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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

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Summary We randomised 128 patients who required operations on mandibular third molars and who had radiological evidence of proximity of the third molar to the canal of the inferior alveolar nerve to one of two operations: extraction [$n = 102$], and coronectomy [$n = 94$]. Some roots were dislodged during intended coronectomy and were therefore removed, resulting in two subgroups (successful coronectomy $n = 58$, and failed coronectomy $n = 36$).

The mean (S.D.) follow up was 25 (13) months. Nineteen nerves were damaged (19%) after extraction, none after successful coronectomy, and three (8%) after failed coronectomy ($p = 0.01$). The incidence of dry socket infection was similar in the three groups (10/102, 10%, 7/58, 12%, and 4/36, 11%, respectively). No root required removal or reoperation.

To our knowledge this is the first clinical trial of the efficacy of coronectomy in preserving the inferior alveolar nerve. The length of follow up was about 2 years, which for the assessment of delayed eruption of the root fragments is not sufficient as this process may continue for up to 10 years. However, it seems that coronectomy reduces the incidence of injury to the inferior alveolar nerve without increasing the risk of dry socket or infection.

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Introduction

Operations on mandibular third molars are common and are complicated by temporary injury to the inferior alveolar nerve in up to 8% and permanent injury in up to 3.6% of cases.[1–19] Risk factors include advanced age[1] and difficult operation,[2] but an important risk factor is the proximity of the third molar to the nerve canal.[3] Coronectomy avoids the nerve canal by ensuring retention of the roots when they are close to the canal (as estimated on radiographs).

Proximity of the inferior alveolar nerve to the apex of the root can be predicted by three radiographic features (diversion of the canal, darkening of the root, and interruption of the lamina dura[20]) and can be seen on periapical panoramic tomographic views.[1,11,21] This offers the opportunity to alter the extraction technique to minimise risk to the nerve.

It is common practice for broken fragments of the root of vital teeth to be left in place and most heal uneventfully.[22,23] Another technique for extraction of a third molar is the deliberate retention of the root adjacent to the nerve (coronectomy) (B. O'Riordan, Uneasy lies the head that wears the crown. Presented at a meeting of the British Association of Oral Maxillofacial Surgeons, June 1997). A study of 100 patients showed that the risk of subsequent infection was minimal and morbidity was less than after the traditional operation.[24–26] Over a period of 2 years some apices migrated and were removed uneventfully under local anaesthetic. On the premise that coronectomy reduces the risk of nerve injury, it has been recommended for those patients for whom there may be serious repercussions from numbness of the lip (wind instrument players, actors, singers, and others).[27] We examined the morbidity associated with the two techniques in a randomised clinical trial.

Patients and methods

During the period 1999—2002, 128 patients attend Guy's Dental Hospital for removal of 196 third molars and took part in a randomised trial. The protocol was approved by the local ethics committee and patients gave informed consent.

The selection criteria were: patients who were judged to be at high risk of injury to the inferior alveolar nerve based on radiographic features in routine preoperative dental pantomographs. These features included the morphology of the root (conical, club, or divergent), proximity of the mandibular third molar to the nerve canal (distant, crossing one lamina dura, or crossing both lamina dura), angulation of the tooth (vertical, mesioangular, distoangular, or horizontal), darkening of roots, deviation of the canal, loss of lamina dura of the canal, narrowing of the canal, deflection of the roots, and narrowing of the roots. A new radiographic sign of a periapical or paradontal radiolucent area (juxta-apical area, Fig. 1) was included in the criteria. Patients who were more predisposed to local infection (from diabetes, immune compromise including HIV and chemotherapy, previous radiotherapy to the head and neck, osteosclerosis, or osteopetrosis), or who had systemic infections were excluded, as were those with previous or existing defects of the inferior alveolar nerve, neuromuscular disorders, or non-vital third molars.

Figure 1. Juxta-apical area.

The teeth to be removed were randomised (using a table of random numbers that was concealed from the surgeon) into two groups: traditional removal $n = 102$, and coronectomy $n = 94$. On occasion attempted coronectomy resulted in roots being mobilised, which necessitated removal of the tooth. The coronectomy group therefore had two subgroups (successful coronectomy $n = 58$, and failed coronectomy $n = 36$).

The anaesthetic methods were similar among the groups ($n = 77$, 60% general anaesthetic; $n = 38$, 30% local anaesthetic; and $n = 13$, 10% sedation and local anaesthetic). Methods of extraction of the 138 roots included a buccal approach and sectioned tooth ($n = 84$, 61%); a buccal approach and lifted tooth ($n = 10$, 7%); a buccal flap and lifted tooth ($n = 22$, 16%); and a solely lifted tooth ($n = 22$, 16%).

