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Bolt, R., Hirani, M., Kyriakidou, E. et al. (3 more authors) (2021) The use of coronectomy to manage symptomatic mandibular third molars : techniques, pitfalls and suggested guidelines. Dental Update, 48 (3). pp. 217-223. ISSN 0305-5000

https://doi.org/10.12968/denu.2021.48.3.217

Oral Surgery

The Use of Coronectomy to Manage Symptomatic Mandibular Third Molars: Techniques, Pitfalls and Suggested Guidelines

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Abstract

Coronectomy is a valuable technique in the management symptomatic mandibular third molars at high risk of inferior alveolar nerve injury. When applied appropriately, the technique may reduce the incidence of inferior alveolar nerve injury in comparison to full surgical removal. Currently, no definitive guidelines exist on when to opt for coronectomy versus full surgical removal, and therefore significant variation in clinical practice exists. This article summarises the surgical stages involved in the coronectomy procedure, reviews the indications and hazards of the technique, and finally provides suggested guidelines to assist the practitioner in the decision-making process of when to opt for coronectomy versus full surgical removal in the management of symptomatic mandibular third molars.

Clinical relevance statement

This opinion paper provides the reader guidance on clinical decision making in relation to the treatment of symptomatic mandibular third molars that are in a close relationship with the inferior alveolar nerve, and provides an illustrated summary of the coronectomy technique.

Brief objectives statement

To review the coronectomy technique and highlight potential hazards with inappropriate application of the technique.

INTRODUCTION

Coronectomy remains a hotly debated issue in the management of the symptomatic mandibular third molar. Use of the technique varies greatly between practitioners, and often fails to adopt an evidence-based approach. Whilst many operators still do not recognise the technique as a valid method of managing a symptomatic third molar, others have inappropriately adopted use of the technique in all cases judged as "high risk". It is widely accepted that the principal factor influencing a decision to undertake coronectomy should be an increased risk of inferior alveolar nerve (IAN) injury, although the exact risk threshold for coronectomy to be warranted remains poorly defined and open to interpretation. Some evidence through randomised controlled trial undermines the routine use of the technique, as the significance of reduced permanent nerve injury when compared to full surgical removal appears questionable [1, 2]. Indeed, primary endpoints for trials have analysed temporary rather than permanent nerve injury due to the large patient numbers required to demonstrate differences in permanent injury rates between coronectomy and full surgical removal – this may indicate that although a statistically significant difference could exist, it is not clinically important to the general "high risk" population. Compounding this finding is the fact that a small number of coronectomied roots will become symptomatic over time, exposing the patient to the further risk of repeat treatment in a surgical field that lacks the usual anatomical landmarks afforded by the presence of a crown.

Despite these shortcomings, a number of randomised trials and systematic reviews have concluded a very low incidence of nerve injury with the coronectomy technique and there is a general consensus that risk of permanent nerve injury is overall reduced[3-5]. Moreover, recent data suggests that as a consequence of root migration, repeat surgery to retrieve symptomatic roots is also associated with a low incidence of nerve injury[5,6]. This opinion paper offers the general dental practitioner a review of the coronectomy technique, discusses the indications that have been

adopted in a tertiary referral centre specialising in inferior alveolar & lingual nerve repair, and further highlights some of the potential hazards with inappropriate application of the technique.

TECHNIQUE

The coronectomy technique was initially described by Ecuyer & Debien in 1984[7], although more informal use of "partial odontectomy" predates this description[8]. The procedure has evolved from initial recommendations of a relatively aggressive reduction of tooth tissue to within 2mm of the IDN, to more conservative tooth reduction that ensures complete removal of enamel[9]. A number of key steps have been proposed as the technique has evolved, and failure to adopt these steps may underlie the variable successes experienced between surgeons. Pogrel, one of the pioneers of coronectomy, recommended the use of antibiotics prior to surgery to avoid root infection with a continued postoperative course; the role of prophylactic antibiotics particularly in the preoperative stage, has been challenged although available evidence to derive a suitable conclusion is limited[10, 11]. A 3-sided mucoperiosteal flap is raised in order to access the crown of the third molar. Initial descriptions of the procedure further recommended the use of a lingual flap in order to protect the lingual nerve from damage during decoronation with fissure bur[10]. Conventional UK practice is to avoid retraction of lingual flaps during third molar surgery due to the increased risk of lingual nerve injury; this has on occasion led to practitioners adopting inappropriate decoronation techniques for UK-based practice. Whilst lingual retraction may allow direct protection of the nerve from fissure bur trauma risked by perforating the lingual cortex (Figure 1a), penetration of the fissure bur beyond lingual cortex without retraction risks lingual nerve injury. Indeed, the authors have received a number of tertiary referrals of lingual nerve injury sustained from fissure bur trauma in this manner during coronectomy. A commendable practice is therefore to limit fissure bur sectioning to just beyond the pulp chamber, with final crown split using a small sized Coupland's elevator or straight Warwick-James **(Figure 2c).** This variation in technique may explain the increased incidence of root

