 0–0.65% cases for coronectomies, whereas it was reported in 2.64–19% cases for standard avulsions [13,14]. In addition, two meta-analyses, one by Long *et al.* (2012) and the other by Cervera-Espert *et al.* (2015), both dealing with the same studies had similar results showing an 89% reduction in the nerve damage risk for coronectomies compared to a standard 3MM avulsion. In summary, many studies (nonrandomized controlled, prospective, and retrospective) found similar results favoring coronectomy (Table I).

The coronectomy minimizes the risk of IAN nerve damage compared to conventional surgical techniques.

#### Complication

##### *Intraoperative complications*

Apart from the complications inherent to any oral surgery (for example; bleeding, pain, fracture, etc.), two specific complications should be highlighted.

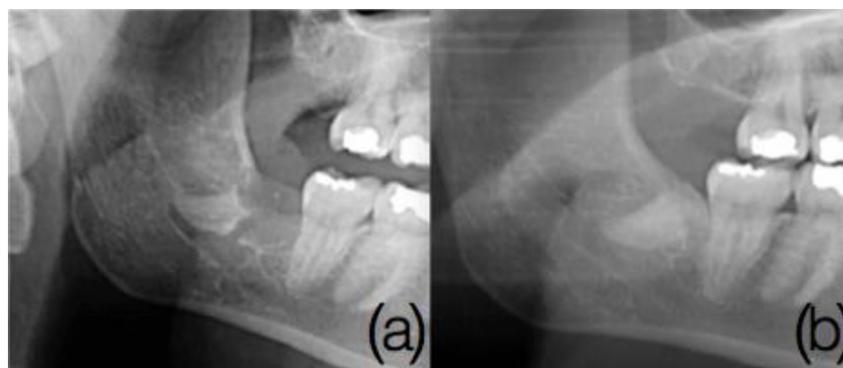
In the event of intraoperative mobilization of the radicular complex, it must be avulsed. Indeed, according to Patel *et al.* (2013), this increases the risk of postoperative infection [26,29]. This risk is higher in conical root cases and in female patients.

In the case of insufficient coronoradicular separation, amelodentinal residue may be observed at the end of the procedure. This will require reintervention to avoid the increased risk of infection.

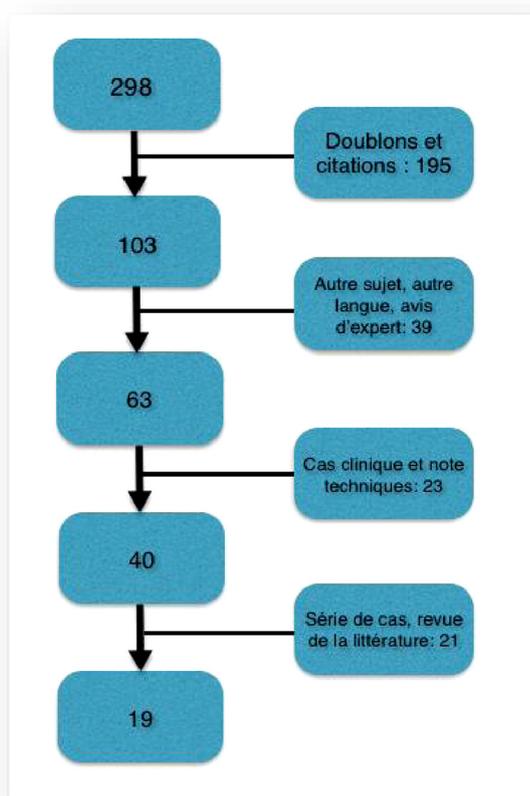
##### *Postoperative infections*

For methodological reasons, controlled group studies were used to investigate short-term (<2 months) postoperative infections, such as dry and suppurative alveolitis. On the other hand, long-term infections (≥2 months) caused specifically by coronectomies were investigated by prospective studies, because they have long-term follow-up.

*Suppurative alveolitis:* Controlled studies conducted by Rendon *et al.* (2005) Leung *et al.* (2009), and Hatano *et al.* (2009) found no statistically significant difference between the two groups [6,13,14]. Other noncontrolled studies found suppurative alveolitis rates for coronectomies that were comparable to the rates found in the literature for standard avulsions (4% for Leung *et al.* (2016) and 2.64% for Aravindaksha *et al.* (2015) [15,17]).