The operations were done by three surgeons with senior house officer trainees as assistants. Coronectomy involved transsection of the tooth 3—4 mm below the enamel of the crown into the dentine. The pulp was left in place after the crown had been levered off (Fig. 2). Where necessary the roots were further reduced with a rose head

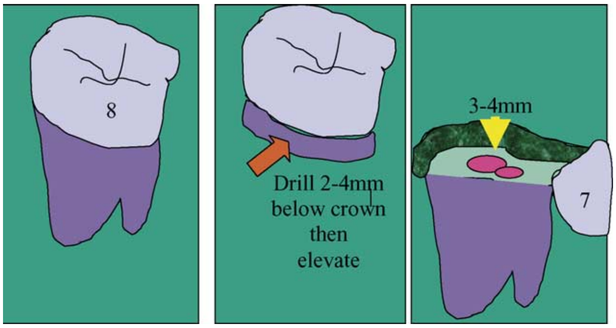

Figure 2. Method used for coronectomy.

bur to 3—4 mm below the alveolar crest (this was not always possible when there were defects in the lingual plate). The socket was then irrigated with saline and the mucoperiosteal flaps replaced with *a single vicryl suture*. No antibiotic was prescribed routinely, but all patients had preoperative chlorhexidine mouth washes.

The mean (S.D.) length of follow up was 25 (13) months. Of the 58 patients who had coronectomy 47 (81%) attended the department for review within the first 6 months. All patients were contacted by telephone within 12—24 h post-operatively.

The function of the inferior alveolar nerve was assessed post-operatively before discharge, 3 days later by telephone and at 1—2 weeks when patients attended the clinic. Those who reported numbness of the lip and or gums were examined further to assess the extent of the damage by standard measures of threshold pressure (light touch thresholds using Semmes Weinstein filaments). This was repeated at 3, 6, and 12 months when necessary. All who had coronectomy were invited to return for review appointments at 6, 12, and 24 months for clinical and radiographic assessment of the retained root fragments. The measures of outcome were the incidence of injury to the inferior alveolar nerve (temporary and permanent), dry socket or soft tissue infection, and the need for reoperation.

Statistical analysis

The Statistical Package for the Social Sciences (SPSS, version 11) was used to analyse the data. Parametric and non-parametric tests (*t* test, chi-square) were used to compare the groups. Probabilities of less than 0.05 were considered significant.

Results

The patients' characteristics were similar in all groups (Table 1). Coronectomy was more likely to fail among women ($p = 0.03$), which implies that the roots were more easily mobilised in women.

Most of the radiographic features were similar in the three groups including loss of lamina dura, proximity to the canal, angulation of the tooth, impaction of the tooth, darkening of roots, and deflection of roots (Table 2). The radiographic features associated with injury to the nerve were juxta-apical area ($p = 0.04$) and deviation of the canal ($p = 0.007$). Radiographic features associated with failed coronectomy were conical root formation ($p < 0.001$) and narrowing of roots within the canal ($p = 0.017$) (Table 2).

The median follow up for the three groups was 25 months (range 6—29) and patients were contacted by telephone 2—5 days after operation and re-examined if they reported sensory disturbances. Nineteen patients (19%) after the traditional operation and 3 patients (8%) after failed coronectomy had signs of injury to the nerve. After coronectomy there were no injuries ($p = 0.008$ compared with traditional extraction). The mean duration of paraesthesia (rather than anaesthesia or dysaesthesia) was 3 weeks, but in two patients the symptoms persisted for more than 6 months (permanent neuropathy). There was no lingual nerve neuropathy.

The incidence of 'dry socket' was similar (10—12%) in all groups (Table 1). It was treated by irrigation with chlorhexidine and dressing with Alvogyl (butyl aminobenzoate, eugenol, and iodoform), to which treatment all the patients responded. One patient after traditional extraction and three after coronectomy developed soft tissue infections that presented as pain, swelling, and lymphadenopathy. No patient required a second operation.

At the time of writing 38 of the 58 patients after coronectomy have been reviewed for at least 13 months. During this time five root segments have started to migrate, less than 2 mm assessed ra-

Figure 3. Post-operative radiographs of root in situ.

Table 1 Complications after removal of third molars.

	Removal ($n = 102$)	Coronectomy ($n = 58$)	Failed coronectomy ($n = 36$)	Significant p value group comparison
Age, mean (S.D.)	27.54 (5.5)	29.0 (6.47)	27.93 (5.8)	
Ethnicity				
White, % (n)	81.4 (83)	89.7 (52)	88.9 (32)	
Black, % (n)	10.8 (11)	10.3 (6)	5.6 (2)	
Indian, % (n)	6.9 (8)	0	5.6 (2)	
Gender				
Male, % (n)	34.2 (35)	29.3 (19)	29.4 (11)	2av2b, $p = 0.045$
Female, % (n)	65.7 (67)	58.6 (39)	71.1 (25)	1v2b, $p = 0.047$
Review period (months), mean (S.D.)	25.75 (9.1)	24 (20.04)	24.56 (8.04)	
IANI, % (n)	18.6 (19)	0	8.3 (5)	1v2a, $p = 0.004$ 1v2b, $p = 0.115$ 2av2b, $p = 0.014$
IANI duration (weeks), mean (S.D.)	2.83 (16.27)	–	2.57 (0.67)	
Dry socket, % (n)	9.6 (10)	12.1 (7)	11.1 (4)	
Infection, % (n)	1 (1)	5.2 (3)	0	
Eruption of roots, % (n)	0	0	0	
Pain, % (n)	21.6 (22)	13.8 (8)	11.1 (4)	
Reoperation, % (n)	0	0	0	

Table 2 Factors associated with failed coronectomy or IANI (n [percentage]).