mobilisation noted in UK studies[1], as should the fissure bur cut not extend to a sufficient depth the operator may risk mobilisation of the roots during the final crown split. Root mobilisation during the process of crown sectioning should prompt a change of treatment to full surgical extraction, and it is therefore important that the patient is consented preoperatively for potential full surgical removal should mobilisation occur.

Pogrel[10] reported that an important aspect of successful coronectomy is the complete reduction of the retained root to 3mm below the alveolar crest in order to ensure postoperative healing with full mucosal coverage and to avoid subsequent root exposure to the oral environment, although some clinicians have also reported success with paracrestal coronectomy as long as complete enamel removal has been achieved. In order to decoronate using Pogrel's recommendations, a fissure bur cut should be undertaken at the level of the amelo-cemental junction and by virtue initial buccal reduction will be at best paracrestal (Figure 2d). Buccal cortex may be removed in order to access the full contour of the crown, although bone removal should be kept to a minimum (Figure 2c). An angular burring path will ensure that adequate lingual tooth tissue is removed, although further buccal reduction will be necessary in order to achieve complete submergence of the root. Buccal root reduction is performed after decoronation and can be completed with a combination of round and fissure burs held in a vertical orientation in order to erode the buccal aspect of the root to 3mm below crestal level (Figure 2e). Although conventional wisdom has led us to believe that retention of roots with exposed pulp chambers may lead to pulpal necrosis and subsequent periapical infection, attempts at coronectomy in combination with MTA root treatment have led to increased failures[12]. More recent reports have also suggested pulp vitality is commonly maintained after coronectomy[13,].

There has been recent interest in undertaking guided bone regeneration (GBR) to assist with achieving full hard tissue coverage of the retained root portion using bone substitute and a resorbable collagen membrane[14]. Although preliminary data suggests that root migration is significantly reduced with GBR, long-term data on success is not available and postoperative pain

appears to be increased. The reduction of root migration may however prove to avoid root re-exposure and therefore need for second surgery.

Periosteal relief and final water-tight, primary closure of the 3-sided flap using vertical mattress sutures is recommended in order to seal the surgical site from the oral environment, although standard interrupted sutures may be more appropriate in cases of difficult access or judged to be at risk of lingual nerve injury. In the recovery period, any early postoperative complications should be managed as "dry socket", and the presence of the persistent root ignored. Resorbable medicaments such as Alveogyl (Septodont) have been recommended[15], although repeated use may lead to pulpal necrosis[13]. Ongoing symptoms may prompt an open discussion with the patient as to whether repeat surgery for root removal is warranted, although re-coronectomy may be feasible if retained enamel is noted on postoperative radiograph[16].

INDICATIONS FOR CORONECTOMY

Role of Cone Beam CT

It is the view of the authors that undertaking coronectomy for all symptomatic mandibular third molars exhibiting plain film features of a close relationship with the IDN is both unnecessary and inappropriate. Foremost, evidence of an intimate relationship on a plain radiograph may not translate to an intimate relationship in 3D, and sectional cone beam CT assessment of any suspicious relationship is a prerequisite to the final decision making process[8]. In fact, as much as 98% of cases demonstrating a high risk relationship on plain film were noted as low risk on subsequent CT review[17];for these cases, CT imaging still acts as a valuable tool in prompting the clinician to recommend full surgical removal rather than coronectomy. CT assessment may therefore either confirm or refute a close relationship and furthermore may greatly assist in quantifying individual risk. In two recent studies of those cases judged as "high risk" based on OPG features, full extraction

was associated with 0% permanent IDN injury if CT assessment demonstrated presence of intact cortical bone between the roots and IDN[18, 19]. Full extraction in such cases should therefore be regarded as treatment of choice unless an overriding patient factor or anatomical configuration warrants coronectomy.