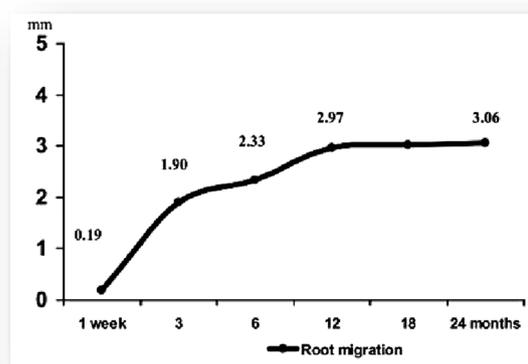
**Fig. 5.** (a) Immediate post-operative radiographic control, (b) at 12 months. It can be noted the coronary migration of the roots.



**Fig. 6.** Flow chart of the bibliographic review.

**Dry socket:** Studies by Leung *et al.* (2009) and by Hatano *et al.* (2009) found a statistically significant difference in favor of the coronectomy, wherein conventional avulsions had a dry socket rate of 2.7–8.47% compared to the lower rate of 0–1.96% for coronectomies [6,13]. Other studies did not specifically address this parameter.

**Long-term infections:** The presence of residual roots in the socket forces the practitioner to consider the potential risk of a long-term infection. The study conducted by Leung *et al.* (2016) which monitored a cohort of 612 coronectomies for 60



**Fig. 7.** The roots migration, from Leung *et al.* (2009) [13].

months, discovered only two (0.33%) infections (at 12 and 24 months) [17]. All the other studies had shorter postoperative monitoring and found no long-term infections.

It seems that the postoperative infection rates are similar for both techniques.

#### *The fate of the residual roots*

Different studies highlight a phenomenon of root migration toward the crown. Leung *et al.* (2009) note a migration of 3.06 mm ( $\pm 1.67$  mm) after 24 months with a migratory peak within the first 3 months, followed by a stabilization up to 36 months (13) (Fig. 7). These results have been confirmed by Kohara *et al.*'s study (2015) (111 teeth monitored for a period of 36 months), which found that 68% roots had migrated, with a peak at 3 months and stabilization at 3.5 mm after 36 months [18]. This study found increased migration in women and younger subjects. The study done by Goto *et al.* (2012) focusing on conical roots also confirms this [21]. Hatano *et al.* (2009) and Kouwenberg *et al.* (2016) found similar migration rates of 84–85% [6,22].

In certain situations, the roots re-erupt in the oral cavity after migration. A reintervention will therefore be guided by symptomatology: pain, infection, or the patient's discomfort.

**Table I.** Main characteristics of the selected studies.

	Design study	Size series (number of 3MM)	Groups	Nerve damage (%)	Diagnosis risk of nerve damage	Maximum follow-up Average follow-up (standard deviation month)	Level evidence HAS
J. Cervera-Espert 2016 [11]	Meta-analysis	sa	sa	Reduced risk of nerve damage 89%	sa	sa	A
H. Long 2012 [12]	Meta-analysis	sa	sa	Reduced risk of nerve damage 89%	sa	sa	A
Y.Y. Leung 2009 [13]	ECR	349	178 E 171 C	5,1 E* 0.65 C*	OPT	24 9.9 (7.7)	B
T. Renton 2005 [14]	ECR	196**	102 E** 58 C** 36 chess	19 E* 0 C* 8,3*	OPT	29 25(13)	B
Cilasun 2011 [16]	ECnR	175	87 E 88 C	1,7 E 0 C	OPT TDM	30 17,3 (NR)	B/C
Y. Hatano 2009 [6]	ECnR	220	118 E 102 C	5 E 1 C	OPT TDM	13 E:13 (1,31) C:13,5 (14,85)	B/C
Y.Y. Leung 2016 [17]	Prospective study	612	sa	0.16	OPT	60	C
K. Kohara 2015 [18]	Prospective study	111	sa	1	OPT TDM	36 NR	C
G. Monaco 2015 [19]	Prospective study	116	sa	0	OPT TDM	36 NR	C
Y.Y. Leung 2012 [20]	Prospective study	135	sa	0	OPT	36 NR	C
S. Goto 2012 [21]	Prospective study	116	sa	0	OPT TDM	12 12(0)	C
A.J. Kouwenberg 2016 [22]	Prospective study	151	sa	0	OPT	6 6(0)	C
J.O. Agbaje 2015 [23]	Prospective study	96	sa	0	OPT TDM	12 NR	C
A. Pogrel 2004 [9]	Prospective study	50	sa	0	OPT TDM	42 22(NR)	C
G. Monaco 2012 [24]	Prospective study	43	sa	0	OPT TDM	12 NR	C
B. Frenkel 2015 [27]	Retrospective study	185	sa	0.98	OPT TDM	12 12	D
B.C. O'Riordan 2004 [26]	Retrospective study	52	sa	7,3	OPT	120 11(NR)	D
A. Shah 2015 [25]	Retrospective study	150	sa	0	NR	60 60 (0)	sa
S.P. Aravindaksha 2015 [15]	ECR	120	66 E 54 C	2.64 E	TDM	12	