	Removal	Coronectomy	Failed coronectomy	Reasons for failed coronectomy p value	Reasons for nerve damage p value
Age					
Ethnicity					
Sex				$p = 0.027$	
Morphology					
Conical	33.4 (33)	27.6 (16)	80.4 (29)	$p < 0.001$	
Divergent	34.3 (35)	48.3 (28)	11.1 (4)		
Club	33.4 (33)	24.1 (14)	8.3 (3)		
Proximity—IAN canal					
Distant	0	0	0		
Touching	20.6 (21)	10.3 (6)	16.7 (6)		
Crossing	79.4 (81)	89.7 (52)	83.3 (30)		
Angulation					
Vertical	50 (51)	41 (24)	61 (22)		
Mesioangular	28.4 (29)	24.1 (14)	19.4 (7)		
Distoangular	9.8 (10)	13.8 (8)	11.1 (4)		
Horizontal	11.1 (12)	20.7 (12)	8.3 (3)		
Impaction					
None	7.8 (8)	6.9 (4)	11.1 (4)		
Soft tissue	9.8 (10)	8.6 (5)	16.7 (6)		
Tooth	40.2 (41)	44.6 (26)	47.2 (17)		
Bone	42.2 (43)	39.7 (23)	22.2 (8)		
Darkening—roots	63.7 (64)	69 (40)	61.1 (22)		
Deviation—canal	16.7 (17)	24.1 (14)	19.4 (7)		$p = 0.007$
Loss of lamina dura	69.6 (71)	63.8 (37)	63.9 (23)		
Narrowing canal	21.6 (22)	22.4 (13)	22.2 (8)		
Juxta-apical area	15.7 (16)	20.7 (12)	16.7 (6)		$p = 0.037$
Deflection roots	10.8 (11)	12.1 (7)	5.9 (2)		
Narrowing—roots	0	8.6 (5)	8.3 (3)	$p = 0.017$	

diographically, from the nerve canal but have not erupted or required extraction (Fig. 3).

Discussion

We found that the inferior alveolar nerve was often injured by extraction of third molars, the roots of which were superimposed radiographically on the nerve canal. This is similar to previous results.[1,4,11] Most of these injuries were temporary but two were permanent both of whom were treated by traditional operation. We found evidence that some radiographic signs may be more predictive of nerve injury than others. These include deviation of the canal at the apex and the presence of the juxta-apical area. This new radiographic sign is a well-circumscribed radiolucent area lateral to the root rather than at the apex. These observations concur with those of a previous study that described one of the radiographic features associated with nerve damage to be deviation of the nerve canal.[11]

The incidence of dry socket was similar in all groups (10—12%). This is higher than previously reported and may be related to the selection of patients, with a high proportion of difficult and deeply-impacted teeth with pericoronitis. During a mean follow up of 25 months, there was no report of periapical infection associated with retained roots. There was some radiological evidence to suggest that five root fragments were starting to migrate from the nerve canal. Case reports have suggested that it can take up to 10 years for the root fragments to erupt, but the advantage is that they can then be removed easily under local anaesthesia without risk to the nerve.[28]

The follow up after coronectomy of 25 months is sufficient to evaluate the incidence of nerve injury, dry socket, and early eruption, but not of late eruption, which can occur up to 10 years after the initial operation.[27] A longer review period may therefore show that a proportion of these retained roots do eventually erupt and may cause a late infection or require removal. One possible advantage, even if second operation is required, is that unless the root is perforated by the IAN, it is likely to erupt away from the nerve, so reducing the potential of nerve injury during the second operation.

Factors that predicted failure of coronectomy included women with conically-rooted teeth that narrowed within the nerve canal. The decision to remove the mobile roots was based on the premise that they had lost their vitality and therefore had an increased susceptibility to infection.

We conclude that, in patients judged to be at risk of iatrogenic injury to the inferior alveolar nerve, coronectomy reduces the chance of injury with no adverse effect on morbidity. However, coronectomy may be complicated by inadvertent mobilisation of the roots during decoronation of the tooth. Women with conically rooted third molars that narrow within the nerve canal are more at risk of failure of coronectomy. There is also evidence that specific radiographic features may indicate proximity of the nerve, including deviation of the canal in association with crossing the canal and one that has not previously been described, the juxta-apical radiolucency.

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INTERESTING CASE: An unusual fracture of the angle of the mandible

There have been several extensive reviews of mandibular fractures, which have classified fractures according to their anatomical location. Our case is unusual, and to our knowledge there have been no previous reports of angle fractures solely below the inferior alveolar nerve and not involving the alveolar segment.

The medial pterygoid muscle presumably distracted the fractured bone segment both medially and superiorly. There was no mental parasthesia as the fracture line was inferior to the mandibular canal, or occlusal derangement as the alveolar process was not involved.

Figure 1 Orthopantomogram showing unusual fracture pattern with overlapping segments of bone (arrowed).

Figure 2 Postero-anterior view showing loss of mandibular angle.

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