Current evidence suggests that CT assessment does not significantly influence nerve injury rates if used solely to modify the surgical approach to undertaking full tooth removal[19-21], and therefore it is important to apply relatively strict criteria for altering the treatment plan from full removal to coronectomy in order for CT planning to be of benefit to outcome.It is not unusual for a patient to desire full removal irrespective of IDN risk so as to gain emotional closure of the ongoing pain relating to a symptomatic third molar and avoid future root infection; a frank discussion as to whether a patient's choice of treatment will be altered in the light of CT findings should take place before the test is requested. Indeed, Cilsun *et al* found that approximately 6.5% of patients carrying high-risk CT features declined coronectomy in preference of full surgical extraction[18]; the value of CT scanning in such cases is more difficult to justify, although on an individual basis CT planning may be of marked benefit to outcome even if full surgical removal is planned (Figure 3). In addition to CT data helping to quantify risk of full surgical removal, the exact location of the IDN may also influence the decision as to whether coronectomy itself presents an unacceptable risk of nerve injury, due to the nerve lying in the direct path of the decoronation cut.

A comprehensive radiographic assessment of nerve injury risk for any one patient is multifactorial, taking into account not only nerve position and canal cortication, but also factors such as root morphology, anticipated regions exposed to burring, and the anticipated path of root extraction. These factors contribute to high inter-operator variability in the interpretation of both OPT and CT imaging.

Clinical Considerations

Horizontal impaction has been reported as a relative contraindication to coronectomy, due to the potential for inadvertent transection of the IDN during completion of the inferior decoronation cut[10]. Monaco *et al* formulated a protocol for managing horizontally-impacted third molars with coronectomy using a final inferior "crown fracture" technique comparable to that described above[22], although the exact position of the IDN in relation to both crown and roots should be borne in mind when determining the feasibility of coronectomy.

If the operator wishes to follow Pogrel's recommendation of subcrestal root reduction, the ability to achieve reduction of tooth tissue to 3mm below the level of the postoperative alveolar crest is an important consideration which may be overlooked. In cases of crestal bone resorption a 3mm subcrestal reduction may broach important structures, such as a root furcation in a case of slender roots (leading to mobilisation) or even the IDN itself. Again, the use of cone beam CT to identify IDN position is critical in avoiding this latter risk. Other contraindications to coronectomy include deep caries, pulpal disease and systemic risks of infection[14]. In such cases, the high risk of failure or systemic sequelae outweigh the potential benefits of the technique. Although association with cysts has also been reported as a contraindication, initial case series suggest success of coronectomy in the management of third molars in association with a dentigerous cyst[23, 24]. Indeed, our experience concurs with such reports, whereby a high risk of IDN injury or jaw fracture may warrant coronectomy as a favoured approach.

Nerve Position

The case of the lingually positioned IDN that can be observed on CT as directly contacting the third molar without intervening bone (Fig. 3), has been highlighted as carrying a risk to the IDN of up to 20% with conventional surgical removal[19, 25]. Ghaemenia *et al* noted that in such very high risk cases,

there is little evidence of risk reduction through altered surgical approach to full extraction and coronectomy may be a preferable alternative[19]. Again, extreme care has to be taken to avoid direct burring of the nerve during crown sectioning, with a final fracture technique advisable. Interestingly, two studies have reported a 0% incidence of IDN injury with full surgical removal if the nerve has direct contact with the root but lies in an apical position. An intimate buccal relationship has also demonstrated a relatively low incidence of injury, whilst data relating to an interradicular relationship suggests relatively high risk[19, 25]. Clearly, the vertical position of the nerve in relation to crown will also influence overall risk although available data is limited.