C: Coronectomy, ECR: Randomized Controlled Trial, ECnR: Controlled Trial, E: Extraction, NR: Not specified, OPT: panoramic X-ray, RdL: Exhaustiv Bibliographic Review, sa: without object, TDM: Tomodensitometry.

\*  $p < 0.05$

\*\* In Renton *et al.* (2005) study, 36 teeth are extracted during the intervention due to mobility [14].

Leung *et al.* (2016) during the 60-month follow-up of 612 coronectomies, observed a re-eruption rate of 2.1% [30]. The coronectomies are conducted without nerve damage, thanks to the apparent distancing between the nerve structures and the roots as a result of migration. Cilasun *et al.* (2011) and Renton *et al.* (2005) indicated that no reintervention was needed after a follow-up of 17 and 25 months, respectively [14,16].

A mesiocrestal migration of residual roots (frequently observed) sometimes requires reintervention, but all safety protocols are observed with respect to IAN.

#### Endodontic treatment is required

Sencimen *et al.* (2010) established two groups with each group having eight patients. In one group (experimental group), the coronectomy was supported by endodontic treatment with mineral trioxide aggregate of the roots. In the other group (the control group), the tooth with the coronectomy received no treatment [18]. A significant complication rate is found in the group receiving the endodontic treatment (seven avulsions needed for the eight residual root complexes).

Some studies have histologically analyzed the pulp tissue of the extracted teeth after their re-eruptions [18,31]. The dental pulp of these teeth was the key determinant in most cases (some cases of partial necrosis were discovered with the necrotic tissue located coronally to the vital apical pulp tissue).

Finally, the long-term prospective studies in which clinical and radiological follow-up was performed reported no signs of pulpal necrosis [17].

#### Endodontic treatment of residual roots is not necessary.

#### Periodontal healing

According to Vignudelli *et al.* (2016), from the 9th month after the coronectomy, the pocket depth distal to the second molar and the distance between the bone crest and the bottom of the bone defect reach normal physiological levels [32].

Kohara *et al.* (2015) confirmed this using 3D CBCT imaging, which revealed that in >90% cases, there were pockets <4 mm as well as new bone growth above the roots [18].

Leaving residual roots in place does not affect the periodontal prognosis of the adjacent tooth.

## Conclusion

The use of the coronectomy as a technique for extracting mandibular wisdom teeth seems to significantly decrease the risk of nerve damage in cases of proximity between IAN and the dental roots without increasing the intraoperative or postoperative complications. It is a simple technique that does not require endodontic treatment of the residual roots. Long-term reinterventions and infections are infrequent.

Coronectomy is therefore a surgical technique of interest which should be more widely taught and practiced. The use of this technique could significantly decrease the postoperative neurological complications that are often the reason for medicolegal cases.

**Conflicts of interests:** The authors declare that they have no conflicts of interest in relation to this article.

*Acknowledgment.* Yolaine David.

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