Removal Versus Coronectomy: A Multifactorial Approach to Decision Making

The final decision making process should take into account all patient, clinical and radiographic variables in order to determine the most effective individualised treatment strategy. Although much literature quotes a greater significance of IDN injury to patients whose livelihood is reliant on intact trigeminal afferents such as public speakers and wind musicians[1, 9], IDN injury is a disastrous consequence of third molar surgery for anyone and therefore treatment strategy should probably not be heavily driven by occupation. Although the final decision process should be patient-led, we have provided tables to help summarise those factors which are indicative, permissive, unfavourable and contraindicative of coronectomy (Table 1) and have summarised a general decision-making algorithm for coronectomy of symptomatic mandibular third molars (Figure 5).

HAZARDS

As eluded to in the preceding text, the major hazards of coronectomy relate to direct bur trauma of either the IDN or lingual nerve. Although both IDN and lingual nerve injury are reported as rare following coronectomy, we have received a disproportionate number of referrals in recent years.

Whilst disconcerting, this experience cannot be translated to accurately representing direct risk of the technique as those clinicians undertaking coronectomy are likely more mindful of nerve injury overall and therefore more likely to refer to tertiary care following injury. Most referrals have related to lingual nerve injury as a consequence of bur penetration through the lingual cortex without protection (Figures 1b & c), reinforcing the need for careful technique involving either direct protection or a crown-fracture approach. Longer term sequelae of coronectomy remain uncertain due to the relatively nascent technique, although much concern regarding apical root infection leading to IDN injury appears unfounded.

CONCLUSION

The vast majority of symptomatic mandibular third molars are most appropriately managed through full surgical removal, even when displaying evidence of an intimate relationship on plain film. Coronectomy is however a valuable technique for those cases carrying high risk of sequelae such as IDN injury or mandibular fracture, as confirmed through CT scanning. It is likely that recent studies evaluating the success of coronectomy through randomised controlled trial have been weakened by the inclusion of those cases not at significant risk of nerve injury, and the value of adopting a coronectomy approach for more specific relationships such as direct contact between a lingual or interradicular IDN and the mandibular third molar may therefore be underestimated. The available evidence suggests that in such high risk cases the coronectomy technique has a superior outcome compared to full removal, and adoption of this strategy should be regarded as an appropriate balance of risk and benefit rather than being dismissed as an “easy option”.

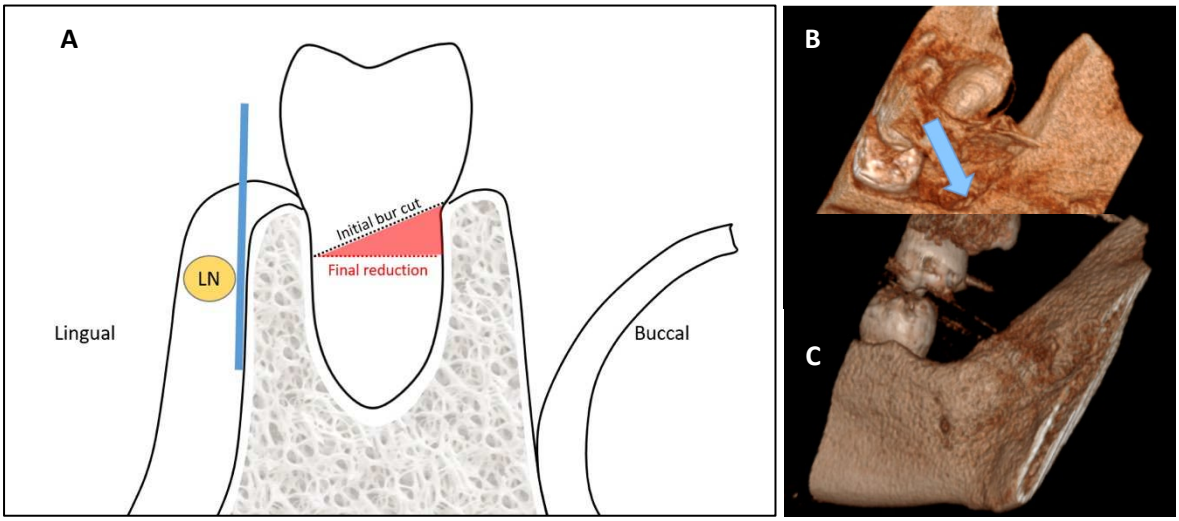

Fig. 1 a) Diagram illustrating decoronation technique proposed by Pogrel *et al*[11] – note that Pogrel *et al* recommended the presence of a lingual retractor (blue line) to obstruct an over-penetrating bur from contacting the lingual nerve (yellow, LN). The initial decoronation cut is then eroded back to the position of the red broken line ("final reduction"); b & c) CBCT 3D renderings from a patient who suffered lingual nerve injury as a consequence lingual cortex perforation with a fissure bur during coronectomy; b) supero-lingual view illustrating bur hole in lingual cortex (red arrow) in relation to retained root (blue arrow); c) infero-lingual view illustrating a clearly visible bur hole in the lingual cortex. We have received a significant number of referrals over recent years regarding lingual nerve injury sustained as a result of aggressive decoronation without lingual protection.

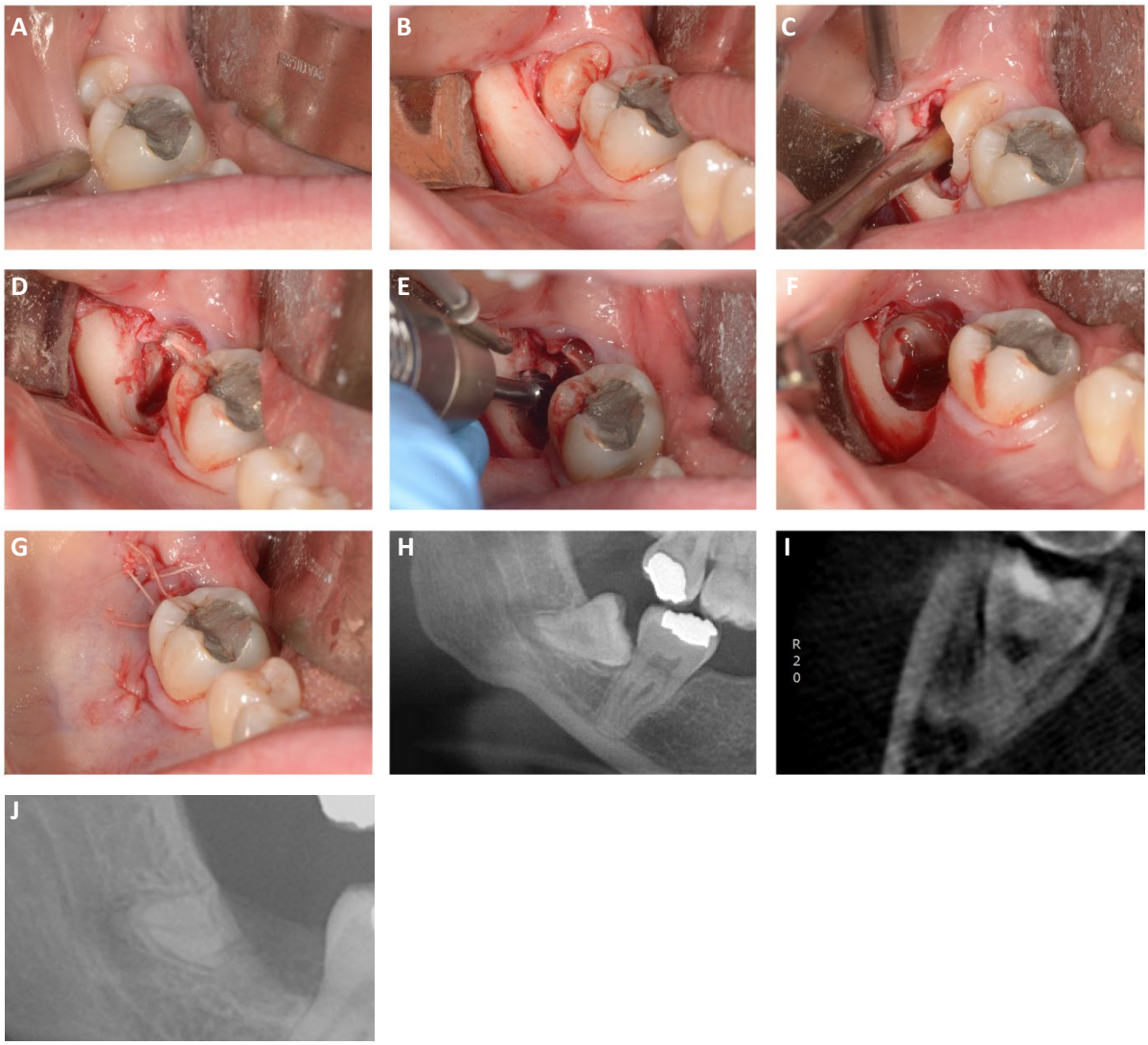

Fig. 2 a) Preoperative view of lower right third molar; b) A 3-sided mucoperiosteal flap is raised; c) The crown is minimally exposed to the point of the amelo-cemental junction and a fissure bur used to create a cut which is propagated using a Coupland's elevator – note the inverted "u" shape of the cut in order to guarantee complete removal of enamel from the submerged mesial portion of crown; d) Post-decoronation image demonstrating the paracrestal level of the buccal root aspect, with more extensive tooth tissue removed lingually as a favourable consequence of bur orientation; e) The buccal aspect may be carefully reduced with a combination of round and fissure burs, taking care to preserve buccal bone and avoid root mobilisation; f) Coronectomy completed and wound gently

debrided g) Water-tight closure with a 5/0 resorbable suture, including closure of mesial and distal reliefs – in this case periosteal release was not necessary; h) Preoperative plain film inferring a high-risk relationship; i) Horizontal cone beam CT section demonstrating an unusual shaped root in direct contact with the IDN, which has adopted an interradicular relationship; j) 6-month postoperative plain film, demonstrating evidence of bony infill over the coronal aspect of the coronectomied lower right third molar, along with migration of the root away from the mandibular canal

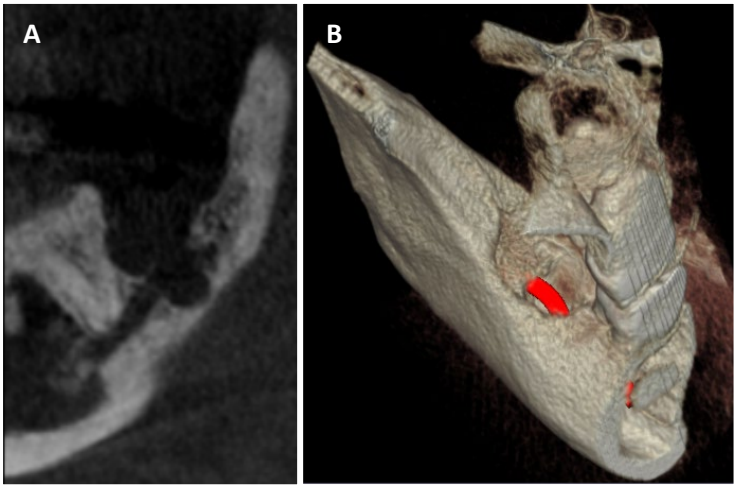

Fig. 3 a) Sagittal section taken from cone beam CT of a patient referred to our department with complete mental anaesthesia following surgical removal of LR8. Note that the ID canal can be observed to run in contact with the apex of LR7, extending distally to communicate with the socket of LR8. The LR8 root was noted at end of surgery to have fully enclaved the nerve – so-called "polo-minting". Upon elevation the root severed the IDN, dragging the proximal stump with it; b) 3D rendering of LR8 socket with nerve mark-up in red, illustrating the likely preoperative course of the IDN – CT planning would have allowed this intimate relationship to be identified and appropriate steps taken to preserve IDN integrity

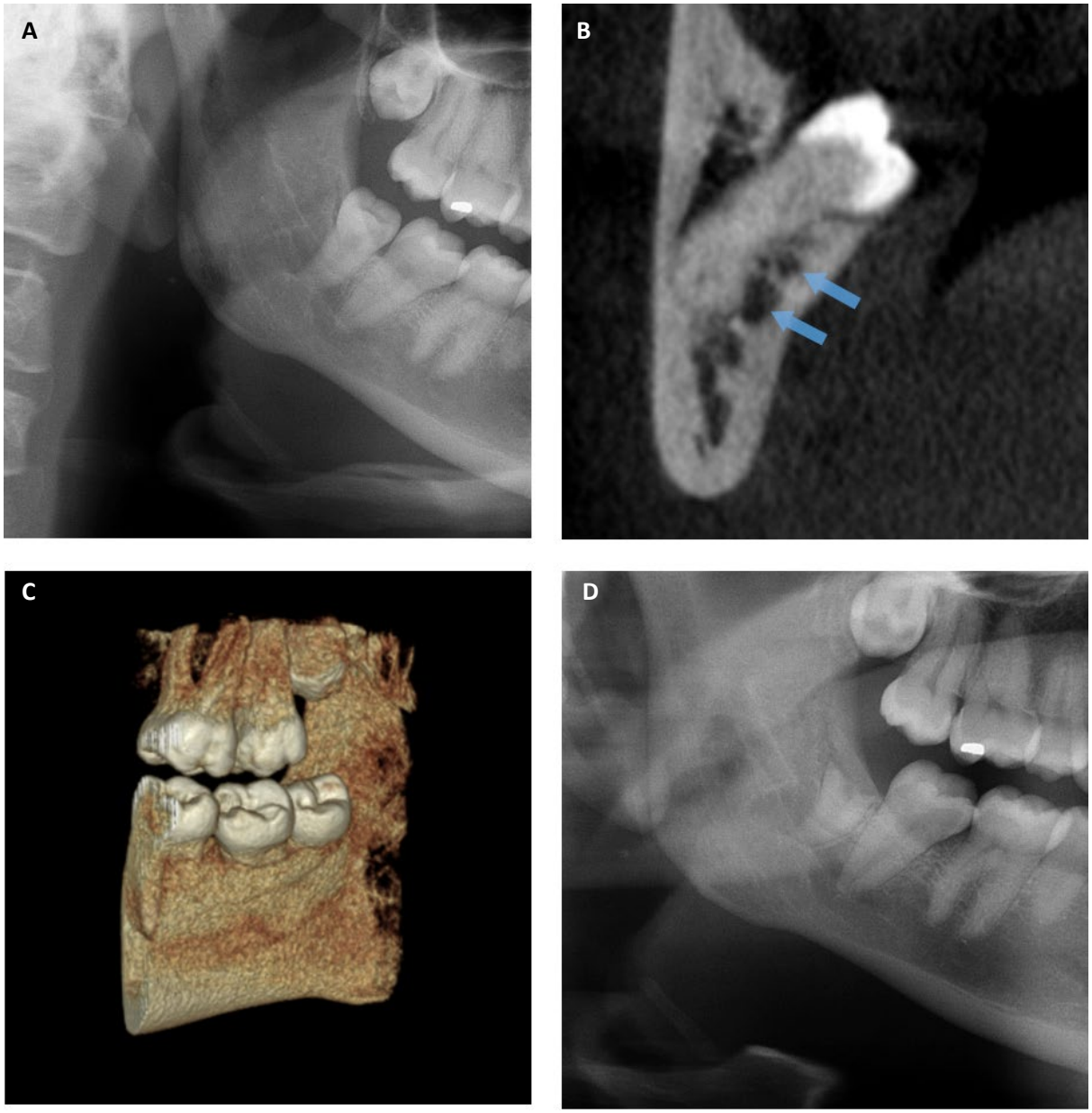

Fig. 4 a) Preoperative plain film demonstrating a potentially high-risk relationship between the IDN and both LR7 and LR8. Note that the IDN separates into two distinct branches at the distal aspect of LR8; b) Coronal section taken from sectional cone beam CT scan, demonstrating a lingual relationship of both branches of the IDN (blue arrows) to the LR8; c) 3D rendering, illustrating the lingual tilt of both LR7 & LR8, in this case increasing the risk of transmission of elevation forces on to the nerve with full surgical removal; d) Postoperative plain film – although full removal of enamel can be observed, the mesial root portion would have benefited from further reduction to achieve a 3mm subcrestal relationship. The patient remains asymptomatic.

Indicative

CT Features	Nerve lingual to third molar or interradicular plus CBCT confirms absence of cortex between nerve and root
	Other anatomical high risk relationship – e.g. nerve completely enclaved by roots, marked nerve/canal compression; particularly when adopting “dumbbell” morphology
Path of extraction	Likely to traumatise IDN
Mandible	Root fused to lower cortical plate, full surgical removal presents unacceptable risk of pathological fracture

Permissive

Orientation	Mesioangular, distoangular or vertical
Crest	3mm subcrestal reduction feasible both lingually and buccally
Roots	Low risk of mobilisation
Patient	Agrees to root retention
	Older age group (>25)
Medical history	Immunocompetent and low risk of systemic sequelae
Tooth	Free of caries, periodontitis and apical pathology

Unfavourable

Orientation	Horizontal
Crest	3mm subcrestal reduction not feasible
Roots	High risk of mobilisation
Patient	Limited access to dental follow-up (e.g. military)
	Younger age group (<25)
CT Features	Cortical bone between IDN and roots

Contraindicated

Patient	Declines root retention
Medical history	High risk of systemic sequelae
Tooth	Caries, periodontal disease or apical pathology
CT Features	Nerve very high and judged to be at risk of bur trauma during coronectomy

Table 1; Factors influencing the decision-making process

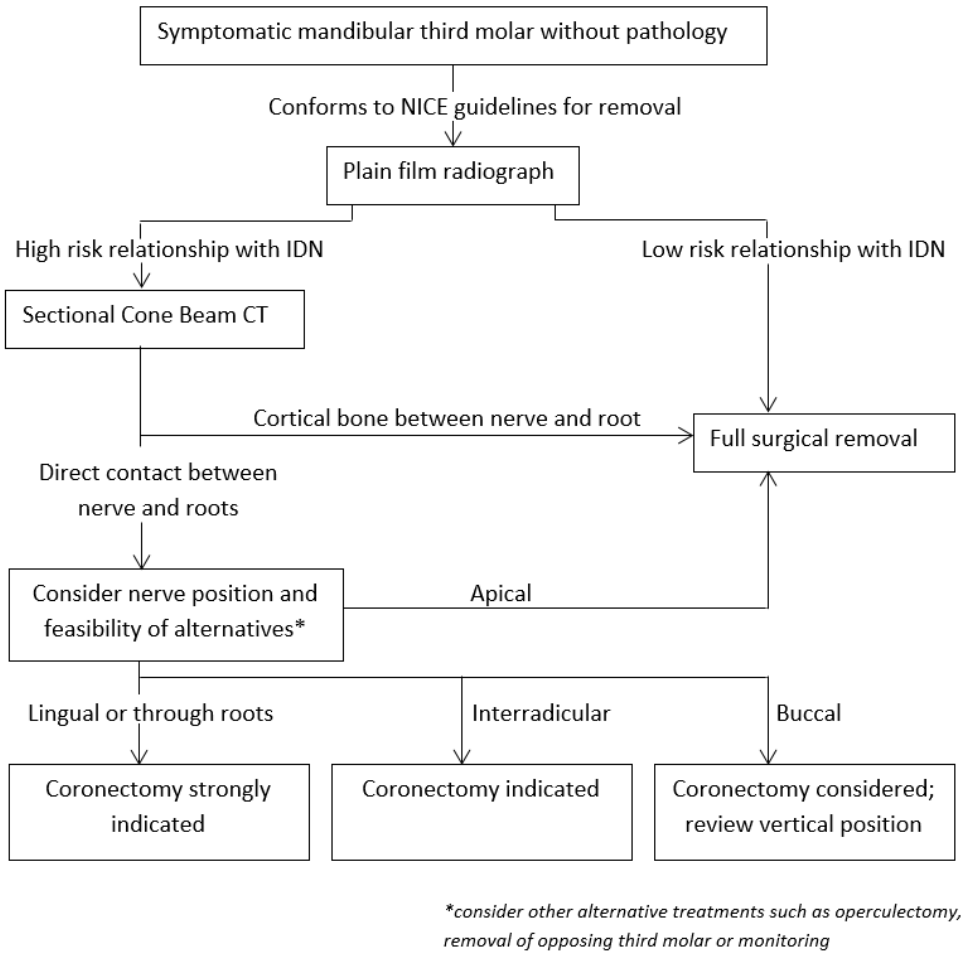

Fig. 5; General decision-making algorithm for managing symptomatic mandibular third molars. Although not aimed to be prescriptive, this algorithm may help guide treatment in the majority of clinical scenarios.

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